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Cognitive and Academic Functioning of Hyperactive Children

BY

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled COGNITIVE AND ACADEMIC FUNCTIONING OF HYPERACTIVE CHILDREN submitted by Glennis A. Liddell in partial fulfillment of the requirements for the degree of DOCTOR OF PHILOSOPHY.

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DEDICATION

This thesis is dedicated

to my sons

Arlin and Kelsey

ABSTRACT

Relationships between hyperactivity and performance on selected cognitive and academic variables were studied for 267 non-referred children of average or above average intelligence ages 7-0 to 8-11 years. These relationships were studied with various groupings of subjects as well as with hyperactivity as a continuous variable. Group comparisons included hyperactive academically achieving/hyperactive delayed/non-hyperactive delayed/non-hyperactive achieving children for both reading and arithmetic skills. Comparisons were also made for hyperactive children with and without conduct problems. Hyperactivity was measured by T-scores from the Conners Teacher Rating Scale. Cognitive skills were studied in the areas of Full Scale IQ, Verbal IQ, Performance IQ, Verbal Comprehension Factor, Perceptual Organization Factor, Third Factor and four memory measures. Academic skills for reading were studied in word analysis, word recognition, comprehension and rate. Academic skills for arithmetic were studied in the areas of content, operations, and applications. The results did not suggest an academically typical hyperactive child. Level of hyperactivity did not strongly predict level of either reading or arithmetic achievement. For the most part, the hyperactive children were similar in their pattern of academic skills development in both reading and arithmetic to the non-hyperactive achieving children. Reading word recognition skill, however, was an area of relative deficit for hyperactive children. A greater percentage of hyperactive children had arithmetic delay than had reading delay. The hyperactive

arithmetic delayed group was poorer verbally, poorer in visual memory, and were extremely weak in WISC-R Third Factor scores. These findings were generally in concurrence with other studies of non-referred children and suggested that only limited generalizations can be made from studies of clinic-referred children to the more general population of hyperactive children.

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Chapter I

Introduction

Hyperactive children are characterized by excessive physical activity, poor attention, and diminished impulse control (American Psychiatric Association, 1987): these characteristics are thought to interfere with their successful functioning in both social and academic settings. Long-term studies have now established that the impact of hyperactivity, once thought to diminish in early adolescence, persists at least into early adulthood (Barkley, Fisher, Edelbrook, & Smallish, 1990; Klein & Mannuzza, 1989). Further, these studies have shown that while some of the characteristics of hyperactivity such as excessive motor activity may decrease with age, poor academic functioning for this group continues. Hyperactivity is associated with more grades failed, higher drop-out rates and poorer grades in school (Klein & Mannuzza, 1991; Weiss & Hechtman, 1986). More specifically, a rate of 58% has been cited for hyperactive children who have failed at least one grade in school (Brown & Borden, 1986). The prevalence of hyperactivity is typically estimated at 3 to 6% of the school -aged population. Since this roughly translates into at least one hyperactive child per classroom it is little wonder that there is widespread concern at both the home and school level concerning effective educational programming for the hyperactive child.

Curiously, in spite of widespread concern regarding the academic performance of hyperactive children, research with a specific educational focus has been relatively scant. Tasks studied have frequently been laboratory rather than classroom ones, educational measures have frequently lacked breadth, educational tasks have often been the outcome measure of an educationally unrelated treatment rather than the focus of the study, and there has been a general failure to link cognitive functioning with academic functioning in specific academic areas such as reading and arithmetic. Few studies have investigated specific skill development within the reading area; even fewer have investigated arithmetic skills. Academic measurement has frequently focused on one skill area such as word recognition to the exclusion of related skills such as reading comprehension. Since different academic skill areas are often dependent upon different cognitive skills, this oversight obscures theoretical as well as practical advancement in the understanding of appropriate educational interventions for hyperactive children.

A further problem has been the lack of recognition in research of the hetrogeneous nature of the hyperactive population. Of particular interest is the overlap of the hyperactive population with both the learning disabled and conduct problem populations. While this overlap is acknowledged in theoretical discussions (Cantwell & Baker, 1991) there is all too often lack of follow-through in experimental work. Thus, most hyperactivity research represents an averaging of results from diverse groups of children which does not facilitate the understanding of cognitive functioning nor the planning of differentiated academic interventions for specific groups of hyperactive children.

As well, nearly all of the hyperactivity research has been with clinic-referred subjects. Recently there has been acknowledgement that these referred children may represent an extreme end of the hyperactivity continuum (Epstein, Shaywitz, Shaywitz, & Woolston, 1991) and as such may limit the extent to which conclusions for this group can be generalized to the hyperactive population as a whole. One of the most obvious differences between clinic-referred and non-referred populations of hyperactive children is the matter of gender. Clinic-referred studies are almost exclusively of boys. Since hyperactive girls may differ behaviourally, cognitively, or academically from hyperactive boys (Ackerman, Roscoe, Dykman, & Oglesby, 1983; Berry, Shaywitz, & Shaywitz, 1985; deHaas & Young, 1984; James & Taylor, 1990; Szatmari, Boyle, & Offord, 1989), the validity of generalizations made from cognitive and academic findings from male only studies to hyperactive girls is questionable.

There is a need for an investigation of the cognitive and academic functioning of non-referred hyperactive children with a research design that takes into account the hetrogeneous nature of this population. Results of such an investigation would potentially enable a more specific description of academic functioning, lead to a better understanding of relationships between cognitive and academic skills for this group, as well as highlight cognitive/academic differences between hyperactive children, normal children, and children with learning problems. Further, a comparison from within the hyperactive group of cognitive and academic skills for achievers and non-achievers could make a contribution to the theoretical understanding of subtypes of hyperactive children which is necessary before appropriate academic programming is implemented.

The present study included an examination of the relationships between hyperactivity and a number of cognitive and academic variables. Specific patterns of academic skill functioning were examined in both reading and arithmetic. Relationships between performance on cognitive and academic variables were examined and compared for various groupings of subjects. Subject groupings included hyperactive children with and without conduct problems, hyperactive children with and without learning problems, and hyperactive/learning problem/normal children.

Chapter II

Selective Review of the Literature

Hyperactivity: Terminology, Measurement, Prevalence

Terminology.

The term "hyperactive" has both singular and plural interpretations. In the singular application of the term it refers to excessive motor activity: in the plural it describes a cluster of associated behaviours sometimes referred to as a syndrome or disorder. These behaviours describe a child who typically is restless and fidgety, who has trouble waiting for a turn, who is easily distracted, and who is a poor listener. Such behaviours are not exclusive to the hyperactive child: taken individually they could, for example, also describe a preschool child, a child with behaviour problems, a mentally retarded child (Taylor, 1986) or a brain injured child (Boling, 1984). Since each behavioural characteristic taken separately could equally describe another population, the key to hyperactivity is the corporate association of the group of behaviours that together are felt to describe hyperactive children.

Whether or not these behaviours are sufficiently distinctive to warrant a valid group has been debated (eg. Aman, 1984; Holborow & Berry, 1985; Prior & Sanson, 1986; Rubenstein, & Brown, 1984; Shaywitz, 1979; Trites & Laprade, 1983). However, the "realness" of the hyperactive child has been apparent to thousands of parents, clinicians, teachers, and researchers. According to Henker and Whalen (1989, p.216), even peers can describe the hyperactive child in the classroom: he "can't sit still, doesn't pay attention, messes around and gets in trouble, is rude, and tries to get others in trouble". At this point in the literature there is general agreement that although the final definition of the construct has yet to be determined, hyperactive children are a distinct group: further, it is recognized that careful subject selection that takes into account the overlap with learning problem and conduct problem groups of children is critical for valid research (Aman, 1984; Epstein, Shaywitz, Shaywitz, & Woolston, 1991; Fletcher, Morris, & Francis, 1991; Weinberg & Emslie, 1991).

The three key features associated with hyperactivity are overactivity, inattention, and impulsivity. Their relative importance and exact relationship has yet to be determined.

Early descriptions of the hyperactive syndrome focused on excessive motor activity as the core symptom (Aman, 1984). Hyperactivity, in the singular sense of the term, is manifested in a number of ways including constant fidgeting, excessive talking, and having difficulty remaining still for expected periods of time - such as remaining seated at a desk in school.

The central issue regarding hyperactivity has not been its presence, since numerous studies have documented differences in motor activity between hyperactive children and controls (including Porrino, Rapport, Bechar, Sceery, Ismon, & Bunney, 1983; Prior, Wallace & Milton, 1984; Schworm & Birnbaum, 1989), but rather in how to interpret this. There has been debate about whether or not overactivity should be viewed as a primary or a secondary symptom (Fleisher, Soodak & Jelin, 1984). Findings that learning disabled children may present as much overactive behaviour in the classroom as hyperactive children (Schworm, & Birnbaum, 1989) has prompted the theory that perhaps learning problems cause the restless behaviour rather than the reverse (McGee & Share, 1988). Many implications stem from this question of cause and effect since the selection of the primary symptom obviously makes considerable difference to the first line of treatment that will be explored. There has also been the interpretation that the critical component is not the amount of activity, but the fact that it is inappropriate activity (Barkley, 1981; Kalverboer, 1988; Ross & Ross, 1982; Sergeant & Scholten, 1985) and, again, this has implications for treatment.

A second key characteristic is inattention. Unlike motor activity which can be directly observed, inattention is a matter of inference. Thus, while descriptors such as "inattentive, lacks concentration" are frequently used, the definition of these in objective behavioural terms is difficult. Failing to carry through on tasks and seeming not to listen have been taken as indicators of inattention (DSM-III, 1980). Inattention has frequently been studied in terms of laboratory tasks but, as will be later detailed, there has not been agreement concerning the ability of laboratory tasks to satisfactorily measure what is meant by the term "inattention". An additional area of controversy has been debate concerning the theoretical and practical possibilities of attention problems existing without hyperactivity (Carlson, Lahey & Nieves, 1986; Hynd, Lorys, Semrud-Clikeman, Nieves, Huettner, Lahey, 1991; Lahey, Hynd, Stone, Lahey, Hynd, Stone, Picacentinti, & Frick, 1989; Weinberg & Emslie, 1991). This line of research was influenced by the finding that the Inattentive Factor from the Conners Teacher Rating Scale was often as sensitive as the Hyperactivity Factor in selecting hyperactive children (Campbell, Endman, & Bernfield, 1977; Werry & Aman, 1984). Also influential here in highlighting inattention as the critical feature was the extensive research on attention carried out by Douglas and her associates in Montreal (1978, 1980, 1983). However, recent research appears to indicate that children who experience attention problems without hyperactivity have a differing etiology and require different treatment from children who are hyperactive (Barkley, 1989; Lahey & Carlson, 1991; Weinberg & Emslie, 1991) and this group of children is no longer classified with hyperactive children in the most recent edition of the Diagnostic and Statistical Manual of Mental Disorders (1987).

Another key characteristic is an impulsive style of responding (Cantwell & Satterfield, 1978; Kuehne, Kehle, & McMahon, 1987). Impulsivity is thought to be evidenced by behaviours such as having trouble waiting for turns in games, blurting out answers before the question is completed, and shifting frequently from one uncompleted activity to another. Again impulsivity has been rather difficult to define psychometrically. For the large part, impulsivity has been measured by performance on the Matching Familiar Figures Test. However, there has been considerable criticism of the psychometric properties of this test (Block, Block, & Harington, 1974; Prior & Sanson, 1986). Poor visual scanning and errors in recall have also been considered as measures of impulsivity (Thompson, Fearn, & Eliot, 1983).

Terminology in this area has not been consistent over the years. More recent terms have included "hyperkinetic reaction of childhood" (DSM-II, 1968), "attention deficit disorder" (with and without hyperactivity) (DSM-III, 1980), and "attention deficit hyperactivity disorder" (DSM-III-R, 1987). "Attention problems," "hyperactivity" and "attention deficit disorder" are often used interchangeably (Dworkin, 1985). Hyperactivity has also been associated with "minimal brain damage" (Blashfield, 1984), a term also applied to learning disabilities (Wender, 1971). In order to achieve some consistency of terminology within this review, the term hyperactivity will be used throughout to represent those children exhibiting the "syndrome" or group of previously discussed behaviours. Studies discussed will be those which included hyperactivity as a criteria for subject selection. As well, since the hyperactivity literature contains many references to the conduct problem population, also an area of diverse terminology, the term "conduct problem" will be used throughout to refer to studies of children variously called "conduct problem", "aggressive", or "conduct disordered".

Measurement of Hyperactivity.

How can hyperactivity in the collective sense of the term best be measured? When is activity level "too much"? These are difficult questions to answer. Differing measurement systems have been used in hyperactivity research.

Many clinic studies with a strong base within the medical model have used the criteria set out by the American Psychiatric Association. Currently this requires eight of fourteen behaviours to be present before the diagnosis of hyperactivity can be made. Since this is essentially a model of deviance, hyperactivity is regarded as pathology (Glow and Glow, 1984) and, like a disease, is seen as either present or absent.

The other approach to measurement is based within the dimensional or quantitative model and views hyperactivity as conceptually existing on a continuum upon which all children may be placed (Quay, 1976). The question becomes not "is the child hyperactive or not?" but "to what extent is the child hyperactive?". This approach utilizes questionnaires to gather information and cut-off points are statistically established to designate hyperactivity levels which exceed average. The most widely used scale in research for assessing hyperactivity has been the Conners' Teacher Rating Scale (Ackerman, Dykman, Oglesby, 1983; Sandberg, 1986). As seen in Table 1 , there is an area of considerable overlap between critical items from the Conners Teacher Rating Scale and the DSM-III-R.

TABLE 1

Comparison of Conners Teacher Rating Scale and DSM-III-R Items to Describe Hyperactivity

CTRS items loading highest on Hyp.Factor (Trites, Blouin, Laprade, 1982)		DSM-III-R items	
Restless	.85	Often fidgets..in adolescents may be limited to feelings of restlessness	1
Constant fidgeting	.84		
Inattentive, easily distracted	.80	Easily distracted by external stimuli	3
Disturbs other children	.78	Often interrupts or intrudes on others eg. butts into other children's games	11
Excitable, impulsive	.74		
Hums & makes other odd noises	.69		
Fails to finish things she starts-short attention span	.66	Difficulty sustaining attention on tasks	8
* Loadings on Hyp. Factor		* Placement on list of 14 items listed in descending discriminatory power	

Since a critical element of "hyperactivity" in the collective sense of the term is that the core characteristics appear together in a child, it is important that the behaviours be highly correlated in the system of measurement. Sandberg (1986) in a study of 226 boys looked at the association between the six items from the CTRS most closely related to the core characteristics. There was a good level of association between children rated by their teachers as overactive and those rated either as impulsive (kappa=0.71) or inattentive (kappa=0.50).

Prevalence.

Most estimates of the number of hyperactive children in the school-aged population fall between 3% (American Psychiatric Association, 1987) and 5% (Weiss & Hechtman, 1986). Although less common, there are estimates of rates as high as 10% (Schecter, 1982; Voeller, 1986).

The ratio of males to females is estimated to be 2 to 4 hyperactive boys for every hyperactive girl (Erikson, 1987). However, the ratio is higher in clinic-referred populations where typically the male:female ratio is 6:1 (Ingersoll, 1988) and has been cited to be as high as 9:1 (Barkley, Fisher, Edelbrook, & Smallish, 1990).

Heterogeneity of Population

Although the hyperactive population has often been treated in research as a homogeneous group, this appears very inappropriate. In particular, there is overlap with both conduct problem and learning disabled populations. Subject selection, then, becomes a key issue in research. Increasingly there have been calls for more heterogeneous groupings of subjects and, in particular, research that documents the effects of "pure hyperactivity" as distinct from conduct or learning problems. (Cantwell & Baker, 1991; Fletcher, Morris, & Francis, 1991).

Overlap with Conduct Problems.

At the behavioural end of the continuum, the hyperactive child shares problems in disruptive behaviour with the overly aggressive child variously referred to as "conduct disordered", "aggressive", "anti-social' or as having "conduct problems" (Hynd & Lewis, 1988; Loney & Milich, 1982; McGee, Williams & Silva, 1985; Prinz, Connor & Wilson, 1981). The extent of the overlap has been estimated to be anywhere from 40% to 75% (Loney & Milich, 1982; Stewart, Cummings, Singer & DeBlois, 1981; Szatmari, Boyle, & Offord, 1989).

Much of the research in this area has been factor analytic aimed at deciding whether or not children with hyperactivity and conduct problem children could be discriminated on the basis of questionnaires. An extensive review by Hinshaw (1987) indicated that the majority of studies (41 of 60) found hyperactivity and conduct problems/aggression to be distinct factors: this was true across ages and true of both clinic referred and non-referred populations. A trend was observed in publication dates of research with more recent studies more likely to find distinct factors. Considerable evidence exists, then, to validate the concepts of hyperactivity and conduct problems as separate although often overlapping diagnostic entities (Hynd & Lewis, 1988). In actual practice the behaviours are so highly correlated that they are often not easy to differentiate (Rutter, 1983). However, this distinction is a necessary one to make if valid conclusions are to be drawn and appropriate interventions prescribed.

While behavioural observations made during academic tasks have been reported to differentiate hyperactive from both hyperactive aggressive and aggressive only boys (Roberts, 1990), only limited research has investigated possible cognitive and academic differences between the two groups. This appears to be an important omission. Since poor school performance has been associated with conduct problems (Atkins, Pelham & Light, 1989), a possible confounding factor in studies which have investigated the academic performance of clinic-referred hyperactive children may be the presence of children with conduct problems. Selected studies of academic-cognitive performance for the two groups are presented in Table 2.

TABLE 2

Academic -Cognitive Differences between Children with Hyperactivity and Conduct Problems: Representative Studies

Researcher	Subjects	Measure	Results
Forness, Cantwell Swanson, Hanna & Youpa, 1991	CR Boys N=27	WISC-R WRMT Keymath PIAT	No diff.HYP/ HYP-CP on WISC-R or Arith. HPY> HYP-CP in RDG.
Frost Moffit McGee, 1989	NR Boys & Girls N=678	WISC-R Neuro-psych battery	HYP lower than CP on VIQ; HYP verbal mem. deficit
Goldstein 1987	NR Boys & Girls N=7119	WRAT	HYP & HYP-CP not sig. different Rdg/ Arith.
Lahey, Green, Forehand, 1980	NR Boys & Girls N=109	MAT	CP & HYP both sig.neg. correl.with Rdg. HYP not CP sig.correl. arith.
Levy Hobbes, 1989	CR Boys N=51	WISC-R CPT	HYP lower than CP on IQ, vigilance
Werry Elkind, Reeves 1987	CR Boys & Girls N=190	Burt Rdg. MFFT, CPT PPVT	No diff H/CP on word reg. No diff. MFFT or CPT HYP < N on PPVT HYP & CP sig diff from N

CR Clinic Referred HYP Hyperactive
NR Non-referred CP Conduct Problem

In terms of IQ, there are conflicting reports both concerning the comparison of the cognitive skills of conduct problem children to normal children and that of conduct problem children with hyperactive children. In a review of this subject, Werry, Reeves, and Elkind (1987) report weak and conflicting evidence that hyperactive and conduct problem children compared with normal children may be of lower intelligence particularly in verbal skills. The results of a four year follow-up study of 34 hyperactive boys and 42 hyperactive and conduct problem boys (August, Stewart, & Holmes, 1983) showed the hyperactive only group with a mean Full Scale IQ of 92 points to be somewhat lower than the mixed hyperactive-conduct problem group with a mean Full Scale IQ of 97 points. The statistical significance of this was not reported.

In general, hyperactive children appear to exhibit more cognitive and academic deficits than children with conduct problems. However, the findings are scant as well as discrepant. It is difficult to make inter-study comparisons because of diverse instrumentation as well as subject selection. In the selected studies summarized in Table 2, for example, three different standardized instruments were used to classify subjects as well as one non-standardized instrument. It is particularly unfortunate that the non-standardized instrument was used in the large study of non-referred children (Goldstein, 1987) since this study would be of potential value because of its combination of academic results and a large sample which included both girls and boys. Many studies in this area have been of males only from a clinic referred population. Since clinic populations may well contain a higher percentage of conduct/aggressive children who are also hyperactive (Hinshaw, 1987) generalizations from this population to all hyperactive children may well contain faulty conclusions.

Overlap with Learning Disabilities.

At the cognitive end of the continuum there is overlap in the cognitive and academic deficits evidenced by both learning disabled and hyperactive children.

Estimates of the degree of overlap between hyperactivity problems and learning disorders vary in magnitude depending upon the definitional criteria and instrumentation used for subject selection. Typically findings report that from one-third to one-half of hyperactive children also have a learning disability (Berry, Shaywitz, & Shaywitz, 1985; Dykman & Ackerman, 1991; Holborow & Berry, 1986; Lambert & Sandoval, 1980). Silver (1986) reported that 15% to 20% of children with learning disability also have attentional problems. However, there is no consensus about how to interpret this overlap. The varying interpretations include learning and hyperactivity viewed as two discrete disorders which share poor attention as a common feature (Douglas, 1983; Spreen Tupper, Risser, Tuokko, & Edgell, 1984); learning disorders as a subset of hyperactivity (Halperin, Gittleman, Klein, Rudel, 1984); and poor attention viewed as a consequence of poor academic skill (Fleisher, Soodak & Jelin, 1984). Those who view the two groups as discrete believe that while presenting symptoms of the groups are sometimes similar, the underlying causes are different. Douglas (1980), for example, believes that hyperactive children have inborn predispositions to problems in impulse control, sustained attention and modulation of arousal levels while learning disabled children are seen as having constitutional problems in areas such as receptive language or visual processing. A similar distinction is made by Kinsbourne and Caplan (1979) who describe the learning problems of learning disabled children as "selective cognitive developmental disorder" - problems in process which may be traced to uneven brain maturation. Hyperactive children, on the other hand, are thought to have problems in "cognitive style" which affect their ability to focus appropriately upon given information.

There have been attempts to discriminate hyperactive and learning disabled children on the basis of both task performance (as reviewed in subsequent sections) as well as upon theoretical construct. It is unclear at this point whether the academic problems co-exist with attentional problems because of an underlying neurological impairment which produces both, whether the poor academics result from poor attending, or whether cognitive style is the central explanation. The overlap in subject characteristics for these two groups creates problems for subject selection, for the generalization of research, and, ultimately, for the proper focus for intervention programs.

Clinic Referred/Non-Referred.

Overwhelmingly often subjects for hyperactivity research have been selected from clinic referred populations. Until recently the main perspective was from within the medical model which views hyperactivity as pathology (Glow & Glow, 1984). However, the growing influence of the quantitative model which views hyperactivity as a continuum upon which all children may be placed (Quay, 1976; Sergeant, 1988) has resulted in more studies of a non-referred population. Because there are so few studies in this area, the main studies will be summarized.

August and Garfinkel (1989) selected 83 males and 12 females from an elementary school populations of 1,038 on the basis of the Hyperactivity Index from the 28 item revised CTRS using a cut-off point of 2 standard deviations above the population mean. These hyperactive children were further divided on the basis of WRAT Reading and Spelling scores into 2 hyperactive only groups (mild and severe) and 1 hyperactive/reading problem group. There was also a normal control group. The test battery was the Detroit Tests of Learning Aptitude-2 (DTLA-2), the Continuous Performance Test (CPT) and the Matching Familiar Figures Test. Results indicated (1) approximately 20% of the hyperactives also had reading problems (2) short-term memory skills were equally impaired for both the severe hyperactive only group and the hyperactive/reading problem group with the mild hyperactive group performing more like the control group (3) the mild hyperactive group was more cognitively similar to the normal group than to the other two groups (4) on measures of impulsivity and planning, there was a continuum of responses ranging from the poorest performance by the hyperactive/reading problem group to the best performance by the control group and (5) the hyperactive/reading problem group were reported to be weaker in verbal-linguistic skills based on poorer performance on the Word Opposites subtest of the DTLA-2 and on the CPT. Although the CPT is more commonly interpreted as measure of attention, poorer performance here was attributed to difficulty making the rapid and accurate sequential letter discriminations required of this test. However, if the lower performance on this test was attributable to this, it is a bit surprising that performance on the Letter Sequence subtest of the DTLA-2 was also not significantly weaker since sequential letter identification skills are also required here. As well, if verbal-linguistic skills were weaker for the hyperactive/reading problem group, lower performance on the Sentence Imitation subtest of the DTLA-2 might also have been expected since this test measures linguistic development along with memory (Wiig & Semel, 1980). On both of these subtests the performance of the hyperactive/reading problem group was weaker than the normals and mild hyperactive only group but not significantly weaker than the severe hyperactive only group. Logically, then, if verbal-linguistic deficits are the explanation, they must also be applied to the severe hyperactive only group which was not poor in reading. It is unfortunate that the WISC-R was not used as well in this study as this would have supplied process information more universally studied and interpreted than that of the DTLA-2 which is most often used as an additional, rather than prime, source of processing information.

McGee (1984, 1985, 1988, 1989) was the primary researcher in a longitudinal study conducted in New Zealand of 1037 birth cohorts. One of the questions studied was the behavioural and cognitive characteristics of hyperactive children with attempts made to differentiate between children with hyperactivity and conduct problems/ hyperactive only children/ children with reading problems.

Hyperactivity was measured by the Rutter Child Scales (Rutter, 1967).

The test battery at age 7 consisted of the Burt Word Reading Test(1976), the WISC-R, and two subtests (auditory reception, verbal expression) from the ITPA. Results were reported for boys only with the groups consisting of 18 hyperactive only boys, 21 conduct problem only boys, 24 hyperactive and conduct problem boys and 426 control boys. The results showed (1) the hyperactive and conduct problem group to be lower in reading (2) no difference in either Verbal IQ or Performance IQ between the hyperactive only and hyperactive and conduct problem groups.

The test battery at age 13 consisted of the WISC-R and a neurological battery of 7 tests including the Trail Making Test and the Rey Auditory Verbal Learning Test. Since hyperactivity was found to be associated with lower Performance IQ, it was felt necessary to control for Performance IQ differences. Therefore, group were selected on the basis of reading performance as well as performance IQ. Comparisons were made between 12 reading problem boys, 13 hyperactive and reading problem boys, 12 hyperactive only boys, and 62 controls. The results showed: (1) the two reading problem groups had lower verbal IQ than the hyperactive only and control groups (2) the two reading problem groups were lower on the Rey Auditory Verbal Learning Test and (3) the hyperactive children were reported to have somewhat lower IQ's.

The groups of subjects here are excellent ones since they compare reading problem only, hyperactive only, and hyperactive and reading problem children. Considering the careful attention to heterogeneous subject groupings, it is rather unfortunate from a psycho-educational point of view that the test battery was not more informative concerning academic skill functioning. Only word recognition skill was measured for reading which is an extremely limited picture of reading ability. As well, no arithmetic or spelling testing was done. Even the generalizability of the WISC-R information was limited because two subtests, Comprehension and Picture Arrangement, were not administered because of time constraints. This affects the generalizability of both the verbal and performance IQ findings and also rules out computations of WISC-R Factor scores which would have been an area of potential interest. Since the battery here was a neuro-psych battery, the main finding that hyperactive only children performed more like normals than like either of the reading problem groups must be tempered with the addition of " on this particular group of tests". There is not the possibility here of comparing findings in the memory and verbal naming areas which have been found to be of interest in other comparisons of reading problem and hyperactive children such as the non-referred population work of Fenton and Wood (1989) and the clinic-referred work of Ackerman, Anhalt, & Dykman (1986).

Few clinic-referred population studies have been carried out using the hyperactive only /hyperactive plus learning problems/learning problems only comparisons utilized by McGee. One such study by Ackerman, Anhalt, & Dykman (1986) found memory skills to differentiate the groups. They did not generally find, as did McGee, that the hyperactive only group was more like the normal group than any other group. However, a flaw in the study was the inadequate control of level of hyperactivity: hyperactivity, as measured by the Hyperactivity Index score of the CTRS, was higher for the reading groups than for the normal group.

Because of the scarcity of studies making comparable groupings of children as well as the lack of standardization in measures, it is difficult at this point in research to draw conclusions about differences between clinic and non-referred populations. However, the general impression is that non-referred hyperactive populations may not be as severely deficit in as many areas as clinic-referred populations. This would be logical since children with a greater degree of problem would naturally be the ones referred for help. As well, it appears that children from clinic-referred populations may present with more multiple problems so that the nature of deficit as well as extent of deficit may differ from non-referred children (Epstein, Shaywitz, Whaywitz, & Woolston, 1991; Werry, 1988). A third source of variance between the two populations is that of gender differences since hyperactive clinic populations are predominantly male. However, there is research that indicates critical differences between hyperactive boys and girls in academic and cognitive performance (Ackerman, Anhalt, & Dykman, 1986; Ackerman, Roscoe, Dykman, & Oglesby, 1983; Berry, Shaywitz, & Shaywitz, 1985; James & Taylor, 1990) and this line of research is currently being extended.

Cognitive Functioning

Attention.

Although for a time hyperactive children were classified as "attention deficit" with the core characteristic thought to be inattention, the attention research has not produced strong and consistent findings.

Part of the problem arises from the theoretical construct "attention". Attention has been metaphorically described as "power", "capacity" and "state" and has been thought of variously as the energy to perform cognitive tasks (Swanson, 1987), the capacity to focus awareness (Reid and Hresko, 1981,) and the concentration of mental effort (Solso, 1979). According to Berlyne (1970), "perhaps the most serious obstacle to progress in the study of attention has been the confusion between a number of quite distinct phenomena to which the term attention has been applied. These phenomena are distinct in the sense that any one of them could occur without the others and that they could well depend on different variables and laws (p.28). At the other extreme, criticism has also been levelled that the common laboratory tasks used to study attention are all intercorrelated and fail to yield sufficient differential information (Werry, Elkind, & Reeve, 1987). As well, interpretations of attention task results are difficult because: (1) attention processes must largely be inferred from task performance on various measures (2) it is difficult to separate attention from other cognitive processes including memory and information processing strategies (Lovejoy & Rasmussen, 1990).

Three types of attention have been studied: sustained attention, selective attention, and, less frequently in the attention deficit disorder research, divided attention.

As seen in Table 3, findings here are diverse and somewhat confusing. Although there is general concensus that hyperactive children experience problems in sustained attention compared with normal children, there is not unanimity of findings (Prior, Sanson, Freethy, & Geffen, 1985; Van der Meere & Sergeant, 1988). As well, some research has indicated that hyperactive children may perform as well as normal children when close external supervision is present (Draeger, Prior, & Sanson, 1986).

TABLE 3

Representative Studies in Sustained and Selective Attention

Study	Subjects	Results
Sustained attention		
Sacher, Logan,	LD/HYP/CP/N	no difference
Wachsmath & Chajczyk, 1988		
Douglas (1983)	mainly HYP/N	HYP deficit
Tarnsowski, Prinz & Ney (1986)	HYP/LD /N	HYP deficit
Swanson (1980)	LD controlled for HYP/ N	LD deficit
Chee, Logan, Schachar, Lindsey & Wachsmuth 1989	HYP/CP HYP & CD/ N	HYP more deficit than HYP & CD; HYP groups poorer than others.
Seidel & Joschko	HYP/N	HYP poorer
Selective attention		
Aman & Turbot (1986)	HYP/N	HYP deficit 1 task, not another
Douglas(1978)	review of 11 HYP studies	no deficit
Tarnowski, Prinz & Ney (1986)	HYP/LD	LD deficit on 1 task; LD&HYP on another.

HYP Hyperactive　　CP Conduct Problem
LD Learning Disabled　　N Normal

Findings regarding children with learning problems have not been clear. "ALthough there is widespread belief that learning handicapped youngsters suffer from impairment in selective attention, a critical review of research in this area suggests this belief is, at best, an oversimplification" (Krupski, 1986, p.187). Selected research findings as presented in Table 3 gives some indication of the findings. Given the diversity of tasks, the difficulties in operationalizing the attention construct, and the lack of stringent subject selection in delineating learning disabled and hyperactive groups, it is not very surprising that the results are inconclusive.

Findings regarding the attention performance of conduct problem groups has also been inconclusive (Aman & Turbot, 1986; Schacher & Logan, 1990). There appears at the present time to be no firm basis upon which to differentiate hyperactive and conduct problem groups on the basis of attention performance on laboratory tasks.

In summary, there has been disagreement concerning which aspects of attention are deficit for hyperactive children or in how their performance on attention tasks differs from conduct problem and learning disabled children. It appears that hyperactive children do have difficulties in sustaining attention although they may share this difficulty with learning disabled children. Recent research using evoked potentials has supported the idea of difficulties in sustained attention for hyperactive children (Klorman, 1991). Learning disabled children, on the other hand, appear to have relatively more problems in selective attention when certain types of task are used. Overall, not only are the findings in the area of attention task specific, but there is no single theory of attention to explain the diverse findings (Felton & Wood, 1989; Borcherding, et al, 1988).

Memory.

Memory tests frequently used have included the memory/attention measures from the Detroit Test of Learning Aptitude, short-term memory subtests from the Weschler Intelligence Scale for Children-Revised, and various experimenter devised free recall measures.

One hypothesis in memory research has been that a modality distinction exists between hyperactive and normal children and there has been limited support for this view. Sutter, Batten, and Bishop(1987), for example, found this distinction when comparing the auditory and visual memory/attention tasks from the Detroit Test of Learning Aptitude with poor performance on auditory rather than visual tasks most strongly discriminating hyperactive children from normal children. Other research using the ITPA Visual Sequential Memory test (Carlson, Lahey, & Neeper, 1986) found hyperactive children to perform as well as controls in visual memory. As well, in recall of high imagery words where supposedly visualization would have played a part, hyperactive were found to perform as well as normal children (Ackerman, Anhart, Dykman, & Holcomb, 1986) .On the other hand, hyperactive children performed more poorly than controls using an adjustment of the WISC-R Coding subtest so that it became a measure of incidental visual memory (Lufi & Cohen, 1985). Since memory tests frequently differ in stimulus presentation as well as mode of response required, further experimentation is necessary using comparable tests. Behavioural observation has found that hyperactive children show better attention than learning disabled children when engaged in visual tasks (Schworm & Birnbaum, 1989). Free recall but not memory recognition tasks have been found to discriminate hyperactive children from normal children (August, 1987; Borcherding, Thompson, Krueski, Bartko, Rapoport, & Weingartner, 1988). This finding has generally been interpreted within the automatic/ effortful distinction where recall is seen as effortful, conscious, intentional and highly affected by subject control, mood,and state of arousal-the latter being factors identified by Douglas (1983) as highly significant to hyperactive performance. As tasks become more familiar with practice, they become automatic and this is thought to free more attentional resources for nonautomatic, effortful tasks.

Additionally, there is some evidence that by manipulating task conditions so that a strategy is "forced" on the subjects as when the subjects are required to categorize memory items before recall, the memory performance of hyperactive children is improved (August, 1987; Voelker, Carter, Sprague, Gdowski, & Lacher, 1989). This along with the finding that hyperactive children were similar to normal children in their knowledge, but not use of memory strategies (Voelker et al, 1989) suggests a memory production rather than skill deficiency.

A finding of production deficiency for hyperactive children may distinguish them from normal children in memory processes, but it is little help in distinguishing them from learning disabled children who have been extensively documented as having memory production problems (Dallago & Moely, 1980; Hallahan & Sapona, 1983; Torgesen, Murphy, & Ivey, 1979; Wong, Wong & Foth, 1977). In the limited number of studies that have attempted to pinpoint memory differences between hyperactive and learning disabled children findings have been inconclusive. Two studies that both used the Rey Auditory Learning Test as a memory measure found discrepant results (McGee, Williams, Moffit, & Anderson, 1989; Felton & Wood, 1989). In a comparison of recall following an orienting task, August (1987) found that hyperactive children did more poorly than either reading disabled or control children on a free recall task, but that all three groups performed similarly after performing a sorting task that provided organizational strategy. On the other hand, Ackerman, Anhalt, Dykman, and Holcomb (1986) found that a semantic and acoustic encoding task improved free recall for hyperactive and normal children, but not the learning disabled group. More studies are needed in this area in order to clarify findings.

More studies are needed along the lines of recent work by Douglas and Benezra (1990) that compared the memory performance of hyperactive, reading disabled, and normal boys under different tasks and conditions including recall and recognition tasks under immediate and delayed conditions as well as paired associate recall across repeated trials. They found that the reading disabled group did more poorly than controls on tasks that required verbal encoding and retrieval. The hyperactive group, on the other hand, did more poorly on tasks such as recall of paired associates over repeated trials that required employment of memory strategies along with sustained effort. Interestingly, while memory differences were found between the hyperactive and the normal group on the one hand and the reading disabled group and the normal group on the other hand, differences between the hyperactive and reading disabled groups were modest.

In summary, poor performance on effortful memory tasks appears to distinguish hyperactive children from normal children. It is not as clear how they differ, or indeed, if they differ, from learning disabled children on this dimension. Limited support exists for a modality distinction in memory with deficits in auditory, but not visual, memory possibly differentiating hyperactive from normal children. Theoretical efforts to explain this memory performance have largely been within the Hasher & Zacks (1979) framework which distinguishes between automatic and non-automatic effortful processes.

IQ Scores.

The Weschler Intelligence Scale for Children-Revised (WISC-R) has been widely used to investigate cognitive functioning in special populations. It would be reasonable to expect cognitive deficits of the hyperactive population to appear in some form of score scatter such as verbal IQ/performance IQ discrepancy or in differences in factor scores on the Verbal Comprehension, Perceptual Organization, or Third Factor. However, as in so many other areas of research with this population, the findings remain inconclusive.

The overall intelligence of hyperactive children has been reported as being lower than that of normal children (Weiss & Hechtman, 1986). This has been found with non-referred subjects (Carlson, Lahey, & Neeper,

1986) as well as clinic-referred subjects (Tarnowski, Prinz, & Ney, 86). These differences may represent a truly lower IQ, an acquired deficiency, or poor test taking skills. However, statements have also been made that no major intellectual problems exist for the hyperactive population (Hinshaw, 1987) and studies can be found that report no significant differences in overall IQ between hyperactive and non-hyperactive children (August & Holmes, 1984). Another variable to consider here that of gender differences since at least one study has reported the IQ of hyperactive girls to be lower than that of hyperactive boys (Ackerman, Roscoe, Dykman, & Oglesby, 1983). Since so much hyperactive research has been conducted only with boys, sex difference is a possible confounding variable in reporting of IQ results.

A reasonably consistent finding has been that lower verbal IQ but not performance IQ differentiates hyperactive from normal children (Borcherding Thompson, Krueski, Bartko, Rapoport, & Weingartner, 1988; Carlson, Lahey, & Neeper, 1986; Lahey, Schaughency, Hynd, Carlson, & Nieves, 1987). Interpretation of this IQ difference has ranged from seeing it as a source of variance that should be controlled (Schare & Schwartz, controlled (Schare & Schwartz, 1988) to viewing it as possibly an essential cognitive feature of attention deficit (Weery et al, 1987). McGee and Share (1988) say that lower verbal IQ for hyperactives is like the lower IQ found for children with reading problems and reflects the reading problem. Since verbal IQ is a measure of accumulated learning as opposed to the more fluid intelligence tested in performance IQ tasks (Sattler, 1982), differences for hyperactive children could also be considered as reflecting their inattentive behaviour in the classroom and similar settings. As such, it could be the consequence of a more basic deficit rather than an explanation for poor academic performance. To make the picture even more confusing, one study has reported lower verbal IQ for conduct problem children compared with normal children (Jurkovic & Prentice, 1977) so that the presence of conduct problem children in hyperactive groupings presents another possible confounding influence in IQ findings although obviously research is needed that directly compares the verbal IQ of hyperactive children with both conduct problem and reading problem groups.

A contrary finding in terms of verbal IQ has been reported by Voeller (1986) who worked with a sample of

15 children selected for evidence of right-hemisphere brain lesion. These children were found to be lower in performance than verbal IQ (with a difference that exceeded 15 points for 9 of them) and to have concomitant problems in arithmetic and interpreting social cues. Of these 15 children, 8 were found to follow DSM-III criteria for hyperactivity with a further 7 to follow the criteria for attention deficit without hyperactivity. Voeller hypothesized a link between right-hemisphere deficit and attention deficit disorder as defined in the 1986 edition of the DSM-III Manual. Although a right-hemisphere deficit is manifested in characteristics typically evidenced by the hyperactive population such as problems in attention and ordering certain information into coherent wholes (Brumback & Weinberg, 1990), there has been insufficient research to permit conclusions. Even with the Voeller study conclusions cannot be made about hyperactivity since the results for the 8 hyperactive children were not analyzed separately from the non-hyperactive children.

Finally, in factor analysis of WISC-R subtest scores, hyperactive children have been reported to be weak in their "Third Factor" scores compared with both

Verbal Comprehension Factor and Perceptual Organization Factor scores (Kirby & Grimby, 1986). The Third Factor has been reported to discriminate hyperactive from conduct problem children (Raine & Jones, 1987), non-learning disabled children with behaviour-emotional problems (Lufi & Cohen, 1985), children referred for school problems (Carter, Zeilko, Oas, & Waltohen, 1990) as well as from normal children.(Brown & Wynne, 1984; Sutter, Bishop, & Battin, 1987; Kinsbourne & Caplan, 1979). However, there do not appear to be any studies that directly compare the Third Factor scores of hyperactive and learning disabled children.

Part of the challenge in interpreting Third Factor findings is that various skills are supposedly measured by this group of subtests including the ability to sustain attention, visual-spatial skill, sequencing ability and the ability to manipulate numerical symbols (Kaufman, 1979; Ownby & Matthews, 1985). Since two of the three subtests here test short-term memory, memory skills are also involved as well as possibly the use of efficient task strategies (Sattler, 1988). A recent study has also suggested that anxiety may play a role in poor performance on this factor. Cohen, Becker and Campbell (1990) in a study of 135 boys and girls correlated Third Factor scores with various factors from the Conners Teacher Rating Scale. They found that an Anxiety Factor, but not the Attention-Deficit-Hyperactivity Factor, significantly correlated with the Third Factor (-.56). One limitation of this study was that it used experimenter derived factors from the CTRS rather than the more universally used ones from the Conners Rating Scales Manual with differing item selection to specify factors.

Academic Functioning

Although constant reference is made in the literature to the academic underachievement of hyperactive children, a uniquely educational perspective on the nature and extent of academic problems as well as treatment strategies is curiously lacking. Educational data is frequently a "by-product" used to study the effectiveness of various interventions rather than a starting point for analysis and intervention planning.

As previously reported, there is a wide spread belief that poor academic functioning is associated with hyperactivity. As expressed by Dworkin (1985, p.79), poor academic functioning has been generally considered to accompany hyperactivity and "virtually all" follow-up studies demonstrate rather marked delays in school achievement. Representative academic findings from both short and long-term studies are shown in Table 4.

Few studies have examined the relative patterns of academic functioning for hyperactive children such as comparing relative achievement in reading to spelling or arithmetic. The limited number of studies making such academic subject comparisons have generally indicated that hyperactive children are more delayed in reading than in arithmetic (Ackerman et al, 1986; Lambert & Sandoval, 1980; McKinney & Speece, 1986). The finding that arithmetic is less delayed than reading may represent a "real" academic difference or it may reflect that arithmetic scores tend to more closely reflect classroom instructional pace and so fluctuate less than reading scores where a child may develop "on his own". Another possibility is that this finding may represent subject selection bias since academic subject groupings are almost without exception made on the basis of reading, not arithmetic, performance.

TABLE 4

Representative Academic Results for Hyperactive Children

Study	N	Groups	Finding
Cantwell & Satterfield 1978	108	HPY N	HYP more delayed rdg., arith., spell.
Carlson, Lahey, & Neeper, 1986	51	HYP N	HYP lower on reading & spelling, not arithmetic
McGee & Share 1988	45	HYP	62% delayed more than 2 yrs. rdg. at 11 yrs.
Riddle & Rappaport 1976	108	HYP N	HYP poorer rdg., arith.
Long term			
Barkley, Fischer, Edelbrock & Smallish, 1990		HYP N	HYP 3x as likely to have failed a grade; 8 x as likely dropped out/been expelled
Charles & Schain 1981	62	HYP	48% 2 yr.or more below gr. level at 12 year.
Huessey 1974	84	HYP	30% acad. achieving
Weiss 1986	121	HYP N	poor school achiev. for HYP

HYP Hyperactive N Normal

Even rarer are comparisons of inter-subject patterns of skill development such as comparisons of reading skills in word recognition and comprehension. One study by August, Stewart, and Holmes (1984) compared clinic-referred hyperactive and reading disabled boys between the ages of 10 and 16 and found the hyperactive group to be significantly better in both word recognition skills (as measured by the WRAT) and comprehension (as measured by the Stanford Reading Diagnostic Test). In arithmetic subskill areas, hyperactive children have been found to take more time to perform computations (Dykman & Ackerman, 1991) which may be related to poorer memorization of basic number facts (Ackerman, Anhalt, & Dykman, 1986).

In comparisons of hyperactive children with conduct problem children, clinic-referred hyperactive-only boys have been found to be significantly better than hyperactive boys with conduct problems in both word recognition as measured by the WRAT and reading comprehension as measured by the Stanford Diagnostic Reading Test. (August, et al 1984). Levy and Hobbes (1989) compared conduct problem/mild hyperactive/ moderate and severe hyperactive boys on a variety of measures including the Boder Test of Reading and

Spelling and the WISC-R. Rather than directly compare mean scores for the groups they used factor analysis to derive what they termed a reading factor (verbal/ performance IQ discrepancy, reading level-chronological age discrepancy, number of syllables read) and a cognitive processing factor (full scale IQ, vigilance, phonetic spelling ability). The reading factor was found not to be significant in differentiating conduct problem from hyperactive groups although the cognitive factor was. Conduct problem children were found to obtain high cognitive factor scores while children with moderate and severe hyperactivity problems obtained low scores. That is, cognitive but not academic factors separated the hyperactive from the conduct problem boys.

Delameter, Lahey, and Drake (1981) selected boys from classes for the learning disabled into a hyperactive plus learning problem group and a learning problem group on the basis of scores on the abbreviated form of the CTRS. No significant differences were found between the groups in either reading recognition or comprehension as measured by the Peabody Individual Achievement Test. There were, however, cognitive differences. They found the hyperactive and learning disabled group to be significantly lower than the learning problem group in verbal IQ, performance IQ, and full scale IQ.

Additionally, there have been attempts to discover what cognitive characteristics might separate not only hyperactive from non-hyperactive children, but also groups of children selected on the basis of academic performance. Some of these studies have been reviewed in the preceding cognitive functioning section and, as noted there, results are generally scant as well as discrepant. Additional studies that used academic groupings will be selectively reviewed.

Hyperactive and non-hyperactive children ages 6 to 11 who were referred for special education services were tested with the WISC-R and the Woodcock Johnson Tests of Cognitive Ability (Bohline, 1985). A significant difference in test performance was found only at age 8 in the area of sound blending.

Singer, Stewart, and Pulaski (1981) compared the cognitive profiles of hyperactive and reading disabled boys. However, this study is more remarkable for its problems with subject selection than for its findings. Children designated as "hyperactive" were drawn from referrals for behaviour to a psychiatric clinic:

children designated as "reading disabled" were drawn from referrals to a child development clinic. Although not acknowledged by the researchers, clearly the hyperactive group would have contained a good number of conduct problem children while the reading disabled group may well [illegible]luded hyperactive children. This subject ove[illegible]nders highly questionable the validity of [illegible]sions drawn which were that hyperactive children were similar to the "backward readers" of Yule (1972).

Hyperactive and learning disabled group comparisons have usually been made only in reading. However, Siegel and Ryan (1989) compared the memory performance of hyperactive children between the ages of 7 and 13 with reading disabled, arithmetic disabled, and normal children. They found the hyperactive group to be more like the normal group in terms of memory performance. The reading disabled group was lower in sentence memory and the arithmetic group was lower in a memory task involving counting.

Finally, although there have been an increasing number of calls for studies to compare academically achieving/academically delayed groups of hyperactive children, to date such studies are relatively few. A two year follow-up study of 52 non-referred children found better verbal skills as measured by the WISC-R Vocabulary subtest to differentiate achievers from non-achievers. A clinic-referred study of 62 hyperactive children and 22 hyperactive and reading disabled children compared the two groups on a number of measures selected for their ability to discriminate poor readers from normal readers (Halperin, Gittleman, Klein & Rudel, 1984). They found, on the whole, few differences between the two groups. However, the hyperactive group was stronger in verbal skills as measured by the WISC-R as well as less cognitively impulsive as measured by the Matching Familiar Figures Test.

In summary, from an educational perspective, few conclusions can be reached on the basis of existing research. Academic failure for hyperactive children has been widely reported. Reading problems appear to be more prevalent than arithmetic problems. Poorer verbal skills may distinguish reading achieving hyperactive children from reading delayed children.

Conceptual Framework

Hyperactivity research has largely been functional in its perspective. Research has been conducted under the umbrella of a general approach such as the behavioural or cognitive, but often has not been guided by a specific conceptual model: this has contributed to fragmented research and has made it difficult to generalize results across studies.

Douglas Model.

One of the few conceptual models specific to hyperactivity research is that of Douglas (1983). Douglas after extensive experimentation identified four constructs she felt were basic to the performance of the attention deficit child. These four areas were described as "constitutionally predetermined" and were thought to distinguish the hyperactive child from both the learning disabled child and the normal child. The four areas of deficit were: impact of reward, investment of attention, inhibition of responding and modulation of arousal. These were seen as interactive. Is there a basic deficit underlying all of these? Douglas speculates that (1) defective inhibitory mechanisms (2) a strong inclination to seek immediate gratification or (3) an imbalance between approach and inhibitory focus could equally account for the data. Common to all three hypotheses is an "emphasis upon the child's inclination to seek salience, novelty, and immediate reinforcement as opposed to an ability to regulate behaviour in accordance with more direct and long term goals" (1983, p.296). Impulsivity, then, is the key construct but is not particularly seen as central to the other process in a causal fashion. This model stresses the role of the individual in cognitive control. The generality of this model is at once both its strength and weakness: it can accommodate a wide range of findings from both the behavioural and cognitive fields; at the same time its lack of specificity can limit its ability to generate hypotheses or discriminate findings.

Effort of Processing Model.

In cognitive research the "effort of processing" theory has been used to explain research results. In general terms, this stems from the general information processing model of Shiffrin & Schneider (1977). This model views attention as operating in (1) an automatic mode where information is quickly processed in parallel as well as in (2) a conscious mode where information is processed more slowly in a serial manner. This model lends itself to slightly different interpretations depending upon which aspects of the model are emphasized. An emphasis upon the self regulatory aspect of the model leads to a focus upon the effort and control of the individual over his/her attending (Wood, 1988). Equally, focus can be given to the rate at which information is processed at input, central, and output stages with the input stage influenced by stimulus degradation, the central stages by the level of the memory load, and the output processes by the number of response alternatives (van der Meere & Sergeant, 1988).

The effortful processing model of Hasher and Zacks (1979) also makes the distinction between automatic and nonautomatic processes. Nonautomatic processes require considerable capacity and are seen as effortful, conscious, intentional and highly affected by subject control, mood, and state of arousal. As tasks become more familiar with practice they become automatic and this is thought to free more attentional resources for nonautomatic, effortful tasks. The notion of limited capacity is key here (Norman & Bobrow, 1976; Neisser, 1967). Automatic processes require only a limited allocation of capacity; nonautomatic tasks considerably more. While in theory tasks are viewed as existing on an automatic-nonautomatic continuum, in research practice, tasks are categorized as one or the other. In terms of school learning, decoding skills in reading are thought to be automatic when mastered as are number facts in arithmetic (Borcherding et al 1988). Problem solving skills and reading comprehension are classified as nonautomatic, effortful tasks (Ackerman & Dykman, 1982; Sternberg & Wagner, 1982). While "energy " for processing is presumed to be limited, changes can be made in the (1) amount of energy directed to the task and (2) efficiency of processing (Berlyne 1970). Factors considered to influence task performance include (a) motivation (b) type of task and (c) IQ - the higher the IQ the less cognitive effort required.

While the Hasher-Zacks model has been useful in explaining some findings in cognitive research with hyperactive children it does have limitations. The distinction between automatic and purposeful processes is not a clear one (Kahneman & Treisman, 1984). Particularly where children are involved there is a problem in designating tasks as effortful or automatic:

for example, at what point exactly does decoding in reading become automatic for a child and how do you measure this? Further, because tasks are classified by each individual researcher as automatic or effortful, comparisons between studies may not be accurate. Thus, one study on the basis of a recognition memory task may conclude that hyperactive children do not significantly differ from normal children in automatic processing (Borcherding, Thompson, et al, 1988) while another study on the basis of arithmetic computations may conclude that they do (Ackerman et al, 1986). There seems as well to be an element of circularity in the argument presented and it is difficult to see how this can be avoided as long as tasks are classified on the basis of researcher discretion.

<u>Summary</u>

Investigations into the cognitive-academic functioning of hyperactive children have resulted in inconclusive and incomplete findings. There is lack of agreement not only regarding the interpretations of findings, but, at a more fundamental level, lack of agreement concerning the nature and extent of deficits for this group of children. Diverse instrumentation, incomplete academic skill assessment, and, in particular, poor subject selection procedures have all contributed to lack of progress in this area.

Although few studies in the area make it difficult at this time to draw conclusions concerning the differences between the cognitive and academic characteristics of non-referred populations of hyperactive children compared to clinic-referred populations, the general impression is that the non-referred children may not be as severely deficit. In comparisons of hyperactive with conduct problem children, the literature indicates that hyperactive children may have more cognitive and academic deficits. Findings relative to the learning disabled population are more confusing. In cognitive areas, hyperactive children appear to have particular problems in sustained attention - an area of difficulty they may share with learning disabled children who, in turn, appear to additionally have problems with selective attention. Hyperactive children appear to have more difficulty with memory tasks that require effortful processing. While the memory performance of both hyperactive and learning disabled children differs from that of normal children, it is more difficult to discern differences in memory when these two special groups are directly compared. Hyperactive children have been found to have lower verbal IQ than normal children but exactly how this relates to similar findings of lower verbal IQ for poor readers is not clear. The Third Factor has been reported to discriminate hyperactive children from normal children and conduct problem children although direct comparisons with learning disabled children have not been made. Academically, hyperactive children are widely reported to experience ongoing and extensive problems. However, relatively little work has investigated the nature of these academic deficits or their relationship to possible cognitive deficits. Reading skills are far more often reported as an area of weakness for hyperactive children than are arithmetic skills.

Rationale

Based on limitations of the hyperactivity research to date, there is particular need for clarification in the following areas.

Since almost all conclusions about the functioning of hyperactive children has been drawn from clinic-referred studies which not only exclude girls from most samples but may well represent a more extreme degree of hyperactivity as well as a multiple rather than single problem child, there is a need for research with non-referred children. In particular, there is a need for more comprehensive research into cognitive and academic skills.

This study was fortunate in having access to a broad data base of non-referred children whose families represented a variety of incomes, occupations, and educational status as well as both urban and rural locations. The cognitive-academic assessment of these children was extremely thorough and yielded data not only concerning level of functioning but provided information diagnostic information.

As was very evident in the literature review, there is an imperative need for a study of hyperactive children that uses detailed academic performance as a starting point in the study rather than as an end point for measuring the effectiveness of various interventions. Effective educational interventions for hyperactive children need to grow out of a detailed understanding of their pattern of academic skill development and its relationship to their cognitive skills. To do this, comprehensive academic measures are required.

To address this need, the present study selected both reading and arithmetic variables with an educational model in mind. For reading this involved an emphasis upon a broad assessment of reading that would give a balanced picture of reading skill development rather than an assessment of just one skill area such as word recognition. As well, there was an emphasis upon skills which can be taught rather than upon inferred processes (Howell, Kaplan, & O'Connell, 1979). Reading skills, then, as selected in accordance with relevance for classroom instruction (Salvia & Ysseldyke, 1978; Smith, 1981) were assessed in the studied in the areas of word analysis skill, word recognition skill, comprehension, and rate. In arithmetic as well, skills were examined that would give a broad picture of relative skill development. This meant going beyond a measure of written computation skills to include skills in word problem solving, understanding of the number system, a knowledge of time, money, and measurement concepts, and the ability to perform mental computations. Arithmetic skills, in a similar manner to reading skills, were assessed within an educational model that stressed instructional groupings of skills (Connolley, Nachtman, & Pritchett, 1982).

Finally, one of the most confusing areas in hyperactivity research is the lack of subject specificity. This is particularly true of the overlap areas between children with hyperactivity, with learning problems, and with conduct problems. Because of this confusion, it is difficult to know the extent and nature of possible cognitive-academic deficits for hyperactive children. As well, since not all hyperactive children do poorly academically, there is a need for research into what has been termed the "resiliant" type of hyperactive child (Henker & Whalen, 1989). The present study will make comparisons among several groups of children in order to arrive at as an exact as possible understanding of the relationship of hyperactivity alone, as distinct for example from learning problems, to cognitive and academic functioning. The comparisons made between groups will include a comparison of hyperactive academically achieving group with a hyperactive non-achieving group, a non-hyperactive non-achieving group, and a non-hyperactive achieving group for both reading and arithmetic. This will enable multiple comparisons of critical interest including an investigation of how hyperactive achieving and non-achieving children may differ in cognitive skills, how the pattern of academic skill development for hyperactive achieving children may differ from that of non-hyperactive achieving children, and how the cognitive skills of hyperactive achieving children differ from both the achieving and non-achieving non-hyperactive groups. As well, comparisons will be made between hyperactive children with and without conduct problems.

The above concerns are addressed in the following research questions which articulated the specific focus of the study.

#1. What is the degree of relationship between hyperactivity and performance on selected academic and cognitive variables for non-referred boys and girls?

#2. How do hyperactive reading achieving children differ cognitively from hyperactive reading delayed children, non-hyperactive reading delayed children, and non-hyperactive reading achieving children?

#3. Is there a difference in the pattern of reading skills shown by hyperactive reading delayed children compared with non-hyperactive reading delayed children, hyperactive reading achieving children an non-hyperactive reading achieving children?

#4. How do hyperactive arithmetic achieving children differ cognitively from hyperactive arithmetic delayed children, non-hyperactive arithmetic delayed children, and non-hyperactive arithmetic achieving children?

#5. How does the pattern of arithmetic skill development differ for hyperactive arithmetic achieving children, hyperactive arithmetic delayed children, non-hyper

active arithmetic delayed children, and non-hyperactive arithmetic achieving children?

#6. How does the academic and cognitive performance of non-referred hyperactive children without conduct problems compare with that of hyperactive children with conduct problems?

Chapter III

Method

Research Overview

The overall purpose of this study was to investigate relationships between hyperactivity and performance by non-referred children on selected cognitive and academic variables. This was examined in two main ways: (1) the study of overall relationships between hyperactivity and the cognitive and academic variables for the entire sample of children and (2) an investigation of relative patterns of cognitive and academic performance for specific groups of children selected from the sample. Criteria for group selection included degree of hyperactivity, degree of academic proficiency in reading or arithmetic, and degree of conduct problem. In the first set of group comparisons the groups compared were hyperactive academically achieving/ hyperactive academically delayed/ non-hyperactive academically delayed/ non-hyperactive academically achieving. In the second set of comparisons the groups compared were hyperactive children with conduct problems/ hyperactive children without conduct problems. In order to carry out these multiple group comparisons, a large number of children from a non-referred source was required : this study selected 267 boys and girls of average or above average intelligence within a narrow grade and age range from a data base. Degree of hyperactivity was determined by comparison with national norms for hyperactivity as provided by a standardized instrument. Cognitive skills were studied in the areas of full scale IQ, verbal IQ, performance IQ, Verbal Comprehension Factor, Perceptual Organization Factor, Third Factor, and four memory measures. Academic skills for reading were studied in word analysis, word recognition, comprehension, and rate. Academic skills for arithmetic were studied in three main areas: content, operations, and applications.

Subjects

The relevant sample was drawn from a hospital data base of 817 neonatal intensive care graduates followed from birth to 8 years of age through the Glenrose Rehabilitation Hospital Neonatal Follow-up Clinic. The 8-year assessments were carried out between September 1983 and June 1986. The Neonatal Follow-up Clinic provides evaluation of perinatal and neonatal care for the Northern and Central Alberta Regional Perinatal Program.

Selection of children from this data base was made on the basis of the following criteria: (1) they had a Full Scale IQ of 86 or above on the Weschler Intelligence Scale for Children -Revised; (2) they were between 7-0 and 8-11 years of age; (3) they were enrolled in grade 2 or 3 at the time of testing; (4) English was the first language of their mother ; in addition, (5) they were not diagnosed as having one or more of the following: cerebral palsy; visual impairment or legal blindness; neurosensory hearing loss; a convulsive disorder; and (6) their data files were complete.

Children excluded because of the IQ criteria were 127 in number (14.8%). Children excluded because of the age criteria were 29 in number (4%). Children excluded because of the grade criteria were 201 in number (24%). Children excluded because of the first language criteria were 121 in number (14.8%). Children excluded because of cerebral palsy, visual impairment or legal blindness, neurosensory hearing loss, or a convulsive disorder were 122 in number (14.9%). Children who were excluded on the basis of one of these four criteria were 215 in number; children who were excluded on the basis of two or more of these four criteria were 154 in number. A further 181 children were excluded because they received alternative educational tests to the ones selected for this study or their data files were incomplete. A total of 267 children met all five criteria and were used as the sample for this study.

Instrumentation

Hyperactivity was measured by T-scores on the Hyperactivity Factor of the Conners Teacher Rating Scale (Conners, 1973) utilizing the 39 item form. The t-scores were derived from the norm tables published by Sattler (1988) based on a sample of Canadian school children in Ottawa ages 4 to 12 years (Trites, Glouin, & Laprade, 1982). These tables allow the transformation of raw scores for each of the six factors (Hyperactivity, Conduct Problem, Emotional-Indulgent, Anxious-Passive, Asocial, Daydreams-Attention) into T-scores with a mean of 50 and a standard deviation of 10. Norms are presented separately for age and gender. For this study the

Hyperactivity and Conduct Problem factors were computed.

A cut-off point of T-score of >60 (>1 S.D.) was used to separate hyperactive from non-hyperactive groups of children. Although this is less than the T-score of 75 (>2 and 1/2 S.D) suggested in the manual for stringent classification of hyperactive children (Conners, 1989), the purpose of this study was to observe overall relationships concerning hyperactivity, not to make clinical judgements about individual children. As well, an examination of the L-shaped distribution of Hyperactivity T-scores suggested that 1 standard deviation would also be a logical cut-off point since these children also represent an extreme of the continuum. A precedent for the use off 1 standard deviation as a cut-off point in hyperactivity research has been established (Frost, Moffitt, & McGee, 1989; Schachar, Sandberg, & Rutter, 1986).

The Conners Teacher Rating Scale (CTRS) was designed to help identify behaviour problems in children ages 4-12 years. The CTRS has gained acceptance as an assessment instrument in North America as well as internationally (Conners, 1989) and has been used extensively in research (Sandberg, 1986). The classroom teacher is asked to rate the child on 39 items with possible responses of "not at all" (0 points), "just a little" (1 point), "pretty much" (2 points) or "very much" (3 points). A total of 17 items are considered to load on the Hyperactivity Factor with most significant loadings obtained from the following 8 items: Constantly fidgeting; Hums and makes other odd noises; Demands must be met immediately; Coordination poor; Restless or overactive; Excitable, impulsive; Inattentive, easily distracted; and Fails to finish things she/he starts.

Test reviewers have indicated that the CTRS has adequate overall reliability and validity (Martin, Hooper, Snow, 1986; Sattler, 1988). Trites, Blouin, & Laprade (1982) found a mean interitem correlation of .95 for the Hyperactivity Factor. Edelbrock, Greenbaum, & Conover (1985) reported an average internal reliability of .94 for the various scales. Interrater reliability has been found to be .94 for a clinic referred population (Homatidis & Konstantareas 1981) and .73 for the ratings of teachers and independent observers of emotionally disturbed children (Kazdin, Esveldt-Dawson, & Loar (1983). A range of .70

to .90 has been reported for test-retest reliability at a 1 month interval (Conners, 1973).

Evidence for acceptable construct validity of the CTRS is supplied in part by factor analytic studies. Major factor analytic studies have found a relatively similar factor structure (Cohen & Hynd, 1986; Conners, 1969; Trites, Blouin, & Laprade, 1982; Werry, Sprague & Cohen, 1975). The main difference has been in whether or not the Inattentive-Passive factor has been found to be independent of the Hyperactivity factor with a few studies reporting the hyperactivity and inattention factors to combine (Cohen & Hynd, 1986; Werry, Sprague, & Cohen, 1975).

The item selection procedures have also been cited as evidence of good content validity (Martin, Hooper, & Snow, 1986).

In terms of criterion related validity, the Hyperactivity Factor of the CTRS has been found to discriminate hyperactive from non-hyperactive children (Aman & Turbott, 1986; Homatidis & Konstantareas, 1981; Kupietz, Bialer, Winsberg, 1972; Sprague, Christensen, & Werry, 1974).

In a predictive validity study, hyperactivity as measured by the CTRS at age 7 was found to be highly predictive of hyperactivity at age 10 (Gillberg & Gillberg, 1983).

In terms of the convergent validity of the instrument as a whole, the CTRS has been found to significantly correlate with the David's Hyperkinetic Scale with normal grade one students (Arnold, Bareby & Smeltzer, 1981) and with teacher ratings of hyperactivity on the Behaviour and Temperament Survey and School Behaviour Survey (Sandoval, 1981). In terms of convergent validity for the Hyperactivity Factor alone, a correlation of .86 has been reported between the Hyperactivity Factor of the CTRS and the Externalizing scale (comprised of Inattentive, Nervous-overactive and Aggressive components) of the Teacher Version of the Child Behaviour Profile (Edlebrock, Greenbaum, & Conover, 1985).

Varied results have been reported for correlations of the CTRS and varied objective measures of activity levels. Significant correlations have been reported between the Hyperactivity Factor and observed behaviours in the classroom such as off task behaviour and excessive motor movements (Abikoff, Gittleman, & Klein, 1980; Copeland & Weissbond, 1978; Milich & Fitzgerald, 1985). Minde (1980) reported a reliability coefficient of .80 for the Hyperactivity Factor and excessive talking. On the other hand, Kiulahar, Siegel, and Ullman (1982) in a study of 40 non-referred boys reported a modest relationship of .55 between observed motor activity and the Hyperactivity Factor. Many factors confound these various studies including type of population studied, type of measurement used, and type of classroom activity observed. As well, some reported correlations are of observed behaviour and individual items of the CTRS (Copeland & Weissbrod, 1978; Schachar, Sandberg & Rutter, 1986) while other studies, as reported previously, are of observed behaviour and the Hyperactivity Factor as a whole.

Cognitive IQ variables were measured by scores obtained from the Wechsler Intelligence Scale for Children-Revised (WISC-R) (Wechsler, 1974). The cognitive IQ variables were as follows:

(1) Overall IQ was the Full Scale IQ score obtained from the WISC-R based on a mean score of 100 with a standard deviation of 15 points.

(2) Verbal IQ was the Verbal IQ score based on a mean score of 100 with a standard deviation of 15 points.

(3) Performance IQ was the Performance IQ score obtained from the WISC-R based on a mean score of 100 with a standard deviation of 15 points.

(4) The Verbal Comprehension Factor was the mean scale score obtained on the Vocabulary, Comprehension, Similarities, and Information subtests of the WISC-R (Kaufman, 1979).

(5) The Perceptual Organization Factor was the mean scale score obtained on the Block Design, Picture Arrangement, Picture Completion, and Object Assembly subtests of the WISC-R (Kaufman, 1979).

(6) The Third Factor was the mean scale score obtained on the Arithmetic, Digit Span, and Coding subtests of the WISC-R (Kaufman, 1979).

Cognitive memory variables were measured by scores from four subtests of the Detroit Tests of Learning Aptitude (Baker & Leland, 1967). The memory variables were as follows:

(1) Auditory memory for sentences was the raw score obtained on the Auditory Attention Span for Related Words.

(2) Auditory memory for words was the raw score obtained on the Auditory Attention Span for Unrelated Words.

(3) Visual memory for letters was the raw score obtained on the Visual Attention Span for Letters.

(4) Visual memory for objects was the raw score obtained on the Visual Attention Span for Objects.

Memory subtests from the Detroit Tests of Learning Aptitude (1967) have been used extensively in research. The manual reports overall test-retest reliability for 48 students at a 5 month interval to be .96. Standardization was carried out on 150 students at each age level between 3 and 19 years. Although the test dardization has been criticized (Buros, 1978; a & Ysseldyke, 1978), in the hands of a skilled examiner it is considered to yield useful information (Compton, 1980).

Academic reading skills were computed in the following areas: word analysis skills, word recognition skills, rate, comprehension, and overall reading achievement level.

Word analysis skills were measured by the raw score obtained on the decoding portion of the Roswell-Chall Diagnostic Reading Test (Chall, 1959; 1971). The Roswell-Chall Diagnostic Reading Test assesses knowledge of consonant sounds in isolation, consonant digraphs, consonant blends, short vowel sounds in c-v-c words, short and long vowel sounds in isolation, rule of silent e, vowel digraphs, diphthongs and vowels controlled by r, and syllabication. The reliability is adequate: the validity is weak but considered to be better than most similar tests (Buros, 1965). Normative data is not given with the earlier version but suggested grade levels corresponding to the expected mastery level of the ten skill areas are given. Grade scores were not needed for this study since only raw scores were used.

Word recognition skills, reading rate, and overall reading achievement level were all derived from scores on the Standard Reading Inventory (McCracken, 1966). Word recognition was the instructional level obtained in reading word lists. Reading rate was the number of words read per minute while silently reading an instructional level passage from the Standard Reading Inventory. Overall reading achievement level (as used in Research Question 1 and in reading group selection) was calculated for each child by subtracting the expected grade level based on years and months in school from the achieved reading level based on the Standard Reading Inventory composite grade level score (derived from word recognition level, passage reading level, and reading rate).

The Standard Reading Inventory is designed to measure word recognition in isolation and context, errors in oral reading, comprehension, and speed of reading. This test was chosen for the battery because it was considered to give accurate levels of reading skills for Edmonton elementary grade children and was widely used by district reading specialists at the time of testing. Buros (1975) reports alternate-form reliabilities for 60 children in grades 1 to 6 ranged from .86 to .91 for the level scores and from .6 to .99 with a median of .93 for the subtest scores. Content validity was corroborated by testing children in grades 1 to 6 and through the validation of experts in the field. Although information about specific norming procedures is lacking, the validity and reliability data assure more comparable and consistent results than are often obtained on similar types of reading inventories.

Reading comprehension was measured by the raw score obtained on the Woodcock-Johnston Passage Comprehension subtest (1977). This subtest measures reading comprehension by the cloze procedure whereby the child is asked to read a short passage and identify a key word missing from the passage. This procedure is considered to tap a relatively high form of reading comprehension because the child must understand the entire section to supply the missing word and must employ a variety of reading skills including sight vocabulary, knowledge of word attack skills, and use of context cues. This is a measure of literal rather than inferential comprehension (Hessler, 1982). Information from the Technical Manual (Woodcock, 1978) indicates that the Woodcock-Johnson Psycho-Educational Battery was standardized in the United States on a national sample of 3935 students from Kindergarten to Grade 12. Special populations such as the severely learning disabled were included in the sample. A median reliability of rating of .86 was obtained for the Passage Comprehension subtest with a reliability of .86 for this subtest at the Grade 3 level. A study using the Passage Comprehension subtest from the Woodcock-Reading Mastery Tests, a subtest which contains, particularly at the primary grade level, items identical to those of the W.J. Psycho-Educational Battery Passage Comprehension subtest (Breen, Lehman, & Carlson, 1984), found that of three standardized tests including the Spache Diagnostic Reading Scales, the WRAT, and Passage Comprehension, the Passage Comprehension yielded scores most commensurate with instructional reading levels as judged by tutor placement (Coleman & Harmer, 1982).

Academic arithmetic skills were measured by scores obtained on the Keymath Diagnostic Arithmetic Test (Keymath) (Connolly, Nachtman, & Pritchett, 1982). The variables used in this study were:

(1) Overall arithmetic skill : the total raw score obtained on the KeyMath.

(2) Content: the sum of scores obtained on the subtests measuring numeration, fractions, and symbol knowledge.

(3) Operations: the sum of score obtained on the subtests measuring addition, subtraction, multiplication, division, mental computation, and numerical reasoning.

(4) Applications: the sum of scores obtained on the word problems, missing elements, money, measurement, and time subtests.

(5) Overall arithmetic achievement level (as used in Research Question #1 and in arithmetic group selection) was computed for each child by subtracting the expected grade level based on years and months in school from

the achieved arithmetic level as measured by the Keymath grade score.

The Keymath is a grade-referenced test. While many arithmetic tests assess only written computation skills, the Keymath assesses a variety of skills in 14 subtests: numeration, fractions, symbol knowledge, computations, mental computations, numerical reasoning, oral word problems, finding the missing element in orally presented word problems, money, metric measurement, and time. Canadian school children were included in the norming group for this test which included 1, 222 children from kindergarten to grade 7. The median reliability (split-half) of the total test across all grades is .96 with a subtest range of .64 to .84. Validity information about the test is limited. However, a correlation of .63 between the Keymath and the WRAT for learning disabled children has been reported (Kratochwill & Demath, 1976). The Keymath was selected because of its recognition and use at the district as well as provincial level as an accurate diagnostic instrument.

Data Collection

The data collection consisted of a test battery individually administered to each child by the present researcher and one other assessor. Reliability training for administration and scoring of the test battery was conducted by two psychologists. The Conners Teacher Rating Scale was administered to the respective teachers of these children by a standardized telephone interview.

The data for the study comes from an established hospital data base. Informed consent of the parents was obtained as part of the original study which as approved by the North and Central Alberta Perinatal Program and the Glenrose Hospital Research and Ethics Committee.

Data Analysis

Research Question 1 regarded hyperactivity as a continuous variable. Statistical analysis was carried out with Pearson product-moment correlations and regression analysis.

Pearson product-moment correlations were calculated between hyperactivity and selected cognitive and academic variables (Auditory memory for sentences, auditory memory for words, visual memory for objects, visual memory for letters, Full Scale IQ, Verbal IQ, Performance IQ, Third Factor, Verbal Comprehension Factor, Perceptual Organization Factor, word attack skills, cloze comprehension, passage reading, word recognition and reading rate) using the SPSS-X Pearson Corr Program. These correlations gave descriptions of the relationships between hyperactivity and the selected variables. Because the literature had strongly suggested a negative relationship between hyperactivity and the selected cognitive and academic variables, the significance level for each correlation was based on a one-tailed test.

Because the initial exploration of the relationships between hyperactivity and selected cognitive and academic variables as outlined above yielded correlations that were lower than expected, further analysis of the relationship between hyperactivity and both reading and arithmetic achievement levels was explored with regression in order to obtain a more detailed picture of the relationship by the plotting of individual cases. This was carried out with the calculation of a regression line using the SPSS-X Regression program. The independent variable was hyperactivity: the dependent variable was overall reading achievement level. Unusual cases for whom hyperactivity level did not predict reading level were selected (on the basis of a standardized residual score of 2 standard deviations or more from the mean) and examined on a case by case basis for common themes such as gender or above average IQ. Similarly, the relationship between arithmetic achievement and hyperactivity was delineated with a regression line. The independent variable was hyperactivity: the dependent variable was overall arithmetic achievement level. Residuals of 2 standard deviations or more from the mean were selected for case by case study.

Research questions 2 - 5 were examined by comparing the performances of groups of subjects selected on the basis of hyperactivity scores and academic achievement levels.

The reading groups were selected on the basis of hyperactivity scores and reading achievement levels as previously described. Four groups were selected: hyperactive reading achieving children obtained a Hyperactivity T-score of greater than 60 (>1 sd) and were less than one year delayed in overall reading achievement level; hyperactive reading delayed children had a Hyperactivity T-score of greater than 60 and were one year or more delayed in overall reading achievement level; non-hyperactive reading delayed children obtained a Hyperactivity T-score of greater than 60 and were one year or more delayed in overall reading achievement level; and non -hyperactive reading achieving children who had a Hyperactivity T-Score of less than 60 and were less than one year delayed in overall reading achievement level.

When selection was carried out using the above criteria, the numbers for the groups were as follows: hyperactive reading achieving group =28; hyperactive reading delayed group =7; non-hyperactive reading delayed group =30 and non-hyperactive reading achieving group =202. To facilitate comparisons of the 4 groups using ANOVA analysis, the non-hyperactive reading achieving group was reduced to a size of 30 by random selection using the SPSS-X sample command.

Arithmetic groups were selected on the basis of hyperactivity scores and arithmetic achievement level as previously described. Four groups were selected: hyperactive arithmetic achieving children obtained a Hyperactivity T-score of greater than 60 (1 S.D.) and were less than one year delayed in overall arithmetic achievement level; hyperactive arithmetic delayed children obtained a Hyperactivity T-score of greater than 60 and were one year or more delayed in overall arithmetic achievement; non-hyperactive arithmetic delayed children had a Hyperactivity T-Score of less than 60 and were one year or more delayed in overall arithmetic achievement level; and non -hyperactive arithmetic achieving children who had a Hyperactivity T-score of less than 60 and were less than one year delayed in overall arithmetic achievement.

When selection was carried out using the above criteria, the numbers for the groups were as follows: hyperactive arithmetic achieving group =24; hyperactive arithmetic delayed group =11; non-hyperactive arithmetic delayed group =35; and non-hyperactive arithmetic achieving group =197. Again, to facilitate comparisons for the 4 groups using ANOVA analysis, the non-hyperactive arithmetic achieving group was reduced to an N of 30 by random selection using the SPSS-X sample command.

Statistical analysis of the reading and arithmetic groups was carried out using a series of one-way analyses of variance (SPSS-X ANOVA program) to investigate possible group differences between either the four reading groups or four arithmetic groups on the following cognitive variables (Research Questions 2 and 4) : Full Scale IQ, Verbal IQ, Performance IQ, Verbal Comprehension Factor, Perceptual Organization Factor, Third Factor, auditory memory for sentences, auditory memory for words, visual memory for letters, visual memory for objects. For the reading groups, academic comparison for the 4 groups was made on the following variables: word attack skills, cloze comprehension, word recognition, and rate (Research Question 3). For the arithmetic groups, academic comparison for the 4 groups was made on the following variables: arithmetic content, arithmetic operations, arithmetic applications (Research Question 5).

Post-hoc comparisons were made between the means of the variables using the Scheffe procedure with the significance level set at .05.

In order to answer Research Question 6, the performance of hyperactive children with and without conduct problems was analyzed. The 35 children with Hyperactivity T-scores of greater than 60 were divided into 2 groups: hyperactive children with conduct problems who had T-scores of greater than 60 on both the Hyperactivity Factor and the Conduct Problem Factor

(N=12) and hyperactive only children with Hyperactivity T-scores of greater than 60 but Conduct Problem T-scores of less than 60 (N=23).

The statistical analysis of differences in performance between the two groups was by t-tests (SPSS-X T test). Mean scores were compared for the following variables: Full Scale IQ, Verbal IQ, Performance IQ, Verbal Comprehension Factor, Perceptual Organization Factor, Third Factor, auditory memory for sentences, auditory memory for words, visual memory for objects, visual memory for letters, word attack skills, reading comprehension, reading rate, and overall arithmetic skill.

Chapter IV

Results

The results will be presented under the following sections : general description of the sample, relationships between hyperactivity and selected cognitive and academic variables when hyperactivity is treated as a continuous variable (Research Question 1), and findings regarding hyperactivity from the analysis of different groupings of subjects selected on the basis of academic performance and hyperactivity level (Research Questions 2 to 5) as well as the presence of hyperactivity with or without conduct problems (Research Question 6).

Sample Description

The sample consisted of 267 children who ranged in age from 7 years 0 months to 8 years 11 months with a mean age of 8 years. The mean Full Scale IQ of the group was 109.2 with a standard deviation of 10.78 and a range from 85 to 142. Boys comprised 55.4% of the sample; girls, 44.6%. (See Table 5).

TABLE 5

Sex/Grade Distribution of Sample

	Grade 2	Grade 3	Total
	N	N	N
Males	95	53	148
Females	73	46	119
Total	178	99	267

TABLE 6

% of Hyperactive and Non-hyperactive Children with Academic Delay

	Hyperactive		Non-hyperactive	
	N	%	N	%
Reading delay	7	20	30	13
Arithmetic delay	11	31	35	15

Academically, 14% of the sample of 267 children were delayed in reading skills by 10 months (an academic year) or more. Seventeen percent of the sample were delayed in arithmetic skills by 10 months or more for grade placement. A total of 23% of the sample were delayed in either reading or arithmetic skills by 10 months or more. By sex, girls accounted for 30% of the children with reading delay; boys for 70% . Girls accounted for 43% of the arithmetic delay; boys for 57%.

Using a t-score of greater than 60 on the CTRS as a measure of hyperactivity, 35 children (13% of the sample) were hyperactive. This would fall within the expected parameters of distribution based on t-scores. A further comparison regarding percentage of hyperactivity was made by looking at the number of these children whose hyperactivity T-score was greater than 60. These children made up 3.7% of the sample. This was lower than the 7% found for non-referred children by McGee, Williams, and Silva (1984) and well within the 3-5% prevalence estimates discussed in Chapter II. Of the hyperactive children in the sample, 18 (51%) were boys and 17 (49%) were girls. This relative equality of boys and girls differed from many studies and reflected a non-referred population as well as the use of norms based on separate calculations for boys and girls. The percentage of hyperactive children experiencing academic delay compared to non-hyperactive children is presented in Table 6. These figures were consistent with the percentage of hyperactive children experiencing reading delay as previously reported for non-referred populations (August & Garfinkel,1989; McGee,Williams, & Silva,1984). In this sample, girls accounted for 57% of the reading delayed group ;boys, 43%. Girls accounted for 45% of the hyperactive arithmetic delayed group; boys, 55%.

Hyperactivity: Overall Relationships

Research Question 1. What is the degree of relationship between hyperactivity and performance on selected academic and cognitive variables for non-referred boys and girls?

Correlations

Correlations between hyperactivity scores as measured by the hyperactivity T-score on the Conners Teacher Rating Scale and 15 dependent variables were determined using Pearson Product Moment Correlations

(SPSS-X Pearson Correlation Program) as seen in Table 7. The significance level of each correlation was based on a one-tailed test. These correlations were calculated to explore overall relationships between hyperactivity and selected cognitive and academic variables.

All correlations except the correlation between hyperactivity and the Perceptual Organization Factor (p=.003) were significant at the .001 level . However, the strength of correlation between the various independent variables and hyperactivity was of only a modest degree with correlations ranging (with the exception of the Perceptual Organization factor at -.16) from -.20 to -.29. The rather narrow range of the correlations appeared to indicate that while hyperactivity was associated in a modest way with

TABLE 7

Pearson Correlations Between Hyperactivity and Dependent Variables

IQ Variables	Correlation Coefficient
Full Scale IQ	-.27
Verbal IQ	-.22
Performance IQ	-.21
Third Factor	-.25
Verbal Comprehension Factor	-.21
Perceptual Organization Factor	-.16
Memory Variables	
Auditory Sentence Memory	-.22
Auditory Word Memory	-.20
Visual Letter Memory	-.23
Visual Object Memory	-.22
Reading Variables	
Comprehension	-.29
Word Recognition	-.26
Rate	-.25
Passage reading	-.24
Word Analysis Skills	-.24

All correlations p<.005

decreased performance on selected IQ, reading and memory variables, no particular pattern of cognitive or academic deficit emerged with this type of analysis.

Regression Analysis for Reading

Reading scores were predicted from hyperactivity scores for the entire sample of 267 children. The correlation between hyperactivity and reading level was a negative one. The regression equation was reading level = 50.59 -1.53 x hyperactivity. Further regression statistics are reported in Appendix B-1.

In order to explore the relationships between reading achievement level and hyperactivity more closely it was decided to examine the residual scores. That is, children were selected whose reading scores were not predicted from hyperactivity. It was hoped that the profile of these exceptional students would shed some light on the mechanisms relating hyperactivity and reading level.

The standardized residuals ranged in value from -2.3163 to 2.9452. Students whose standardized residual scores were greater than 2 standard deviations above or below the mean were studied on a case by case basis for common themes. There were 16 cases.

Thirteen of the cases were good readers whose reading scores were greater than 3 years advanced for age. Sex distribution was fairly equal (Female, 54%;Male, 46%). Hyperactivity scores ranged from 39 to 57 with an average score of 45 so that in all cases hyperactivity fell within average range. Their Full Scale IQ ranged from 109 to 142 with an average of 124.5. Mean score intelligence, then , was above average for this group. Although these children were above average in reading, they were only average in arithmetic with only 1 child of the 13 who was above average (greater than 1 year advanced for age) in arithmetic.

Three of the outliers were poor readers. They were all male. Their hyperactivity scores ranged from 40 to 67 with an average score of 53. Full scale IQ ranged from 91 to 103 with an average IQ score of 98. These children were all below average in arithmetic as well as reading.

So although the good readers tended to be somewhat below average in hyperactivity level, the variation of scores shows that hyperactivity does not seem to either advance or restrict reading level. The poor readers also had a substantial spread in hyperactivity scores.

Although higher readers tended to be somewhat lower in hyperactivity, poor readers were not necessarily high in hyperactivity. These findings cast doubt on the hyperactivity-reading achievement relationship generally suggested in the literature.

Regression Analysis for Arithmetic

Arithmetic scores were predicted from hyperactivity scores for the entire sample of 267 children. The regression equation was arithmetic achievement level = 48.80 -2.72 x hyperactivity. Further regression statistics are reported in Appendix B-2.

The standardized residuals ranged in value from -2.45277 to 3.55113. Following the same procedure as carried out with reading , children whose standardized residual scores were greater than 2 standard deviations above or below the mean were studied on a case by case basis for common themes. There were 14 cases.

Seven of the cases were average or above in arithmetic skills; seven were delayed. For both groups mean hyperactivity scores were within average range.

For the achieving arithmetic group, 71 % were males and 29% females compared with 43% males and 57% females for the poor arithmetic group. Full Scale IQ scores for the good arithmetic group ranged from 108 to 142 with a mean IQ of 127.4. Full Scale IQ scores for the poor arithmetic group ranged from 86 to 100 with a mean IQ of 92.1. All but 1 of the good arithmetic group were above average in reading. 4 of the poor arithmetic group were average in reading and 3 were below average.

As found with reading achievement levels, hyperactivity did not strongly predict arithmetic achievement level. Some of the children with the highest hyperactivity scores were average in arithmetic while some children with average hyperactivity scores were delayed in arithmetic skills. On the whole, while children with higher achievement levels in arithmetic tended to have lower hyperactivity scores along with higher IQ levels, children with lower arithmetic levels showed considerable variability in hyperactivity level although IQ levels for the exceptional cases tended to be lower. Again, these findings cast doubt on the strong hyperactivity-academic achievement relationship suggested in the literature.

Reading Groups

Analysis of the reading and cognitive performance of 4 groups of children hyperactive, reading achieving (HRA); hyperactive, reading delayed (HRD); non-hyperactive, reading delayed (NHRA); non-hyperactive, reading achieving (NHRA) selected on the basis of overall reading level and hyperactivity as described in the preceding chapter was conducted to examine research questions 2 and 3. As previously described the non-hyperactive reading achieving group of 30 children was randomly selected from a pool of 232 children.

Because the children represented a 2 year span of age and a 2 year span in grade level and were tested at different times throughout the year, a one-way analysis of variance was done to compare equivalency of age and grade placement for the groups. The groups did not differ significantly in age, $F\ (3,\ 91) = 1.010$, $p = .392$, but there was a significant difference in grade placement, $F\ (3,\ 91) = 9.309$, $p < .001$. The HRA group was significantly different from the NHRD group and the NHRA was different from both group HRD and NHRD, $F(3,\ 91)=9.309$, $p <.001$). As seen in Table 8, children with reading problems, hyperactive or not, tended to be tested somewhat earlier in the

TABLE 8

Description of Reading Groups

	N	Age in mos.	Grade Placement in mos.
Group		M	M
HRA	28	96.04	38.8
HRD	7	94.00	34.0
NHRD	30	96.60	34.8
NHRA	30	96.77	39.8

TABLE 9

Mean CTRS Factor Scores for the Reading Groups

	Hyperactivity		Conduct Prob	
Group	M	SD	M	SD
HRA	67.36	6.70	57.25	11.18
HRD	66.14	2.91	56.57	7.60
NHRD	46.73	4.60	44.83	1.87
NHRA	46.50	5.18	45.07	3.03

academic year than other children. This difference between groups translated into a difference between HRA and NHRD of 4 months;between NHRA and HRD of 5.8 months; and between NHRA and HRD of 5 months - all of which are less than the 6 months difference often used clinically to interpret meaningful academic differences.

As noted in Table 9, a difference of 20 points (2 standard deviations) in hyperactivity T -scores separated the hyperactive/non-hyperactive groups :this was greater than that which might have been expected on the basis of the selection criteria which was a T-score of > 60 for the hyperactive groups. In terms of statistical differences, both hyperactive groups were significantly different from the non-hyperactive groups, $F(3, 91) = 104.806$, $p < .001$.

As might be expected given the amount of overlap between hyperactivity and conduct problems, the hyperactive groups were significantly higher in scores on the conduct problems factor than the non-hyperactive groups, $F(3, 91) = 24.325$, $p <.001$. However, it should be noted that all of the groups, including the hyperactive groups, were within average range on this factor. As well, it should be noted that the reading delayed group of hyperactive children was not more hyperactive than the achieving hyperactive group.

In the results that follow, the F values refer to the overall tests amongst groups with specific between groups differences where they occur evaluated at the .05 level.

Research Question 2: How do hyperactive reading achieving children differ cognitively from hyperactive reading delayed children, non-hyperactive reading delayed children, and normal children?

Cognitive analysis was of the following variables: Full Scale IQ, Verbal IQ, Performance IQ, Verbal Comprehension Factor, Third Factor, Perceptual Organization Factor, auditory sentence memory, auditory word memory, visual letter memory , and visual object memory. A one way analysis of variance was computed with each of these variables and the four reading groups. Post-hoc analysis was determined by a Scheffe procedure with the significance set at a .05 level

The results of the cognitive IQ score analysis are shown in Tables 10 and 11. In terms of statistical significance : (1) No significant differences were found for Full Scale IQ, Performance IQ, or the

TABLE 10

Mean IQ Scores for Reading Groups

	FS IQ		Verbal IQ		Performance IQ	
Group	M	SD	M	SD	M	SD
HRD	100.71	12.08	98.86	11.52	102.43	11.00
NHRD	103.80	8.00	104.00	8.89	103.47	9.87
HRA	104.68	11.01	104.21	10.24	104.79	12.66
NHRA	110.63	9.22	110.93	9.57	108.17	11.70
			NHRA>HRD			

TABLE 11

Mean WISC-R Factor Scores for Reading Groups

	VC Factor		PO Factor		Third Factor	
Group	M	SD	M	SD	M	SD
HRD	99.58	12.44	103.43	12.51	95.29	11.67
NHRD	106.22	9.10	106.03	10.38	93.69	10.62
HRA	105.99	10.30	107.31	13.26	94.81	12.65
NHRA	111.81	9.80	107.63	11.37	105.35	11.15
	NHRA>HRD				NHRA>NHRD, HRD	

Perceptual Organization Factor (2) The NHRA group was stronger than the HRD group in Verbal IQ, $F(3, 91) = 4.583$, $p =.005$ and the Verbal Comprehension Factor, $F(3, 91) = 3.738$, $p =.014$ and (3) The NHRA group was stronger than both the NHRD and HRA groups on the Third Factor, $F(3,91) = 6.341$, $p = .0006$.

No differences, then were found in non-verbal areas. Verbal differences were found. A consistent pattern of group performance which occurred for 5 of the 6 IQ cognitive variables was the HRD <NHRD <or = HRA <NHRA pattern. This differs from the hyperactive/ non-hyperactive performance pattern that might have expected on the basis of the literature.

Memory Variables were analyzed using a one-way analysis of variance.Post-hoc analysis was carried out with a Scheffe analysis with the significance level set at .05. The summary of results can be seen in Table 12.

No significant differences were found between the groups on performance on the auditory word memory task or the visual object memory task although the results for visual object memory approached significance, $F(3, 90) = 2.63$, $p = .055$. There was a difference in

TABLE 12

Mean Memory scores for Reading Groups

	Auditory Sentence Memory		Auditory Word Memory	
Group	M	SD	M	SD
HRD	36.00	12.17	36.71	5.91
NHRD	49.83	11.29	39.57	5.91
HRA	48.32	12.05	40.57	6.11
NHRA	55.03	13.30	43.27	6.14
	NHRA>HRD		No difference	

	Visual Letter Memory		Visual Object Memory	
Group	M	SD	M	SD
HRA	39.29	7.74	35.67	3.08
NHRD	42.87	5.96	40.30	5.51
HRA	44.36	8.49	39.43	5.97
NHRA	51.40	7.89	42.17	5.90
	NHRA>HRD		No difference	

auditory memory for sentences, $F(3, 91) = 4.919$, $p = .003$, with the NHRA group significantly better than the HRD group. Although statistical differences were found only with the auditory memory task, the pattern of performance was very similar for three of the memory tasks: auditory word memory, auditory sentence memory, and visual object memory. That is, the HRD group was poorest in memory performance ;the NHRA group was the strongest. Mean memory scores for the NHRD and HRA groups fell between and were fairly equal. On visual memory for letters, however, the pattern was altered. Here the NHRA group was stronger than each of the remaining groups with $F(3, 91) = 9.173$, $p < .001$.

Research Question 3: Is there a difference in the pattern of reading skills shown by hyperactive reading delayed children (HRD) compared with non-hyperactive reading delayed children(NHRD) , hyperactive reading achieving children (HRA) and non-hyperactive achieving children (NHRA)?

Reading variables analyzed with the reading groups were word analysis , word recognition, comprehension, and reading rate. These were analyzed with one-way ANOVA with statistical difference between groups determined by a Scheffe procedure with significance levels set at .05. As seen in Table 13 significant differences between groups were found in all areas.

In word analysis, $F(3, 91) = 20.670$, $p < .001$, there was a significant difference between the HRA group and both the HRD and NHRD groups and between the NHRA group and both the HRD and NHRD groups. In comprehension, $F(3, 91) = 19.83$, $p < .001$, there was a significant difference between the HRA group and both of the reading delayed groups as well as between the NHRA group and both of the delayed groups. For word recognition skills, $F(3, 91) = 30.54$, $p < .001$, the HRA group was significantly better than the delayed groups but the NHRA group was also significantly better than the HRA group. In reading rate, although mean scores showed the HRA group again to be better than the delayed groups, a statistically significant difference in rate was found only between the NHRA group and the 2 reading delayed groups with $F (3, 91) = 11.74$, $p <.001$.

TABLE 13

Mean Reading Scores for Reading Groups

	Word Analysis		Word Recognition	
Group	M	SD	M	SD
HRD	51.00	24.54	3.14	1.46
NHRD	63.03	16.13	3.93	1.23
HRA	78.54	12.06	6.54	2.17
NHRA	85.87	9.63	8.16	2.26
	HRA>HRD, NHRD		HRA>HRD, NHRD	
	NHRA>HRD, NHRD		NHRA>HRA, HRD, NHRD	

	Comprehension		Rate	
Group	M	SD	M	SD
HRD	6.00	2.58	47.71	32.1
NHRD	6.93	2.26	55.13	13.1
HRA	9.57	2.52	72.57	27.6
NHRA	11.30	2.56	89.40	28.8
	HRA>HRD, NHRD		NHRA >HRD, NHRD	
	NHRA>HRD, NHRD			

The differences between the achieving and delayed groups translated into meaningful clinical differences (which exceeded the maximum of 5.8 months difference found between the NHRA and HRD groups in grade placement). For example, reading comprehension scores were at approximately the mid-grade one level for the delayed groups and at a mid-grade 2 to early grade 3 level for the achieving groups.

As found with most of the cognitive variables, the order of performance on reading variables was HRD < NHRD < HRA < NHRA. However, unlike several cognitive variables where the performance of the hyperactive reading achieving group was most like the non-hyperactive poor reading group, here the hyperactive reading achieving group was most like the non-hyperactive reading achieving group. A significant difference between these two groups was found on only one variable, word recognition.

Reading errors were analyzed for each group looking at the percentage of total errors for each of the error types: substitutions, omissions, mispronunciations, self-corrections, aided, insertions, and scanning. Since the error pattern for each of the

TABLE 14

Analysis of Type of Reading Error

%	Subs.	Omiss.	Misp.	S.C.	Aided	Ins.	Scan.
HRD	41.5	10	13	12	14	8	<1
NHRD	47	6	15	15	15	3	0
HRA	45	11	12	12	15	4	1
NHRA	32	19	16	12	14	8	0

four groups was very similar, further analysis looking at statistical differences was not carried out. As seen in Table 14 the general pattern of errors was very similar for each of the 4 groups. The NHRA group differed somewhat from the other 3 groups in making fewer substitution errors and more omission errors. The similarity of pattern was rather surprising since the impulsive approach of hyperactive children could have been expected to result in a different error pattern from that shown by non-hyperactive children.

Arithmetic Groups

There were four arithmetic groups: (hyperactive arithmetic achieving (HAA) ;(hyperactive arithmetic delayed (HAD);non-hyperactive, arithmetic delayed (NHAD); and non-hyperactive, arithmetic achieving (NHAA). As described previously , the NHAA group was randomly selected from a pool of 197 children.

A one-way analysis of variance was done to compare equivalency of age and grade placement for the groups. The groups did not differ significantly in age, $F(3, 96)=1.559$, $p=.204$, but there was a difference in grade placement, $F(3, 96)=3.503$, $p=.018$, with the HAA

TABLE 15

Description of Arithmetic Groups

Group	N	Age in Mos.	Grade Placement in Mos.
HAA	24	95.33	38.96
HAD	11	96.27	35.45
NHAD	35	99.34	35.51
NHAA	30	95.50	37.70

TABLE 16

Mean CTRS Factor Scores for Arithmetic Groups

	Hyperactivity		Conduct Problem	
Group	M	SD	M	SD
HAA	67.88	7.03	58.79	11.27
HAD	65.45	3.56	53.45	7.62
NHAD	47.26	5.63	44.57	1.70
NHAA	46.13	5.18	45.73	2.79

group significantly different from the NHAD group (as indicated by the Scheffe procedure). However, the overall picture is more one of the two delayed groups being tested somewhat earlier in the academic year with consequent small differences in grade placement between the four groups resulting in a statistical difference for the HAA and NHAD groups. Because arithmetic skill development tends to closely follow classroom instruction, caution should be used in interpreting score differences between these 2 groups although the difference here of approximately 3.5 months is a relatively small one in clinical terms.

These findings are very similar in to those found for the four reading groups. The two hyperactive arithmetic groups differed by about 2 standard deviations (20 points) from the non-hyperactive groups in Hyperactivity Factor T-scores. The one way analysis of variance showed $F(3, 96) = 97.552$, $p <.001$. The two hyperactive groups were higher than the non hyperactive groups for conduct problems, $F(3, 96) = 29.400$, $p <.001$. However, all four of the groups fell within average range on T-scores for the Conduct Problem Factor.

Research Question 4: How do hyperactive arithmetic achieving children differ cognitively from hyperactive arithmetic delayed children, non-hyperactive arithmetic delayed children and non-hyperactive arithmetic achieving children?

Cognitive analysis was of the same 6 IQ variables analyzed for the reading groups (Full Scale IQ, Verbal IQ, Performance IQ, Verbal Comprehension Factor, Third Factor, Perceptual Organization Factor) and the same 4 Memory variables (auditory sentence memory, visual letter memory, auditory word memory, visual object memory). A one-way analysis of variance was computed with each of these variables and the four arithmetic groups.

The IQ score results are shown in Tables 17 and 18. The IQ results in terms of statistical differences showed: (1) The HAA group was significantly different from the HAD group for Verbal IQ, $F(3, 96) = 12.264$, $p < .001$; Verbal Comprehension Factor, $F(3, 96) = 9.698$, $p < 001$; and the Third Factor, $F(3, 96) = 9.433$, $p < 001$. For these same 3 variables the NHAA group was also significantly different from the 2 delayed groups and (2) The NHAA group was significantly

TABLE 17

Mean IQ Scores for Arithmetic Groups

Group	Full Scale IQ M	Full Scale IQ SD	Verbal IQ M	Verbal IQ SD	Performance IQ M	Performance IQ SD
HAD	98.09	8.65	95.55	7.36	101.91	11.45
NHAD	102.20	7.88	101.86	9.60	102.77	11.48
HAA	106.54	11.32	106.63	10.03	105.42	12.65
NHAA	113.27	8.76	113.00	9.36	110.83	9.63
	NHAA>HAD, NHAD		HAA>HAD NHAA>HAD, NHAD		NHAA>NHAD	

TABLE 18

Mean WISC-R Factor Scores for Arithmetic Groups

Group	V.C. Factor M	V.C. Factor SD	PO Factor M	PO Factor SD	Third Factor M	Third Factor SD
HAD	97.33	7.83	105.24	13.45	86.80	11.93
NHAD	104.70	10.47	105.71	11.45	91.33	10.46
HAA	108.09	10.50	107.13	13.03	98.63	10.75
NHAA	114.50	9.57	112.00	8.22	103.37	11.7
	HAA>HAD NHAA>HAD, NHAD				HAA>HAD NHAA>HAD, NHAD	

different from the NHAD group on Performance IQ, $F(3, 96)=.3, 290$, $p=.024$. However, this was more an indication of the extent of the spread between the highest and lowest scores than a difference between 2 groups.

No significant differences were found , then, between the groups for the Perceptual Organization Factor. Small differences were found for Performance IQ with a statistical difference between the 2 non-hyperactive groups. However, the spread in Performance IQ between the highest and lowest of 9 points was relatively small compared with the spread of 17 points in Verbal IQ.

There were marked differences between the groups in terms of verbal skills including both Verbal IQ and the Verbal Comprehension Factor. Unlike the reading groups, the hyperactive arithmetic delayed group was distinctly poorer than either the hyperactive arithmetic achieving group or the non-hyperactive, arithmetic delayed group in verbal skills.

The score pattern of hyperactive delayed < non-hyperactive delayed < hyperactive achieving < non-hyperactive achieving was again present but there were significant groupings with hyperactive delayed < non-hyperactive delayed = hyperactive achieving < non-hyperactive achieving rather than a gradual score increment.

As seen in Table 19 ,the pattern found in preceding analyses of HAD< NHAD < HAA < NHAA was found here as well with the 2 Auditory Memory variables. However, with the 2 Visual Memory variables, all three groups were found to be significantly different from the low performing HAD group. For Visual Letters this was $F(3, 96)=6.992$, $p= .0003$. For Visual Objects this was $F(3, 96) = 7.081$, $p =.0002$. The HAD group appeared, then, to be particularly weak in visual memory skills.

TABLE 19

Mean Memory Scores for Arithmetic Groups

	Aud. Sentence Memory		Aud. Word Memory	
Group	M	SD	M	SD
HAD	38.64	11.28	36.82	5.93
NHAD	48.60	12.92	38.34	6.45
HAA	49.17	12.43	41.17	5.92
NHAA	51.07	14.48	42.70	5.08
	NHAA> HAD		NHAA >HAD, NHAD	

	Visual Letter Memory		Visual Object Memory	
Group	M	SD	M	SD
HAD	37.09	5.63	33.30	3.37
NHAD	45.14	6.13	39.26	6.13
HAA	46.21	8.09	41.04	4.91
NHAA	48.40	7.64	42.30	5.83
	NHAA,NHAD,HAA>HAD		NHAA, NHAD, HAA> HAD	

Research Question 5: How does the pattern of arithmetic skill development differ for hyperactive arithmetic achieving children, hyperactive arithmetic delayed children, non-hyperactive arithmetic delayed children, and non-hyperactive arithmetic achieving children?

Total arithmetic scores for the 4 arithmetic groups was analyzed with a one-way analysis of variance. The results are reported in Appendix B-15. As would be expected with the selection criteria, the achieving groups were significantly better than the non-achieving groups in overall arithmetic scores, $F(3, 96) = 15.66$, $p<.001$.

The pattern of arithmetic performance was analyzed using the Connelly & Nachtman model which looked at computations , operations, and applications. A one-way analysis of variance was computed with each of these 3 arithmetic variables and the 4 arithmetic groups. The means and standard deviations are reported in Table 20.

In terms of statistical differences as determined by the Scheffe procedure with significance set at the .05 level:(1) In all 3 subskill areas the non-hyperactive achieving group was significantly better

TABLE 20

Mean Arithmetic Subscores for Arithmetic Groups

	Content		Operations		Applications	
Group	M	SD	M	SD	M	SD
HAD	24	4	22	7	22	7
NHAD	27	2	23	4	27	5
HAA	28	3	28	6	31	8
NHAA	30	5	31	7	36	9
	HAA>HAD		HAA>HAD, NHAD		HAA>HAD	
	NHAA>HAD, NHAD		NHAA>HAD, NHAD		NHAD>HAD, NHAD	

than both the non-achieving groups. This included content, $F(3, 96) = 9.84$, $p <.001$; operations, $F(3, 96) = 13.68$, $p <.001$; and application, $F (3, 96) = 13.91$, $p <.001$ and (2) The hyperactive arithmetic achieving group was different from the hyperactive non-achieving group in content, operations, and application scores. It was different from the non-hyperactive, non-achieving group on only one score, operations. This difference must be interpreted with caution since grade placement for the 2 groups was significantly different with the non-hyperactive delayed groups seen 3.5 months earlier in the school year than the hyperactive delayed group.

There was no pattern of arithmetic skill development found to be associated with hyperactivity. Although previous research in this area is scarce, some findings had indicated a particular problem with hyperactive children with computations (Ackerman, Anhalt, & Dykman, 1986). However, the subskill area on the Keymath tapping computation skill, Operations, was not a particular problem area for the hyperactive children as a group. Although hyperactive children as a group were not academically distinctive, there was a group of hyperactive arithmetic delayed children who were markedly poorer than the other groups in overall arithmetic skill as well as each of the 3 subskill areas of content, operations, and applications.

Hyperactive/Hyperactive-Conduct Problem Groups

Research Question 6: How does the academic and cognitive performance of non-referred hyperactive children without significant conduct problems differ from those with significant conduct problems?

As described in the preceding chapter, for this portion of the study the hyperactive children were divided into 2 groups. Group 1 (HYPCON) consisted of children whose hyperactivity score as well as conduct problem score was > 60 on the Conners' Teacher Rating Scale (N=12). Group 2 (HYP) consisted of children whose hyperactivity score was >60 but whose conduct problem score was < 60 (N=23).

Equivalency of age and grade placement for the 2 groups was examined. The results of a two-tailed t-test showed that at a .05 level of significance (t= .85) there was no difference between the groups for grade placement. A two-tailed t-test did however show a significant difference at the .05 level in age for the two groups (t.=-2.00). This difference in age would not affect the IQ variables since these scores were already transformed from age tables, but would affect the Memory variables since these comparisons were of raw scores. Interpretations, then, of memory variables must bear in mind the age difference between the groups with Group 2 (Hyp) being 3.1 months older than Group 1. Although this is a statistical difference, it would be considered only a slight difference in ages in clinical terms. Differences in age would not be considered to influence academic results since grade placement was the critical factor here.

Cognitive analysis was of the same 6 IQ variables and 4 Memory variables used with the reading and arithmetic groups. The means and standard deviations of the cognitive variables for the two groups are presented in Table 21.

The t-test results as reported in Appendix B-17 showed no significant differences between the groups on any of the cognitive variables.

The means and standard deviations of the academic scores for the 2 groups are presented in Table 22.

TABLE 21

Mean Cognitive Scores for Hyperactive-Conduct Problem/Hyperactive Groups

Variable	Group 1(HYP-CON) (N=12)		Group 2 (HYP) (N=23)	
	M	SD	M	SD
Full Scale IQ	106.83	8.91	102.35	12.06
Verbal IQ	106.83	8.62	101.22	11.12
Performance IQ	105.50	9.46	103.70	13.60
V.C. Factor	108.94	9.50	102.50	11.08
P.O. Factor	108.00	9.96	105.77	14.53
Third Factor	94.50	11.51	95.12	12.93
Aud.Sentences	44.83	12.96	46.39	13.13
Aud. Words	76.75	24.92	82.43	24.50
Vis. Letters	98.75	14.50	101.57	15.57
Vis. Objects	94.00	26.26	93.75	28.58

TABLE 22

Mean Academic Scores Hyperactive-Conduct Problem/

Hyperactive Groups

Academic Area	Group 1 (HYP-CON) (N=12)		Group 2 (HYP) (N=23)	
	M	SD	M	S D
Reading				
Word Analysis	63.67	22.95	77.91	14.13
Word recognition	4.75	2.34	6.43	2.35
Comprehension	7.67	3.70	9.48	2.19
Rate	60.83	29.59	71.13	29.96
Arithmetic				
	82.17	17.93	81.39	17.82

In terms of arithmetic performance there was not significant difference between the arithmetic score means of the two groups (t=1.28, p=.21). There were, however, some differences in reading performance between the two groups.Word analysis skills were significantly stronger for Group 2 (t=-.28, p.=.03). Word recognition skills were also stronger for Group 2 (t=-2.02, p=.05). Comprehension skills (t=-83, p=.08), while not significantly different at the .05 level, were stronger for Group 2. There was no statistical difference in reading rate (t=-.97, p=.34).

These academic results indicate no difference in arithmetic performance for the two groups. Reading scores for the hyperactive only group were overall stronger than scores for the hyperactive-conduct problem group in all areas but reading rate. Statistical differences were found in word analysis and word recognition skills.

Supplementary Analysis

(a) Further analysis of Third Factor scores for the 4 Arithmetic groups was carried out in order to examine in more detail the low scores of the hyperactive arithmetic delayed group on the

Third Factor. A further analysis of subtest performance was done to see if the difference could be explained primarily by lower scores for the hyperactive, arithmetic delayed group on the WISC-R Arithmetic subtest.

A one-way analysis of variance was computed for the 4 arithmetic groups (hyperactive, arithmetic achieving; hyperactive, arithmetic delayed ;non-hyperactive, arithmetic delayed;non-hyperactive, arithmetic achieving) with the 3 subtests from the WISC-R that make up the Third Factor: Arithmetic, Digit Span, and Coding. Results are presented in Table 23.

In terms of statistical differences:(1) There was a significant difference between the HAA group and the NHAD group as well as between the NHAA group and the 2 arithmetic delayed groups in Arithmetic scores, $F(3, 96) = 9.59$, $p < .001$.and (2) there was a significant difference between the NHAA group and the HAD group in Digit Span scores , $F(3, 96) = 4.12$, $p = .01$.

Although the HRD group was also relatively lower in Coding, this difference was smaller than on the other two subtests making up the Third Factor and was not statistically different (see Appendix B-18).

TABLE 23

Mean Third Factor Subtest Scores for Arithmetic Groups

	Arithmetic		Digit Span		Coding	
Group	M	SD	M	SD	M	SD
HAD	8.45	2.42	7.27	2.33	8.27	3.17
NHAD	8.57	1.56	8.83	2.46	8.66	2.87
HAA	10.29	2.27	9.46	2.15	9.63	3.03
NHAA	11.17	2.55	10.03	2.37	10.33	2.20
	HAA> NHAD NHAA> HAD, NHAD		NHAA> HAD		No sig. diff.	

Of interest in this analysis was the question of whether the very poor performance of the HAD group on the Third Factor was attributable only to very weak arithmetic skills. The results indicate that digit span, a short term memory measure, was weak as well with mean scores here falling into the below average classification. Also of interest was the question of whether or not both hyperactive groups would do poorly on the Arithmetic subtest since this subtest has been designated a good measure of automaticity (Ackerman et al., 1986). There was no support here for the idea that hyperactive children as a group perform poorly on this measure: the performance of the hyperactive achieving group was not different from that of the non-hyperactive achieving group. Again, group divisions were along achieving/non-achieving rather than hyperactive/non-hyperactive lines.

CHAPTER V

Discussion

Research Question 1: Hyperactivity: Overall Relationships

Correlations between selected cognitive and academic variables and hyperactivity scores were examined before group analyses were carried out in order to fully utilize the data from the total number of children in the study (N=267) and to gain an overall perspective of these relationships.

The narrow range of correlations between cognitive variables and hyperactivity did not suggest a particular pattern of deficit other than that verbal skills were more closely associated with hyperactivity than non-verbal skills. Also, the Third Factor appeared to be relatively strongly associated with hyperactivity. These results are supported in a general sense by the literature regarding both verbal skills (Borcherding et al,1988;Carlson et al,1986;Lahey et al,1987) and the Third Factor (Kirby & Grimby,1986) although, since group comparison analysis data is usually reported, there were no studies with which to directly compare this finding.

The two regression analyses, as would be expected, found negative relationships between hyperactivity and both reading achievement and arithmetic achievement. Given the amount of attention directed at the subject of poor academic achievement and hyperactivity, however, the modest degree of relationship was surprising. Hyperactivity accounted for only 5.5% of the variance in reading scores and 3.5% of the variance in arithmetic scores.

The slightly greater predictability of hyperactivity level for reading than arithmetic appeared to result from the distribution of academic scores. Whereas reading ranged from 3 years delay to 4 years advanced for age, arithmetic ranged only from 2 years delayed to approximately 1 1/2 years advanced for age. This distribution would be expected since arithmetic skill development more closely follows classroom instruction than does reading development.

An examination of outliers (N=16 for reading; N=14 for arithmetic) indicated few common themes. Variability rather than homogeneity appeared to rule. However, in both academic areas, IQ appeared to be an explanation for academic scores not predicted by hyperactivity. That is, children with above average IQ had above average academic achievement and those with lower IQ had below average achievement. Further analysis in this area would be necessary to more exactly study the contribution of each of hyperactivity level and IQ level to academic achievement.

Research Questions 2 and 3: Reading Groups

No differences were found between the groups for non-verbal performance. This agrees with the predominant view in the literature that non-verbal skills do not markedly differ for hyperactive children compared with non-hyperactive children.

Verbal differences, most clearly seen in the Verbal Comprehension Factor, were found. However, the picture was more complex than that most often presented in the literature where the poorer verbal skills of hyperactive children are described in relationship to normal children. In this study, because of the inclusion of a non -hyperactive but academically poor group as a comparison, the difference in verbal skills was better represented by a score pattern of hyperactive delayed < non-hyperactive delayed = or < hyperactive achieving < non-hyperactive achieving than by a hyperactive/non-hyperactive diochotomy. Why this should be so is not well explained by previous hypotheses regarding the verbal skills of hyperactive children.

McGee (1989), for example, felt lower verbal skills might be an outcome, rather than a cause of poor reading. However, his explanation would not be valid here because in this study the hyperactive good readers as well as hyperactive poor readers had lower verbal skills than the normal group. Poor reading, then, cannot be used to explain the discrepancy in verbal performance. Another explanation could be that the lower verbal scores might represent a history of inattention in classroom and other settings. This inattention over time could negatively affect the child's store of acquired information and verbal skills have been described as "crystallized" ability that reflect in part past learning (Sattler,1988, p.173). While this explanation would rationalize the performance of the hyperactive children, it would not explain the lower verbal skills of the poor reading non-hyperactive group. A third possible explanation is that since lower verbal skills have been found to be typical also of conduct disordered children (Jurovic & Prentice,1977), lower verbal skills for hyperactives might be traced to this overlap with the conduct disordered . However, this does not seem strongly supported in the present research since a comparison between hyperactive and hyperactive-conduct problem groups showed verbal scores for the hyperactive only group to be lower (although not significantly different) than the scores for the hyperactive-conduct problem group.

Perhaps two independent explanations are required to explain the findings but none of the three hypotheses referred to above can be used in combination because of logical exclusions. Some other explanation or combination of explanations not yet generated in the literature seem to be required here. One possible hypothesis is that verbal skills are only part of the explanation. The non-hyperactive poor reader group may have other process difficulties, for example, auditory processing difficulties, that have specifically contributed to problems in acquiring reading skills and that are also present in the hyperactive poor reader group. That this group does so poorly academically may reflect a cumulative deficit in several areas including attention, verbal skills, and other learning process areas. More specific work with heterogeneous groupings such as those in this study would be needed in order to specify deficits .

Memory functioning has been a frequently studied aspect of the cognitive performance of various groups of special children such as the hyperactive and the learning disabled. Generally speaking, both of these groups have been found to be lower in aspects of memory functioning than normal children although relatively few studies have directly compared hyperactive with reading disabled children. Based on previous research, the two hyperactive groups and the reading problem group might have been expected to be significantly different from the normal group in memory performance. Such was not the case. Although the normal group was always better in terms of mean scores than the other 3 groups on each of the 4 memory tests and although the normal group was significantly different from the other 3 groups on one memory measure, visual letters, the overall pattern was more one of gradual increments in memory performance. In other words, the hyperactive delayed <non-hyperactive delayed < hyperactive achieving < non-hyperactive achieving pattern was again evident although for 2 of the 4 memory measures, the non-hyperactive academically delayed group was slightly stronger than the hyperactive achieving group .

Memory variables, like the IQ variables, found the hyperactive reading achieving group more similar to the non-hyperactive reading reading delayed group than either the other hyperactive group or the normal group. This pattern held true for all 4 memory tests. There was no evidence here of a difference in modality performance as had been previously reported (Sutter, Batten & Bishop,1987).

On auditory memory tests, a relatively large range of scores across the groups was present for auditory memory for sentences (with a significant difference in scores between the HRD and NHRA groups) whereas in auditory memory for words the spread of scores was relatively small (with no significant differences). Since auditory sentence memory is considered to be a strong measure of linguistic development (Hammill,1985;Wiig & Semel,1980), these findings may reflect discrepant verbal skill development as well as memory functioning.

Visual Memory for Letters was found to discriminate groups but the difference was not between hyperactive and non-hyperactive children but between non-hyperactive achieving children and all other groups. Without further study, it is difficult to find a satisfactory unitary explanation this. Rather, diverse elements appear to be at work. Sutter, Battin and Bishop (1986) in their study of the psychometric test performance of hyperactive and non-hyperactive children felt that the Detroit Visual Memory for Letters grouped within an achievement factor rather than a memory factor. In other words, this test may reflect present reading achievement. This would be in agreement with the view of Bryant and Bradley (1985) that reading skills may determine memory performance rather than the reverse. However, while this would explain the poor performance of the poor reading groups in this study in visual memory for letters, it would not explain the weak performance of the hyperactive good reading group. Since visual memory for letters requires a diversity of skills including rote memory, sequencing ability, and use of appropriate memory strategies, poorer performance here may indicate a breakdown in one or more memory processes for the three groups. Alternately, some other factor or group of factors not included in this study may be necessary to complete the picture. Clearly, however, hyperactivity is not the main factor in explaining performance on this test.

In terms of comparison with other studies of non-referred children, these memory results are not in accordance with McGee's (1989) finding of a verbal memory deficit for poor readers but not for hyperactive children. However, although both studies were of non-referred children, there were several other differences between the studies. McGee used different memory measures, different reading measures, and included only males in his study.

In terms of overall reading achievement levels, since one of the criteria for group selection was degree of reading proficiency, the two groups selected for good reading ability would be expected to be better in reading than the poor reading ability groups. However, if hyperactive children were much poorer in reading skills than normal children, the HRA group could have been expected to be better than the delayed groups but significantly poorer than the NHRA group. Such was not the case. The hyperactive reading achieving group was not significantly different from the non-hyperactive reading achieving group in terms of overall reading achievement level although it was significantly different from both of the delayed groups. In view of the often reported finding that hyperactive children are delayed in reading skills, this was a bit surprising but not without precedent in non-referred subject research (McGee,Williams, Moffitt, & Anderson,1989).

The two good reading groups, whether hyperactive or not, were very similar in their pattern of reading skill performance. Scores in word analysis skills and reading comprehension did not significantly differ for the 2 groups (although the non-hyperactive group did have higher scores). As well, the analysis of errors showed few differences between hyperactive and non-hyperactive children. Although no previous research appears to have been conducted with reading error analysis, since hyperactive children are impulsive they might have been expected to make relatively more errors in insertions, self-corrections, or omissions. An alternative view would be that since self-corrections can be taken as evidence of good self-monitoring strategies, impulsive children could have been expected to make fewer self-corrections. In either case, a different error pattern for the hyperactive children could have been expected but was not realized in these results.

However, differences for hyperactive children were found in word recognition skills: in this area there was a significant difference between the hyperactive and non-hyperactive good readers. An important point here is that concomitant weaknesses were not found for the hyperactive good readers in word analysis or reading comprehension skills. Thus, hyperactive good readers were just as proficient as non-hyperactive good readers in decoding and, further, could read a similar level of material when meaningful comprehension was involved. However, they were weaker in identifying words in isolation, a skill sometimes referred to as "name calling". This suggests several points of interest.

One is that since nearly all studies have included only a measure of word recognition skill for testing reading proficiency, such as provided by the WRAT, a true picture of reading proficiency may not have been given for hyperactive children. That is, the one reading skill consistently measured appears to be the area of greatest weakness for hyperactive children. Reporting skill in this area alone for hyperactive children does not provide an understanding of the pattern of reading development and ,as well, may well underestimate the true skill level.

Why hyperactive children would be relatively weaker in word recognition skills is a matter of speculation that may relate to the effortful processing model since word recognition is considered an automatic task (Samuels,1987). As reviewed in Chapter II, findings in this area have been inconsistent: some researchers, primarily on the basis of memory tasks, have found hyperactive children to be deficient in effortful processing (Borcherding, et al, 1988; Douglas & Benezra,1990) ; others, on the basis of academic tasks, have found them deficient in automatic processes (Ackerman et al,1986). If automaticity were the reason for weak word recognition skills, then reading rate, also a measure of automaticity, could be expected to be low for hyperactive children as well. In this skill area, while hyperactive good readers were relatively slower in reading rate than non-hyperactive good readers, there was not a statistical difference. Obviously there is not enough information here to decide the extent to which automaticity does or does not play a part in word recognition performance for hyperactive children. However, the limited evidence here does not compellingly suggest a sole basis in lack of automaticity.

A second component that appears to be related to word recognition is that of memory skills. Visual memory skills for letters were found to be weak for both hyperactive groups. Weak visual memory skills have been hypothesized to underlie lack of automaticity (Webster,1979). As well, good performance on the word recognition task would appear to depend upon the ability to remember words previously seen, a visual memory task. Perhaps more research in this area would make clearer the connections between memory performance and word recognition skill. One aspect of memory that may have relevance here is the so called "meaningful/non-meaningful " distinction since limited evidence exists that more meaningful memory tasks such as memory for prose may be better for hyperactive children than more rote tasks (O'Neil & Douglas, 1991).

In summary, these reading skill results do not suggest a "hyperactive reader" (although the predominantly male non-hyperactive poor reader group suggests it may resemble the poor reader group described in the learning disability literature).

Academically, hyperactive reading achieving children performed very similarly to non-hyperactive reading achieving children. Conversely, hyperactive poor readers performed similarly to non-hyperactive poor readers. However, a difference was found in word recognition skills where although hyperactive good readers were more skilled than both poor reader groups, they were significantly weaker than non-hyperactive good readers. This was discussed as relating to weak memory skills as well as to possible weakness in automaticity. This finding of relatively weaker skills in word recognition suggests that since the reading instruments most frequently used measure only this aspect of reading, the true reading ability of hyperactive children may often be underestimated. Certainly an accurate picture of relative strengths and weakness within reading is not presented.

Research Questions 4 and 5: Arithmetic Groups

One limitation of previous research with hyperactive children has been that academic groups almost without exception were selected on the basis of reading performance. While some children with reading problems also have arithmetic problems (Smith,1983), there are also distinct subtypes within each of these academic areas (Rourke & Strang,1983) so that group selection based on reading performance alone will not yield optimal information. To gain a clear picture of cognitive and academic functioning in arithmetic, it is necessary to select subjects on the basis of arithmetic performance as was done in this study. Hence, while there was some overlap of subjects between poor reading and poor arithmetic groups for both the hyperactive and non-hyperactive children, approximately half of the poor arithmetic groups were made up of children with problems exclusively in arithmetic.

In spite of the strong impression from the literature that hyperactive children have reading problems but not arithmetic problems, one of the surprising findings in this study was that a greater percentage of hyperactive children had arithmetic problems than had reading problems . For the hyperactive children 20% had reading delay compared with 31% with arithmetic delay. This is in contrast to the non-hyperactive children who showed 13% with reading delay and 15% with arithmetic delay.

This finding may be related to the following factors: (1) the fact that this population is a non-referred one. Since most of the existing studies were done with clinic referred populations often referred for behaviour and/or reading problems it is perhaps not surprising that they would be low in reading scores with arithmetic scores a possible relative strength. One of the few non-referred studies (Goldstein,1987) found hyperactive only girls as well as boys to be relatively, although not significantly , lower in arithmetic scores on the WRAT compared with reading scores. This was not true of hyperactive-aggressive groups or hyperactive-low attention groups. Unfortunately, McGee with his large follow-up study of non-referred children did not include a measure of arithmetic functioning; (2) the fact that traditionally in academic literature far more attention has been given to the investigation of reading problems than arithmetic problems ;(3) the inclusion in this study of females. As previously noted, many previous studies have been of males only. Since girls tend to experience relatively more problems in arithmetic than reading (Vogel,1990), the inclusion of girls in the subject population could bring a more balanced representation of reading/arithmetic problems and (4) girls have been noted to have particular problems in math reasoning,although not necessarily computations (Vogel,1990). Since the Keymath, unlike the widely used WRAT which measures only computations, tests a variety of math skills including several subtests of various types of math reasoning, the use of this test may have enabled a more sensitive measurement of existing arithmetic problems.

Not only were numerically more arithmetic delayed hyperactive children found than reading delayed, but there was some evidence that the hyperactive arithmetic delayed group was more specifically disabled than the poor reading group. That is, while a high percentage of the hyperactive poor reader group was also delayed in arithmetic suggesting a general academic delay more than a specific reading delay at least half of the arithmetic problem group had only arithmetic delay.

No significant differences were found between the groups in non-verbal skills. This would be in keeping with the consistent reports in the literature of relatively intact performance in the non-verbal area for hyperactive children. There were, however, considerable differences between the groups in verbal skills with the hyperactive arithmetic delayed group distinctly poorer than any of the other groups in verbal skills suggesting a specific cognitive deficit.

In terms of memory performance, again the HAD group appeared to be cognitively different from the other groups. Poor memory skills in general and poor visual memory skills in particular appeared to characterize this group while perceptual organization skills, including a measure of spatial reasoning, were not different from that of the other 3 groups. This is in agreement with the statement by Ackerman et al.(1986) that hyperactive children with arithmetic problems have a major cognitive deficit in memory but not in spatial reasoning (as might be expected from an application of the arithmetic subtypes derived by Rourke and Strang,1983).

In view of the extensive range of Third Factor scores (16 points) along with the very weak performance by the HAD group on this measure, a supplementary analysis was carried out regarding the group scores for each of the 3 subtest areas of Arithmetic, Digit Span, and Coding. Of particular interest was whether other areas beside Arithmetic were weak for the HAD group. The results indicated significantly lower scores in Arithmetic for both arithmetic delayed groups, hyperactive or not. Additionally, scores in Digit Span were also poorer for the HAD group. Since this subtest measures short-term memory and attention as well as sequencing ability (Kaufman,1979;Sattler,1988), these skills may be particularly problematic for this group. Coding subtest scores showed no significant differences between groups. Since this subtest measures visual-motor coordination as well as attention, short-term memory, and cognitive flexability (Sattler,1988), relatively less differences here may mirror the relatively less differences found in non-verbal IQ measures .

Although further investigation is needed, this supplementary analysis appears to contribute to the overall picture of the HAD group as a cognitively distinct group with deficit cognitive areas theoretically linked to arithmetic performance.

In terms of patterns of academic functioning, previous research has linked hyperactive children with decreased automaticity resulting in poor computation skills (Ackerman,Anhalt,& Dykman,1986) as well as poorer problem solving skills (Douglas ,1980;Douglas & Benezra,1990). Although the computation questions from the Keymath used in this study were not timed and so do not give an accurate picture of degree of automatization according to Ackerman et al.(1986), the Arithmetic subtest of the WISC-R is reported to be a good measure of automaticity (Ackerman et al,1986). As previously noted, both of the poor arithmetic groups did poorly on the Arithmetic subtest. Further, both of the achieving groups, whether hyperactive or not, did relatively well on this subtest with a mean score of 10 of the hyperactive gro[illegible]r the non-hyperactive group. There was no di[illegible]ce statistically or clinically between these groups as would be expected if an automaticity deficit was present. As noted in the reading discussion, automaticity does not, on its own, appear to satisfactorily explain the performance of hyperactive children.

These findings relate in a general manner to the arithmetic model outlined by Batchelor,Gray and Dean (1990) who found that poor arithmetic performance of learning disabled children rested upon limited working memory as well as the cumulative effects of long-term memory (memory for facts, arithmetic vocabulary, knowledge of problem types) and concluded that a strong memory processing component was present in arithmetic performance. In this study, the HAD group can be seen to perform poorly in memory tasks. However, since a strong component of Third Factor performance is attention (Kaufman,1979), it could be speculated that an attention component should be added to the memory processing component of the model to explain arithmetic performance. As discussed in the literature review, attention and memory are closely related processes. In terms of classroom performance, it makes sense that a strong element of attention is necessary to follow instruction in arithmetic and since arithmetic skill development is very sequential ,inattention at one stage of instruction would affect performance in future stages of skills as well.

In summary of this area, the hyperactive arithmetic delayed group was poorer verbally ,poorer in visual memory, and were extremely weak in their Third Factor scores. Without further study, it is not possible to determine whether hyperactive arithmetic delayed children are more cognitively distinct than are hyperactive reading delayed children.

Research Question 6: Hyperactive and Conduct Problem Groups

Because of the extensive overlap between hyperactivity and conduct disorder as discussed in the literature review, a critical question in research into the academic functioning of hyperactive children is the extent to which each of the problem areas hyperactivity and conduct problems contribute to academic problems.

In this study children who had both conduct problems and hyperactivity made up 34% of the hyperactive subjects. This is lower than Goldstein's 1987 study of non-referred children ages 6 to 11 that found 33 of the 72 subjects (46%) to have both conduct problems and hyperactivity. However, Goldstein's study was of boys only. In terms of clinic referred children, an overlap as high as 71% has been reported (Loney & Milich,1982). From this limited basis, it appears that the overlap between conduct disorder and hyperactivity might be considerably lower for the non-referred population than it is for the clinic referred population. This would be logical since referrals are made on the basis of presenting problems in some setting and the behaviours presented by conduct disorder children would probably cause more disruption and more problems than those of children who were only over active. Werry,Reeves,& Elkind (1987) have noted that children with multiple problems are more likely to be referred than those with a single problem.

No cognitive differences were found between the hyperactive only and hyperactive-conduct problem groups. Differences were found, however, in reading with the hyperactive only group stronger in reading with significant differences found in word analysis and word recognition skills.

As noted in Chapter II, previous research regarding possible cognitive/academic differences for hyperactive/conduct problem groups has been discrepant. However, it is interesting to note that the results from this study agree in many points with the results from both a large non-referred study (August & Garfinkel,1989) and a small clinic referred study (Forness,Cantwell, Swanson,Hanna,& Youpa,1991). Specifically, all three studies found few cognitive differences but stronger reading skills for hyperactive-only children. One of the factors these studies had in common is that the measurement of both hyperactivity and conduct problems was carefully controlled in subject groups specification. This is not the case in many studies where hyperactive groups may contain conduct problems not specified and conduct problem groups may contain hyperactivity not specified. Certainly too many conclusions cannot be drawn from this limited base, but it appears that in the matter of measuring the relative contributions of hyperactivity and conduct problems to cognitive and academic performance, careful subject selection may be as or more important than the clinic/non-referred distinction.

Since there were no differences in cognitive performance between the two groups, cognitive deficits, at least on the basis of the measures selected for this study, cannot be used as an explanation for the superior reading skills of the hyperactive only group. Perhaps it is necessary to go beyond cognitive factors to examine such home and school factors as SES levels, motivation, or school attendance to find explanations for differences. Perhaps the dual hyperactive -conduct problem group spend significantly more time in school misbehaving, missing out classroom instructions, failing to complete assignments, and so on. Perhaps more of this group come from dysfunctional families and home problems interfere with academic progress. More research is warranted here.

Another possibility is that the hyperactive-only group was better in reading because it had more girls in it (61% girls compared with 25 % in the hyperactive -conduct problem group). Reading problems are more commonly associated with boys than girls (Reid & Hresko,1981) and conduct problem boys have been found to have weaker reading skills than conduct problem girls (Goldstein,1987). However, a gender difference explanation would not be congruent with the Forness et al.(1991) study that reported similar results to the present study but was exclusively of boys.

Supplementary Analysis: Third Factor

As reported in Chapter II, some previous research had indicated that the WISC-R Third Factor might be useful to discriminate hyperactive children from other groups such as normal children and conduct disordered children. If these scores could be used in this way it would be of obvious practical benefit to the clinician since WISC-R test data are available for most children experiencing problems of some description.

This study differed from previous research in two main respects: (1) the children in this study were non-referred (2) a direct comparison was made in this study between hyperactive children, non-hyperactive children with reading or arithmetic problems, and "normal " children.

As reported in the previous chapter, for the arithmetic groups the Third Factor did distinguish hyperactive children either with or without academic problem from non-hyperactive academically achieving children. However, low Third Factor scores were also found for non-hyperactive children with either reading or arithmetic problems. This reduces the potential usefulness of the Third Factor in making differential diagnosis of children since, at least for this sample, it did not differentiate hyperactive achievers/ hyperactive non-achievers/ non-hyperactive non-achievers.

This finding does not support the research of Carter,Zelko,Oas, and Waltonen (1990) who found the Third Factor to discriminate hyperactive children from other children referred for a variety of reasons to an educational clinic. However, as the authors state, the characteristics of their sample (males only, children of military personnel) does limit the generalizations that can be made from their study. Another difference between the two studies may be the clinic referred/non-referred distinction.

Since the Third Factor is potentially a useful tool for diagnosis, more work need to be done in this area. Possible areas to explore would include looking at male/female performance differences as well as further investigations with both referred and non-referred populations that directly make the comparisons made in this study.

GENERAL OBSERVATIONS AND IMPLICATIONS

These findings suggest that only limited generalizations can be made from studies of clinic-referred children to the more general population of hyperactive children. Since at the present time the literature is replete with clinic-referred studies, more attention needs to be directed to non-referred hyperactive children . A better understanding of differences between these two groups could lead to an increased theoretical understanding of the nature of "pure" hyperactivity, as well as point the way to more effective interventions.

This research did not support the notion of an academically typical hyperactive child. Being classified as hyperactive did not strongly predict the level of either a child's reading or arithmetic achievement. For a significant number of the hyperactive children in this study, specifically 80 % in reading and 69 % in arithmetic, academic skills were at or above grade level. This was despite performance on cognitive measures that tended to most closely resemble the non-hyperactive academically delayed children . In this study relatively weaker cognitive functioning in areas such as verbal skills did not necessarily translate into academic deficit. Therefore, studies that concentrate on cognitive performance alone and hypothesize from these findings to predict academic results may be in error. This study clearly indicates the need to include both cognitive and academic measures so that valid links between the two can be established.

A small group of the hyperactive children did evidence significant academic delays. This group differed cognitively in degree from the other groups with particularly extensive deficits in memory and verbal measures. Although interventions for hyperactive children have frequently been limited to medical intervention with drugs, the indications are strong that for this group of hyperactive-learning problem children academically focused intervention is critical. However, more research is needed to explore specific links between academic and cognitive functioning for this group.

A particularly strong need was suggested from this study for more investigation with the group of hyperactive children experiencing difficulty in arithmetic. There is a need for a direct comparison of arithmetic and reading groups on cognitive measures as well as a need for more information concerning the specific links between cognitive and arithmetic functioning for this group. As previously described, the Batchelor,Gray and Dean (1990) arithmetic model , with modification, might be a suitable starting point here.

A score pattern of hyperactive academic delayed group < non-hyperactive delayed group < or = hyperactive achieving group < non-hyperactive achieving group was consistently found although group differences in scores were often not statistically different. This pattern of gradual score increment could be explained by a cumulative deficit model. That is, the presence of two problem areas appeared to result in poorer academic outcome than the presence of one problem area alone. This could be seen in the cumulative deficit of the hyperactive and learning problem group as well as in the hyperactive and conduct problem group. At the present time, requirements for receiving special service at the school level are often based on classification in only one area. These findings suggest that perhaps number of problems might be a better indicator of need for academic help.

Finally, the study of achieving and not achieving groups of hyperactive children could be broadened beyond the scope of this study to a more ecological perspective. Such a study would move beyond focus on cognitive factors that might account for the academic success of the hyperactive achieving group to include factors outside the child. This could include various family and school factors such as parental level of education, number of family relocations, and class size.

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APPENDIX A

Items from the Conners Teacher Rating Scale (CTRS-39)

1. Constantly fidgeting
2. Hums and makes other odd noises
3. Demands must be met immediately
4. Coordination poor
5. Restless or overactive
6. Excitable,impulsive
7. Inattentive,easily distracted
8. Fails to finish things s/he starts
9. Overly sensitive
10. Overly serious or sad
11. Daydreams
12. Sullen or sulky
13. Cries often or easily
14. Disturbs other children
15. Quarrelsome
16. Mood changes quickly and drastically
17. Acts smart
18. Destructive
19. Steals
20. Lies
21. Temper outbursts, explosive and unpredictable behaviour
22. Isolates him/herself from other children
23. Appears to be unaccepted by group
24. Appears to be easily lead
25. No sense of fair play
26. Appears to lack leadership
27. Does not get along with opposite sex
28. Does not get along with same sex
29. Teases other children or inteferes with their activities
30. Submissive
31. Defiant
32. Impudent
33. Shy
34. Fearful
35. Excessive demands for teacher's attention
36. Stubborn
37. Overly anxious to please
38. Uncooperative
39. Attendance problem

APPENDIX B-1

Regression Statistics for Reading

Regression of hyperactivity on overall reading achievement level

Correlation -.2350 R Squared.0552 2-tailed sig..0001

Intercept (S.E.) 50.59 Slope (S.E.) -1.53

APPENDIX B-2

Regression Statistics for Arithmetic

Regression of hyperactivity on overall arithmetic achievement level

Correlation -.1859   R Squared .0346   2-tailed Sig..0023

Intercept (S.E.) 48.80   Slope (S.E.) -2.72

APPENDIX B-3

One Way Analysis of Variance of Full Scale IQ for Reading Groups

Dependent Variable: Full Scale IQ

Total Population Mean = 105.990 (N=95)

Group Means

HRA	HRD	NHRD	NHRA
104.679	100.714	103.800	110.633
(N=28)	(N=7)	(N=30)	(N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	1033.687	3	344.562	3.703	.015
Within Groups	8467.302	91	93.047		

APPENDIX B-4

One Way Analysis of Variance of Verbal and Performance IQ for Reading Groups

Dependent Variable: Verbal IQ

Total Population Mean = 105.874 (N=95)

Group Means

HRA	HRD	NHRD	NHRA
104.214 (N=28)	98.857 (N=7)	104.00 (N=30)	110.933 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	1295.046	3	431.682	4.583	.005
Within Groups	8571.438	91	94.192		

Dependent Variable: Performance IQ

Total Population Mean = 105.263 (N=95)

Group Means

HRA	HRD	NHRD	NHRA
104.786 (N=28)	102.429 (N=7)	103.467 (N=30)	108.167 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	412.353	3	137.453	1.056	.372
Within Groups	11848.062	91	130.199		

APPENDIX B-5

One Way Analysis of Variance of WISC-R Factor Scores for Reading Groups

Dependent Variable: Verbal Comprehension Factor

Total Population Mean = 107.427 (N=95)

Group Means

HRA	HRD	NHRD	NHRA
105.990 (N=28)	99.580 (N=7)	106.223 (N=30)	111.809 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	1108.796	3	369.599	3.738	.014
Within Groups	8997.164	91	98.870		

Dependent Variable: Perceptual Organization Factor

Total Population Mean = 106.720 (N=95)

Group Means

HRA	HRD	NHRD	NHRA
107.314 (N=28)	103.429 (N=7)	106.027 (N=30)	107.627 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	124.806	3	41.602	.301	.824
Within Groups	12565.626	91	138.084		

Dependent Variable: Third Factor

Total Population Mean = 97.823 (N=95)

Group Means

HRA	HRD	NHRD	NHRA
94.814 (N=28)	95.286 (N=7)	93.693 (N=30)	105.353 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	2511.333	3	837.111	6.341	.001
Within Groups	12013.456	91	132.016		

APPENDIX B-6

One Way Analysis of Variance of Auditory Memory Scores for Reading Groups

Dependent Variable: Auditory Memory for Sentences

Total Population Mean = 50.01 (N=95)

Group Means

HRA	HRD	NHRD	NHRA
48.32 (N=28)	36.00 (N=7)	49.83 (N=30)	55.03 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	2211.749	3	737.250	4.919	.003
Within Groups	13639.240	91	49.881		

Dependent Variable: Auditory Memory for Words

Total Population Mean = 40.820 (N=95)

Group Means

HRA	HRD	NHRD	NHRA
40.57 (N=28)	36.71 (N=7)	39.57 (N=30)	43.27 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	346.439	3	115.480	3.16	.03
Within Groups	3325.519	91	36.544		

APPENDIX B-7

One Way Analysis of Variance of Visual Memory Scores for Reading Groups

Dependent Variable: Visual Letter Memory

Total Population Mean = 45.737 (N=95)

Group Means

HRA	HRD	NHRD	NHRA
44.358 (N=28)	39.286 (N=7)	42.867 (N=30)	51.400 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	1553.897	3	517.966	9.173	.000
Within Groups	6692.421	94	56.467		

Dependent Variable: Visual Object Memory

Total Population Mean = 40.340 (N=94)

Group Means

HRA	HRD	NHRD	NHRA
39.429 (N=28)	35.667 (N=6)	40.300 (N=30)	42.167 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	254.449	3	84.816	2.632	.055
Within Groups	2900.657	90	32.230		

APPENDIX B-8

One Way Analysis of Variance of Word Analysis and Word Recognition for Reading Groups

Dependent Variable: Word Analyis

Total Population Mean = 73.93 (N=95)

Group Means

HRA	HRD	NHRD	NHRA
75.536 (N=28)	51.000 (N=7)	63.033 (N=30)	85.867 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	1211.087	3	4037.029	20.667	.000
Within Groups	17773.398	91			

Dependent Variable: Word Recognition

Total Population Mean = 5.979 (N=95)

Group Means

HRA	HRD	NHRD	NHRA
6.536 (N=28)	3.143 (N=7)	3.933 (N=30)	8.167 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	334.103	3	111.368	30.539	.000
Within Groups	331.855	91	3.647		

APPENDIX B-9

One Way Analysis of Variance of Comprehension and Rate for Reading Groups

Dependent Variable: Comprehension

Total Population Mean = 9.021 (N=95)

Group Means

HRA	HRD	NHRD	NHRA
9.571 (N=28)	6.000 (N=7)	6.933 (N=30)	11.300 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	358.934	3	119.645	19.831	.000
Within Groups	549.024	91	6.033		

Dependent Variable: Rate

Total Population Mean = 70.547 (N=95)

Group Means

HRA	HRD	NHRD	NHRA
72.571 (N=28)	47.714 (N=7)	55.133 (N=30)	89.400 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	21554.585	3	7184.862	11.738	.000
Within Groups	55700.952	91	612.098		

APPENDIX B-10

One Way Analysis of Variance of Full Scale IQ for Arithmetic Groups

Dependent Variable: Full Scale IQ

Total Population Mean = 106.110 (N=100)

Group Means

HAA	HAD	NHAD	NHAA
106.542 (N=24)	98.091 (N=11)	102.200 (N=35)	113.267 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	2783.456	3	927.819	11.092	.000
Within Groups	8030.334	96	83.650		

APPENDIX B-11

One Way Analysis of Variance of Verbal and Performance IQ for Arithmetic Groups

Dependent Variable: Verbal IQ

Total Population Mean = 105.650 (N=100)

Group Means

HAA	HAD	NHAD	NHAD
106.625 (N=24)	95.546 (N=11)	101.857 (N=35)	113.000 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	3270.112	3	1090.037	12.264	.000
Within Groups	11802.750	96	88.882		

Dependent Variable: Performance IQ

Total Population Mean = 105.730 (N=100)

Group Means

HAA	HAD	NHAD	NHAA
105.417 (N=24)	101.909 (N=11)	102.771 (N=35)	110.833 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	1250.630	3	416.877	3.290	.024
Within Groups	12165.081	96	126.720		

APPENDIX B-12

One Way Analysis of Variance of WISC-R Factor Scores for Arithmetic Groups

Dependent Variable: Verbal Comprehension Factor

Total Population Mean = 107.64 (N=100)

Group Means

HAA	HAD	NHAD	NHAA
108.085 (N=24)	97.327 (N=11)	104.704 (N=35)	114.504 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	2889.765	3	963.255	9.698	.000
Within Groups	9535.410	96	99.327		

Dependent Variable: Perceptual Organization Factor

Total Population Mean = 107.89 (N=100)

Group Means

HAA	HAD	NHAD	NHAA
107.133 (N=24)	105.236 (N=11)	105.714 (N=35)	112.000 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	763.644	3	254.548	2.009	.1179
Within Groups	12165.662	96	126.726		

Dependent Variable:Third Factor

Total Population Mean = 96.194 (N= 100)

Group Means

HAA	HAD	NHAD	NHAA
98.625	86.800	91.326	103.373
(N=24)	(N=11)	(N=35)	(N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	3488.346	3	1162.782	9.433	.000
Within Groups	11833.691	96	123.268		

APPENDIX B-13

One Way Analysis of Variance of Auditory Memory Scores for Arithmetic Groups

Dependent Variable: Auditory Memory for Sentences

Total Population Mean = 50.180 (N=100)

Group Means

HAA	HAD	NHAD	NHAA
49.167 (N=24)	38.636 (N=11)	48.600 (N=35)	57.068 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	3000.615	3	1000.205	5.851	.001
Within Groups	16412.146	96	170.60		

Dependent Variable: Auditory Memory for Words

Total Population Mean = 40.160 (N=100)

Group Means

HAA	HAD	NHAD	NHAA
41.168 (N=24)	36.819 (N=11)	38.343 (N=35)	42.700 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	456.285	3	152.095	4.394	.006
Within Groups	3323.155	96	34.616		

APPENDIX B-14

One Way Analysis of Variance of Visual Memory Scores for Arithmetic Groups

Dependent Variable: Visual Letter Memory

Total Population Mean = 45.490 (N=100)

Group Means

HAA	HAD	NHAD	NHAA
46.208 (N=24)	37.091 (N=11)	45.143 (N=35)	48.400 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	1046.637	3	348.880	6.992	.0003
Within Groups	4790.353	96	49.900		

Dependent Variable: Visual Objects

Total Population Mean = 40.010 (N=99)

Group Means

HAA	HAD	NHAD	NHAA
41.042 (N=24)	33.300 (N=10)	39.257 (N=35)	42.300 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	652.956	3	217.649	7.081	.0002
Within Groups	2920.044	95	30.737		

APPENDIX B-15

Analysis of Variance of Mean Arithmetic Scores for Arithmetic Groups

Dependent Variable: Mean Arithmetic Scores

Total Population Mean =84.130 (N=100)

Group Means

HAA	HAD	NHAD	NHAA
87.708 (N=24)	68.455 (N=11)	75.886 (N=35)	96.633 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	10079.115	3	3359.705	15.661	.000
Within Groups	20594.195	96	214.523		

APPENDIX B-16

One Way Analysis of Variance of Mean Arithmetic Subscores for Arithmetic Groups

Dependent Variable: Content

Total Population Mean = 27.580 (N=100)

Group Means

HAA	HAD	NHAD	NHAA
28.000 (N=24)	24.090 (N=11)	26.286 (N=35)	30.033 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	377.341	3	125.781	9.841	.000
Within Groups	1227.019	96	12.781		

Dependent Variable: Operations

Total Population Mean = 26.430 (N=100)

Group Means

HAA	HAD	NHAD	NHAA
28.417 (N=24)	22.891 (N=11)	22.657 (N=35)	30.833 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	1381.715	3	460.572	13.677	.000
Within Groups	3232.794	96	33.675		

Dependent Variable:Applications

Total Population Mean =30.140 (N=100)

Group Means

HAA	HAD	NHAD	NHAA
31.250 (N=24)	22.273 (N=11)	26.42 (N=35)	36.100 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	2179.973	3	726.658	13.907	.000
Within Groups	5016.068	96	52.251		

APPENDIX B-17

T-test Results for Hyperactive-Conduct Problem/Hyperactive Groups (df=3)

Variable	t value	2-tail prob.
Full Scale IQ	1.13	.26
Verbal IQ	1.52	.14
Performance IQ	0.41	.68
Verbal Comprehension Factor	1.71	.10
Perceptual Organization Factor	0.47	.64
Third Factor	-0.14	.89
Aud.Sentence Memory	0.33	.74
Aud.Word Memory	-0.65	.52
Visual Letter Memory	0.52	.61
Visual Object Memory	0.02	.98
Word Analysis	2.28	.03
Word Recognition	-2.02	.05
Comprehension	-1.83	.08
Rate	-0.97	.34
Arithmetic	0.12	.90

APPENDIX B-18

One Way Analysis of Variance of Mean Third Factor Subtest Scores for Arithmetic Groups

Dependent Variable: Arithmetic Subtest

Total Population Mean = 9.750 (N=100)

Group Means

HAA	HAD	NHAD	NHAA
10.292 (N=24)	8.455 (N=11)	8.571 (N=35)	11.167 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	134.326	3	44.775	9.586	.000
Within Groups	448.424		4.671		

Dependent Variable: Digit Span

Total Population Mean = 9.170 (N=100)

Group Means

HAA	HAD	NHAD	NHAA
9.458 (N=24)	7.273 (N=11)	8.829 (N=35)	10.033 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	68.032	3	22.677	4.123	.009
Within Groups	528.078	96	5.501		

Dependent Variable: Coding

Total Population Mean =9.350 (N=100)

Group Means

HAA	HAD	NHAD	NHAA
9.625 (N=24)	8.273 (N=11)	8.657 (N=35)	10.333 (N=30)

Source	Sum of Squares	df	Mean Squares	F	F prob.
Between Groups	60.391	3	20.130	2.639	.054
Within Groups	732.360	96			