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Sex differences in the manifestation of Attention Deficit-Hyperactivity Disorder

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SEX DIFFERENCES IN THE MANIFESTATION OF ATTENTION DEFICIT-HYPERACTIVITY DISORDER

by

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Abstract

SEX DIFFERENCES IN THE MANIFESTATION OF ATTENTION DEFICIT-HYPERACTIVTY DISORDER

by

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The purpose of the present research was to examine gender differences in the manifestation of Attention Deficit-Hyperactivity Disorder (ADHD). Experiment 1 investigated sex differences in attention and behavior problems in a sample of eighty-five (42 boys and 43 girls) non-referred children. Each child was administered a test brief battery which consisted of a continuous performance test, the Matching Familiar Figures Test, Digit Span and Peabody Picture Vocabulary Test. In addition, children were rated by parents and teachers using the Revised Conners Questionnaires. Teachers rated boys with ADHD as having more behavioral problems than girls, but ADHD boys and girls failed to differ in severity of attention and cognitive deficits. Severity of behavioral problems in girls, but not boys, was found to be highly correlated with attentional and academic problems. These results suggest that ADHD

manifests differently in boys and girls, and that ADHD girls may be a more homogeneous group.

Some investigators have suggested that girls have a higher threshold for the manifestation of ADHD, and may be more severely impaired than boys. This hypothesis is based on results of clinic studies and, therefore, these findings may be an artifact of the differing selection and referral processes for boys and girls. The goal of Experiment 2 was to distinguish between referral biases and differences in affliction by comparing groups of clinic-referred ADHD children, teacher-identified ADHD children and normal controls. Children were compared on attentional, behavioral, intellectual and academic measures. In addition, incidence of hyperactivity, academic problems, substance abuse and emotional problems among relatives were compared. The results did not support the hypothesis that girls have a higher threshold for the manifestation of ADHD. Referred ADHD girls were found to be as disruptive as referred boys, but more impaired cognitively and academically. This suggests that there are biases in the referral of boys and girls, and that girls are referred only when severely impaired behaviorally, cognitively and academically.

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Introduction

Attention Deficit-Hyperactivity Disorder (ADHD) (American Psychiatric Association, 1987) represents one of the most common disorders in current child psychiatry practice and is presumed to affect 5 to 20 percent of all school-age children (Bosco & Robin, 1980; Sprague, Christensen & Werry, 1974). The preponderance of ADHD in males is a well documented phenomenon, with reported male to female ratios ranging from 4:1 to 8:1 (Barkley, 1987; Glow, 1980; Holborow, Berry & Elkins, 1984). Despite the higher incidence of ADHD in boys, a considerable number of school-age girls have ADHD. Yet, studies of ADHD girls are scarce. Most studies have either used only boys as subjects or have combined the sexes into a single group, thereby masking possible gender differences. As a result, little is known about (1) possible differences in manifestation, either in severity or symptomatology between the sexes, and (2) the reasons for the higher incidence of ADHD in boys.

The aims of the present research were to examine gender differences in the manifestation of ADHD. The following sections will first review the characteristics of ADHD, the reported differences between ADHD boys and girls, and the models developed to account for the higher incidence of ADHD in boys. Subsequent sections will describe the present research.

Attention Deficit-Hyperactivity Disorder

ADHD is characterized primarily by symptoms of inattention, impulsivity and motor overactivity. The onset of ADHD is typically before 4 years of age, although it frequently goes unnoticed until the child enters school (American Psychiatric Association, 1987). The motor overactivity usually subsides during puberty, but the inattention, impulsivity and associated cognitive deficits frequently persist into adulthood (Borland & Heckman, 1976; Gittelman, Mannuzza, Shenker & Bonagura, 1985; Hechtman, Weiss & Perlman, 1984). In addition to the primary problems that define the disorder, ADHD children often have other problems such as academic difficulties (Cantwell & Satterfield, 1978; Lambert & Sandoval, 1980), conduct problems (Loney, Langhorne & Paternite, 1978; Milich, Loney & Landau, 1982), and poor peer relations (King & Young, 1981; Milich & Landau, 1982).

To complicate matters further, ADHD children do not exhibit the same symptoms in all situations or even in the same situation at all times (Jacob, O'Leary & Rosemblad, 1978; Sleator & Ullman, 1981). They may be indistinguishable from their peers, for example, during free play or in novel situations. Yet, in familiar situations or in settings requiring a degree of self-restraint, their behavior is more likely to be disruptive (Zentall, 1980).

These diverse symptoms originally led to the broad designation of "minimal brain dysfunction" and to numerous attempts to document brain impairment in ADHD children. The higher incidence of neurological "soft signs" (Wikler, Dixon & Parker, 1970) and of abnormal EEG activity in ADHD children (Capute, Niedermeyer & Richardson, 1968; Satterfield, 1973) have been used to support the view that the etiology of the disorder involves some kind of neurological damage. In addition, behavioral problems similar to those seen in ADHD children are frequently seen in children with documented central nervous system (CNS) lesions (Naughon, 1971; Shaffer, Chadwick & Rutter, 1975). However, for the most part, ADHD children have normal neurological examination findings (Halperin, Gittelman, Katz & Struve, 1986). Moreover, many normal children have EEG abnormalities or minor neurological signs (Wikler et al., 1970). At best, evidence of a focal CNS abnormality is observed only in a small fraction of ADHD children (Ferguson & Rapoport, 1983).

The absence of clear brain dysfunction in ADHD children and the increased importance of attention deficits led to the diagnosis of "attention deficit disorder" (ADD), with and without hyperactivity, in the third edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-III) (American Psychiatric Association, 1980). The more recent diagnosis of "attention deficit-hyperactivity disorder" in the latest revision of the Manual (DSM-III-R) (American Psychiatric Association, 1987) acknowledges the importance of both attentional and behavioral problems in ADHD children.

While some studies of ADHD children have found them to be more active than controls in all settings and at all times (Porrino, Rapoport, Behar, Sceery, Ismond & Bunney, 1983), in recent years there has been an increased interest on the more subtle attentional and cognitive problems characteristic of ADHD children.

Attentional and Cognitive Deficits Associated with ADHD

ADHD children do poorly on tasks that require focussed concentration and sustained effort. They often abandon tasks without having adequately understood the material, or respond impulsively without considering all of the relevant aspects of a situation (Douglas, 1983). Their academic achievement is usually below normal

(Keogh, 1971), and they tend to present a higher incidence of specific reading and arithmetic disabilities (Cantwell & Satterfield, 1978; Lambert & Sandoval, 1980).

A group of closely related deficits have been postulated to account for the poor performance of ADHD children on cognitive and academic tasks. Problems in arousal, sustained attention, selective attention and inhibitory control are among those deficits that have been suggested.

Arousal. Some investigators have proposed that ADHD children are generally under-aroused (Satterfield, Cantwell, Lesser & Podosin, 1972; Satterfield & Dawson, 1971) and, therefore, engage in exciting activities to arrive at an optimal level of CNS stimulation (Zentall & Zentall, 1983). It is presumed that an optimal level of stimulation is necessary for adequate performance on any task and, consequently, poorer performance is likely to occur in states of lower arousal and alertness (Eysenck, 1982).

Research on physiological indices have provided some supportive evidence for the CNS under-arousal theory. ADHD children are sometimes found to have lower basal skin conductance levels (Satterfield et al., 1972; Satterfield & Dawson, 1971) and higher amplitude of the auditory evoked response (Satterfield et al., 1972) than normal controls. Furthermore, ADHD children have been found to differ from normal children on several EEG characteristics. They show a higher EEG amplitude, larger range of amplitude and higher energy in the low frequency band of the resting EEG (Satterfield et al., 1972).

However, these findings have not been consistently replicated. ADHD children often do not to differ from controls on physiological indices (Cohen & Douglas, 1972), and are at times found to be over-aroused (Firestone & Douglas, 1975). More recently, some investigators (Zentall & Zentall, 1976; Zentall & Zentall, 1986) have proposed that ADHD children display levels of arousal at both extremes of the continuum. Therefore, it is possible than rather than being generally under- or over-aroused, ADHD children have difficulty modulating their arousal levels to meet situational demands (Douglas, 1983).

At present, the available evidence does not support the hypothesis of CNS under-arousal in ADHD children (Hastings & Barkley, 1978). Furthermore, not enough is known about the relationship among arousal, attentional and cognitive processes to develop a comprehensive theory of their relationship. Clearly, an optimal level of arousal is necessary, but not sufficient, for adequate performance. Even simple tasks in which ADHD children have difficulty, place some kind of processing demands on the subject. This suggests that other factors come into play aside from a possible altered arousal mechanism.

Sustained attention. More conclusive findings are reported in the area of sustained attention, in which most investigators agree that ADHD children show a deficit. Vigilance or sustained attention is defined as the ability to perform a repetitive task for a certain period of time, usually longer than ten minutes (Davies, Jones & Taylor, 1984). ADHD children constantly begin new tasks, but leave them uncompleted to move on to more interesting projects. They are described by teachers and parents as distractible, inattentive and unable to finish things they start (American Psychiatric Association, 1987).

ADHD children consistently perform worse than normal children on traditional vigilance measures, such as the continuous performance test (CPT) (Rosenthal & Allen, 1978; Rosvold, Mirsky, Sarasan, Bransome & Beck, 1956; Sykes, Douglas & Morgenstern, 1973; Sykes, Douglas, Weiss & Minde, 1971). They make more omission (signals not detected) and commission (incorrect detections) errors, and generally have slower reaction times than normal children. At times their performance has been shown to decline over time (Sykes et al., 1973), but this has not been the case in all studies (van der Meere & Sergeant, 1988b).

Traditionally, omission errors on the CPT have been postulated to measure inattention and commission errors have been commonly thought to measure impulsivity (O'Dougherty, Nuechterlein & Drew, 1984, Sykes et al., 1971). Recent studies suggest that this distinction may not be as clear-cut. Halperin and colleagues (Halperin, Wolf, Pascualvaca et al., 1988; Halperin, Wolf & Young, 1989) have proposed that commission errors may not represent a unitary measure, but that the various types of commission errors may be reflective of different psychological processes.

Using the A-X paradigm (Rosvold et al., 1956), in which the child has to respond whenever he/she sees an _X_ preceded by an _A_, Halperin and colleagues (Halperin, Wolf, Pascualvaca et al., 1988; Halperin, Wolf & Young, 1989) found that the different types of commission errors occurred at different reaction times and were related to different factors of teacher behavior ratings. For example, responses to the _X_ not preceded by an _A_ (X-Only errors) had slower reaction times than hits, and were correlated with teacher ratings of inattention. On the other hand, responses to a letter other than _X_ preceded by an A (A-Not-X errors) had faster reaction times and correlated with teacher ratings of impulsivity and hyperactivity. Responses to sequences of two letters containing neither an A nor an X (Random errors) and responses to the letter A (A-Only errors) were not consistently correlated with teacher ratings.

These findings suggest that the CPT, which has been conceptualized as a global measure of sustained attention, may be tapping different psychological processes. Given this, one would gain a better understanding of the poor performance of children in this task by looking at the individual processes.

Signal detection analyses of the CPT data have yielded inconclusive results. One would predict that ADHD children have lower d′ (perceptual sensitivity) and Beta (response bias) based on their impulsivity and tendency to make more omission and commission errors in the CPT (Sykes et al., 1971; Sykes et al., 1973). Some studies have found that ADHD children have lower Betas than controls, but do not differ on d′ (Nuechterlein, 1983), whereas other studies find just the reverse (van der Meere & Sergeant, 1988b)

Selective attention. Another area in which ADHD children have been postulated to show a deficit is in selective attention, or the ability to focus on critical stimuli, while ignoring non-critical stimuli. Tests commonly used to measure selective attention involve a task that is disrupted by the presence of distracting or contradictory stimuli. Examples of these tasks are selective and dichotic listening tasks, central-incidental learning taks, speeded classification tasks, visual search and time sharing tasks (Davies et al., 1984).

Many investigators have found that ADHD children do poorer than controls in the presence of distractors (Radosh & Gittelman, 1981; Rosenthal & Allen, 1980), but others have failed to find any differences (Aman & Turbott, 1986; Douglas, 1972; van der Meere & Sergeant, 1988a). Generally, it has been assumed that ADHD children have problems on selective attention tasks because of one of the following: defective filter mechanisms, difficulty with concurrent processing, or failure to differentiate between critical and non-critical stimuli (Douglas, 1983). However, ADHD children tend to do worse than controls on selective attention tasks only when the salience of the irrelevant stimuli is high, or when interesting distractors (e.g., drawings, pictures) are used (Rosenthal & Allen, 1980). Furthermore, although ADHD children seem to pay more attention to the distracting stimuli, they, at times, fail to differ from controls in their task performance (Bremer & Stern, 1976).

Other interpretations could, therefore, account for the observed deficits. For example, it is possible that ADHD children focus on interesting features of the tasks and shift their attention quickly from one stimulus to the next without losing track of the relevant task requirements. Similarly, a tendency to respond to non-relevant stimuli rather than an inability to discriminate between relevant and non-relevant stimuli can also account for the observed deficits (Douglas, 1983). Therefore, the available data do not conclusively support the existence of selective attention deficits in ADHD children; other explanations may account for the available findings.

Inhibitory control. Problems of ADHD children in inhibitory control or ability to withhold a response are well documented. These children's impulsive tendencies have been observed over a wide range of tasks as manifested by either an inability to withhold a response in simple tasks, or a tendency to respond without having a clear understanding of the problem in more complex tasks (Douglas, 1983).

One of the most commonly used tests of impulsivity is the Matching Familiar Figures Test (MFFT) (Kagan, 1964). The MFFT is a matching to sample test which involves the presentation of a standard figure along with other highly similar figures. The subject is instructed to identify the figure that exactly matches the standard. On the MFFT, ADHD children tend to maximize speed to the detriment of accuracy, that is, they exhibit shorter latencies and higher error scores (Messer, 1976). There is some evidence that children classified as impulsive on the MFFT are also considered impulsive in other contexts (e.g., the classroom) (Kinsbourne & Caplan, 1979).

A tendency for ADHD children to respond impulsively has also been observed in differential reinforcement tasks, in which the subject is instructed to withhold responding in order to receive a reward. ADHD children tend to respond more frequently than normal children in these tasks, and therefore obtain fewer rewards (Gordon, 1979). Similarly, ADHD children act in an impulsive manner in risk-taking situations and fail to take into account future consequences of their behavior. They are also more likely to relinquish longer term gains for immediate rewards (Gorenstein & Newman, 1980).

Memory. The performance of ADHD children on higher-order cognitive tasks reflects their difficulty organizing and integrating the material. For example, they do not experience unusual difficulty on simple memory tasks which require either immediate or delayed recall of verbal and nonverbal information in its original form (Douglas, 1983). In contrast, they do generally worse on memory tasks in which the information has to be organized for efficient acquisition, and in more complex, demanding tasks. They use less elaborate mnemonic strategies and are less likely to continue struggling with the tasks (Spring, Yellin & Greenberg, 1976; Weingartner, Rapoport, Ebert & Caine, 1980).

Summary. The poor performance of ADHD children on attentional and cognitive tasks can be attributed to a group of closely-related deficits. Since most experimental tasks involve several of the proposed mechanisms, a distinction among them is often difficult. In addition, investigators have differed in the way they define these processes and, at times, the same finding has been interpreted to indicate a problem in several of these processes.

Based on the available evidence, it appears that ADHD children do not have difficulty in the initial focussing of attention but, rather, in sustaining attention over time, especially on routine tasks (Sykes et al., 1971; Sykes et al., 1973). There is current disagreement as to whether this difficulty is unique to ADHD children or a nonspecific correlate of psychopathology (Schachar, Logan, Wachsmuth & Chajczyk, 1988).

The tendency of ADHD children to focus on interesting aspects of tasks and their difficulty in inhibiting a response also seem to impair their performance on tasks which contain distractors. It is unlikely, however, that they are unable to ignore distractors and have problems in selective attention per se. An altered arousal mechanism has also been postulated (Satterfield et al., 1972), but there is insufficient evidence to support the hypotheses that ADHD children are either under-or over-aroused (Hastings & Barkley, 1978).

The performance of ADHD children in most tasks is characterized by a difficulty withholding responses and lack of self-control to meet situational demands. ADHD children are disinclined to process information beyond the most salient aspects of the tasks, and are likely to respond without having a clear understanding of the situation. The performance of ADHD children on higher-order cognitive tasks is also characterized by a lack of effort and inadequate processing strategies (Weingartner et al., 1980). Their deficits are particularly evident when they are working on tasks which they do not find interesting and when they have to perform tasks at a rate which is different than one of their own choosing (Sykes et al., 1973; Whalen, Henker, Collins, Finck & Dotemoto, 1979).

Sex Differences in ADHD

While ADHD in boys has been the subject of extensive research and discussion, very little is known about girls diagnosed with ADHD. Early studies of overactive boys and girls (Entwistle & Cunningham, 1968; Kagan & Moss, 1962) supported a hypothesis put forward by Maccoby (1967) which stated that impulsivity is positively related to intellectual performance for girls, whereas inhibition is positively related to intellect in boys.

For example, Battle and Lacey (1972) found that the correlation between intelligence and motor activity tended to be positive for females but negative for males. Overactive females demonstrated greater achievement efforts in childhood and were more confident of their intellectual capacities in adolescence. Overactive males, in contrast, had lower standards for academic achievement and showed a general lack of interest in intellectual tasks. These results suggest that ADHD may be associated with a more positive outcome in girls than in boys. However, hyperactivity, as defined by Battle and Lacey (1972), denotes the high end of the normal activity dimension which may not be, by itself, detrimental. It is therefore possible that these findings do not generalize to a pathological population. In fact, studies of teacher-identified ADHD girls suggest that ADHD creates problems for girls just as it does for boys.

School samples. School samples of ADHD children are comprised of those children who, according to teachers, are inattentive, impulsive and hyperactive. In some instances, teachers directly select children with problems suggestive of ADHD (Prinz & Loney, 1974), but, more frequently, this is done through the use of teacher rating scales (deHaas & Young, 1984). Teacher rating scales are widely used in ADHD research, and rest on the assumption that teachers observe the child over time and can compare his/her behavior to same-age peers (American Psychiatric Association, 1987). Among the rating scales, the Conners Teacher Questionnaire (Goyette, Conners & Ulrich, 1978) has been perhaps the most widely used. This scale shows good reliability (Goyette et al., 1978) and adequate correlations with objective measures of attention and impulsivity (Brown & Wynne, 1982).

Boys generally obtain higher (more deviant) scores than girls in teacher rating scales (Goyette et al., 1978) and therefore more boys fall in the "abnormal" range, which is usually defined as two standard deviations above the mean. To avoid this problem, separate cut-offs are recommended for boys and girls in order to select samples of children who are equally deviant from their same-sex norms. One important point to keep in mind is that the scores derived from rating scales are continuously distributed. Therefore, the cut-off is arbitrary in that children above it are considered "deviant" whereas those below it are considered normal.

Studies of sex differences in ADHD using either direct teachers' report or teacher rating scales have found that ADHD is associated with similar deficits in girls and boys. Girls identified by their teacher as having ADHD, much like ADHD boys, do worse on objective measures of attention, and are rated as more behaviorally disturbed than their peers (deHaas & Young, 1984). Furthermore, compared to normal girls, teacher-identified ADHD girls have lower IQs. They are also less well-adjusted, tend to have poorer self-esteem and behave in a manner that impairs their peer relations (Prinz & Loney, 1974).

Nevertheless, differences in the manifestation of the syndrome between genders have been reported. Generally, teacher-identified ADHD boys have been found to be more hyperactive and to have more conduct problems than ADHD girls; but boys and girls do not appear to differ in severity of attention problems (deHaas, 1986; McGee, Williams & Silva, 1987). ADHD boys are sometimes rated as more inattentive by their teachers than ADHD girls (McGee et al., 1987), but no gender differences have been found on objective measures of attention (deHaas, 1986). This suggests that ADHD boys may be perceived as more inattentive because of their behavioral problems. Indeed, when the effects of hyperactivity and behavior problems are controlled, sex differences in ratings of inattention are eliminated (McGee et al., 1987). Research involving clinic-referred samples of ADHD children have reported further differences between ADHD boys and girls.

Clinic samples. Consistent with school-based samples, studies of clinic samples report no differences in severity of attention problems between ADHD boys and ADHD girls (Barkley, 1988; Berry, Shaywitz & Shaywitz, 1985; Breen, 1988; Kashani, Chapel, Ellis & Shekim, 1979) and generally find ADHD boys to be more hyperactive and to have more behavior problems than ADHD girls (Berry et al., 1985; Kashani et al., 1979). Notwithstanding, differences have been identified between the two sampling sectors. Clinic-referred ADHD girls are found to be intellectually and academically impaired relative to clinic-referred ADHD boys (Ackerman, Dykman & Oglesby, 1983; Berry et al., 1985; Kashani et al., 1979), although there have been some exceptions (Befera & Barkley, 1985; Breen & Barkley, 1987). Furthermore, ADHD girls have been reported to come from more disadvantaged backgrounds than boys; their families have a lower socioeconomic status (SES), and their parents have a higher rate of divorce, increased rate of alcoholism and more psychiatric problems than ADHD boys (Berry et al., 1985; Kashani et al., 1979). In addition, ADHD girls are referred for treatment at younger ages and more frequently because of poor school performance. ADHD boys, in contrast, are most often referred because of hyperactivity and behavior problems (Berry et al., 1985; Kashani et al., 1979).

Summary. Based on the findings from clinic studies, it has been suggested that ADHD girls have more predisposing factors in their families than ADHD boys, and when impaired, are more severely affected (Berry et al., 1985; Kashani et al., 1979). This implies that there is something about the sex of the individual that influences the susceptibility to, or the manifestation of, ADHD. This interpretation is consistent with a pattern of affliction seen in disorders such as Tourette's Syndrome (Kidd, Prusoff & Cohen, 1980) and autism (Tsai & Beisler, 1983) where girls are less frequently affected but, when affected, show more severe deficits and have a higher incidence of affected relatives than boys.

Alternatively, it is possible that the more pervasive impairments in intellectual and academic functions found in clinic-referred ADHD girls reflect selective referral rather than true differences in manifestation. Since ADHD boys tend to have more behavioral problems than ADHD girls, they may be more likely to be noticed and referred. By the same token, it is possible that ADHD girls are only referred when they are severely impaired, especially in intellectual and academic functions. This would, in part, explain the difference in the findings between studies of clinic-referred ADHD children and those selected from school samples through the use of teacher rating scales. In agreement with this hypothesis, McGee and co-workers (1987) reported that over a period of six years, parents sought help more frequently for boys (both ADHD and normal) than for girls, suggesting that boys are more frequently referred for treatment than girls. At present, however, there is insufficient evidence to distinguish between referral biases and real differences in affliction between the sexes.

Models of Sex Differences in ADHD

The reasons for gender differences in manifestation and incidence of ADHD remain unclear. Some investigators have implicated the importance of identification biases, socialization practices, brain organization and differential susceptibility of the male central nervous system as contributing factors. The main theoretical points of these models will be briefly reviewed in the next sections.

Identification Biases

The notion of identification biases is based on the premise that disorders may express themselves differently in the two sexes and, therefore, may be more noticeable in one than in the other. For example, ADHD boys are more behaviorally disturbed than ADHD girls (deHaas, 1986; Berry et al., 1985) and may be, as a result, more likely to be identified and referred. Evidence supporting this view is derived from studies of children with attention deficit disorder without hyperactivity (ADD). These studies report male:female ratios closer to unity; they also find ADD girls, who are less behaviorally impaired than boys, to be older at referral (Berry et al., 1985). These findings support the hypothesis that boys are more easily identified and referred because of their more severe behavioral problems.

Further evidence supporting the presence of identification and referral biases comes from research on reading disabilities. Investigators have consistently found smaller sex ratios (1.2-2.8 male:1 female) in reading disabled children selected from school samples (Berger, Yule & Rutter, 1975) than in those selected from clinic (4:1) (Critchley, 1970) or special education programs (5.9:1) (Finucci & Childs, 1980). These findings suggest that reading disabled females are not being identified as frequently as reading disabled males. Unfortunately, similar studies using school and clinic populations of ADHD children have not been done.

Developing the concept of identification bias, Werry and Quay (1971) have proposed that boys may not necessarily have more problems than girls but, instead, may be perceived as having more problems. On measures that are commonly used to identify ADHD children, such as teacher rating scales, boys typically obtain more deviant scores than girls (Taylor & Sandberg, 1984; Werry & Hawthorne, 1976). Normal boys are usually rated by their teachers as being more active and disruptive than normal girls (Goyette et al., 1978). Boys also time their actions differently from girls. They change activities more frequently and spend less time in play organized by teachers (McGuinness, 1987). Girls, in contrast, are more quiet, withdrawn, and sensitive (Werry and Quay, 1971). Werry and Quay (1971) suggest that boys are perceived as having more problems than girls because the characteristics that boys present are related to "badness" in our society. The question remains as to whether we are referring to hyperactive boys or just boys.

Clearly, identification processes reflect the referring person's tolerance for inappropriate behavior. However, teachers, who are are most frequently involved in identification and referral, have been shown to reliably discriminate between ADHD and normal children (Sandoval, 1977). Teacher ratings have also been found to correlate with objective measures of impulsivity and attention (Brown & Wynne, 1982) and to be adequate predictors of medication response (Brown & Sleator, 1979; Mash & Terdal, 1981). This suggests that, at least for boys, teacher evaluations are adequate gauges of problematic behavior.

Less research has been done with girls as subjects and, as a result, little is known about teacher's ability to identify problematic behavior in girls. It is certainly possible that boys are more likely to be identified because of their more serious behavioral problems. However, it is also possible that hyperactivity in girls may be less tolerated because it deviates more from societal expectations and gender sterotyping; this would be the case even if their problems are less severe than boys´. The use of same-sex norms to identify groups of ADHD children should reduce possible biases by creating groups of children that are equally deviant from their same-sex peers.

Social and Environmental Models.

Among the theories which emphasize socialization practices in the development of sex differences, Maccoby´s theory (Maccoby & Jacklin, 1974) is perhaps the one most frequently cited. Maccoby proposed that sex differences in temperament and intellectual functioning are the result of the interaction between social demands and certain biological determinants (most likely genetic). The encouragement of sex-appropriate behaviors by parents and other adults, coupled with the child´s spontaneous learning of behaviors appropriate for his/her sex through imitation, "help produce or augment" these differences. Maccoby (Maccoby & Jacklin, 1974) applied these concepts to normal children and, although she used them to explain why boys are more hyperactive than girls, she made no attempt at explaining why ADHD is more common in males. The importance of socialization practices in the development of sex differences in ADHD is based on the premise that boys are reinforced for exploring their environment and engage in active play, whereas girls are encouraged to participate in more sedentary activities (Whalen & Henker, 1980). There is extensive research which supports the idea that boys and girls are subjected to different experiences and societal expectations (Maccoby & Jacklin, 1974). There is also little contention regarding boys' greater activity levels. However, increased activity and ADHD are not synonymous. Overactivity may not be considered undesirable, but inattention, impulsivity and overactivity in combination are certainly regarded as inappropriate. Therefore, it is difficult to conceptualize them as being shaped or reinforced by society. Again, a distinction may have to be made between gender differences in normal and pathological populations.

The unequal sex ratios in a number of childhood disorders have also been attributed to increased susceptibility of males to adverse environmental influences (Rutter, 1970; Cadoret & Caine, 1980). Boys are more susceptible than girls to the effects of marital discord and the quality of family relationships such as frequency of quarreling, amount of hostility and criticism between parents (Cadoret & Caine, 1980). It has been found, for example, that the worse the parental marriage the higher the rate of disorders for boys, but not girls (Cadoret & Caine, 1980). Similarly, reading ability in males has been found to be affected by factors such as low SES, emotional problems and family constitution, whereas the same factors have not been found to have a significant effect on reading ability of girls (Cicirelli, 1967). It is not clear, however, what factors may differentially lead to the development of specific disorders, or how these factors may occur.

At present, the role of socialization practices, tolerance of deviant behaviors and susceptability to environmental stresses in the development of sex differences need to be determined. Although these factors most likely play a role in the identification or exacerbation of symptoms, it is doubtful that they represent the only factors contributing to sex differences in incidence and manifestation of ADHD. Furthermore, the reported greater vulnerability of males to environmental factors may very well be biologically determined (Rutter, 1970).

Biological Models

Males appear to be more vulnerable to almost any kind of physical hazard. Not only do they suffer more from complications of pregnancy and childbirth (McMillen, 1979; Reinisch, Gandelman & Spiegel, 1979), but their increased vulnerability to disease covers the whole lifespan (Reinisch et al., 1979). The greater propensity of boys to developmental failures (Stewart, 1970) and sex differences in response to intrauterine insults (Halverson & Victor, 1976; Quinn & Rapoport, 1974; Firestone, Lewy & Douglas, 1976; Firestone, Peters, Rivier & Knights, 1978) have been implicated as contributory factors for the higher incidence of several disorders in boys, including ADHD. But, why are males more vulnerable to complications and how does this vulnerability manifest itself?

Developmental lag. The notion that males possess a more immature CNS than females is derived primarily from research on physical parameters. The rate of physical maturation differs between the sexes with males showing, for instance, a slower rate of bone growth and a later onset of puberty (Tanner, 1962). It is presumed that sex differences in maturational rate are reflected not only on physical, but also on psychological and behavioral parameters (Waber, 1976).

The developmental lag theory has received much attention in the literature on sex differences to account for the earlier onset of certain aptitutes in females (Waber, 1976; Waber, 1977; Waber, Bauermeister, Cohen, Ferber & Wolf, 1981). It has also been supported by studies of physiological markers of childhood disorders including ADHD (Shaywitz, Cohen, Leckman, Young & Bowers, 1980; Yo-cum & Yo-feng, 1984). These studies have found lower accummulations of dopaminergic metabolites relative to serotonergic metabolites in girls. If serotonin has an inhibitory effect on dopaminergic activity, then it can be postulated that girls possess a more modulated or mature CNS functioning, especially in relation to central inhibitory mechanisms. The developmental lag theory fails to explain, however, the earlier onset of some abilities in males (e.g., visuo-spatial skills) (McGlone, 1980).

Related to slower developmental pace, is the idea of extended vulnerability (Ounsted & Taylor, 1972). Ounsted and Taylor (1972) suggested that the Y chromosome retards the developmental process of males, thereby increasing their period of vulnerability and their amount of exposure to adverse environmental events. Immature organisms are more susceptible to damage than mature ones and, as a result, males are susceptible for longer periods of time than females. While there is sufficient evidence to support that females mature earlier than males (Hutt, 1972), and that immature organisms are more susceptible than mature ones to a variety of hazards (Rutter, 1970), it is not known how this susceptibility comes about or precisely what it is.

Immunoreactive theory. Gualtieri and Hicks (1985) have specifically addressed how this vulnerability may evolve. These authors propose that the mother's immunological tolerance to the fetus is not absolute, but that it can break down during pregnancy. This is especially true: (1) if the fetus is a male, since males on the average, are more antigenic than females, and (2) if the mother has been sensitized by previous male pregnancies. Maternal antibodies can damage the developing central nervous system of the fetus, thereby exercising long-term effects on the neurological and cognitive development of the fetus. Although Gualtieri and Hicks present a very attractive and stimulating idea, supportive evidence, at present, is very scanty. To this author's knowledge, there is no research on the effects of birth order, sex of siblings and family composition on the development of ADHD.

Differences in cortical organization. Sex differences in brain organization have been implicated in the onset of ADHD. Males are thought to be more lateralized than females (McGlone, 1980), which presumably puts them at a risk for certain conditions. These include disorders associated with diminished left-hemisphere functions such as ADHD, dyslexia (Geschwind and Galaburda, 1983) and aggressive psychopathology (Flor-Henry, 1974).

There are considerable problems with this position. First, there is no sufficient evidence to indicate that females' brain are more symmetrically organized than males. In fact, some studies find no difference between males and females (Fairweather, 1982) while others find differences depending on task paramaters (Healey, Waldstein & Goodglass, 1985). Second, there is no data to support a left hemisphere deficit in ADHD children. Finally, it is not clear how differences in brain asymmetry can selectively result in left-hemisphere dysfunction.

Endocrinological models. Hormonal levels and left-hemisphere vulnerability have been recently implicated in selective male affliction. Geschwind and Galaburda (Geschwind and Galaburda, 1985a, 1985b, 1985c) have proposed that testosterone retards the growth of certain areas of the left hemisphere in utero. The right hemisphere is generally not affected by the disrupting influences of testosterone because it matures earlier. However, testosterone may interfere with cell migration, resulting in abnormalities of the left hemisphere. This would be especially true for males because of their higher level of testosterone. Abnormalities in cell migration will result, Geschwind and Galaburda speculate, not only in disorders which are associated with diminished left-hemisphere functions, but also in enhanced right-hemisphere functions.

The notion that gonadal hormones affect brain structures and are important in the control of some sexually dimorphic behaviors is well established in animals. Testosterone has been shown to have an effect on cell migration and neural development (Toran-Allerand, 1978; Nottebohm, 1981). Prenatal exposure to testosterone has also been implicated in rough and tumble play in rats (Meaney & Stewart, 1981) and rhesus monkeys (Goy, 1978). Studies with humans, although more limited, also support the effects of gonadal hormones on sexually dimorphic behaviors. For example, girls with congenital adrenal hyperplasia, a condition in which excess amounts of androgens are secreted by the adrenal cortex, are more active and similar to boys in certain aspects of social behavior (Money & Ehrhardt, 1972). Similarly, sex hormones administered during pregnancy have been found to increase hyperactivity in the offspring (Nichols & Chen, 1981).

In sum, there is some evidence that supports Geschwind and Galaburda's model, at least as it pertains to sex differences in activity levels. However, the model brings together findings from a number of areas and more data are needed before it can be effectively applied to the study of sex differences in ADHD. At present, there is little direct evidence to support any one of these biological models as the sole explanation for the male:female discrepancy in ADHD.

Genetic models. The contribution of genetic factors in the etiology of ADHD was first proposed based on the results of early family studies. These studies consistently reported a higher incidence of hyperactivity among relatives of ADHD children than among relatives of controls (Cantwell, 1972; Morrison & Stewart, 1971). These findings supported a familial transmission of the disorder, but could not distinguish between genetic and environmental influences. However, more direct evidence for a genetic component have been obtained in adoption and twin studies. The concordance rate for ADHD has been found to be higher in monozygotic than in dizygotic twins (Lopez, 1965; Willerman, 1973) and in full than in half siblings (Safer, 1973). Moreover, there is no difference in incidence between adoptive relatives of ADHD children and biological relatives of controls

(Cantwell, 1975).

Given the higher incidence of ADHD in males, sex-linked inheritance has been suggested as a possible mode of transmission. However, the number of instances in which ADHD boys have affected fathers (Cantwell, 1972; Morrison & Stewart, 1971) rules out sex-linked inheritance. Clearly, both genetic and environmental factors are important in the etiology of ADHD (Willerman, 1973). Therefore, the most plausible hypothesis is that genetic and environmental factors interact to generate a risk or susceptibility in individuals, and that the likelihood of expressing that susceptibility is modified by sex. This model, referred to as the threshold model, with its assumptions and predictions is presented below.

The Threshold Model

The threshold model assumes that genetic predisposition interacts with environmental factors to generate a liability in the individual. Individuals with multiple risk factors above a certain critical number (i.e., threshold) in the distribution are expected to manifest the disorder (Carter, 1970; Falconer, 1965; Reich, Cloninger & Guze, 1975; Reich, James & Morris, 1972).

The model makes several assumptions (Carter, 1970;

Falconer, 1965). First, it is expected that the more severely affected individuals possess a higher number of risk factors. Second, the higher the incidence of a disorder, the lower the threshold is expected to be. Third, relatives of affected individuals are expected to have more risk factors than the general population, although less that the affected group. Fourth, the risk to develop a disease varies from one family to another, since it is not a matter of the presence or absence of a single risk factor but the average of factors. Therefore, the more individuals affected within a family, the higher the number of risk factors.

When a disorder is more frequent in one sex, the less-frequently affected sex presumably has a higher threshold (Carter, 1970). More risk factors must therefore be present before an individual of that sex is affected at all. There are two formulations of this model. The first one assumes that the liability distribution of risk factors in both sexes is congruent, but that the thresholds differ (Carter, 1970) (see Figure 1). The second assumes that the liability distribution of males is more deviant relative to that of females, but only one threshold is conceptualized (Carter & Evans, 1969) (see Figure 2). Both models predict that more

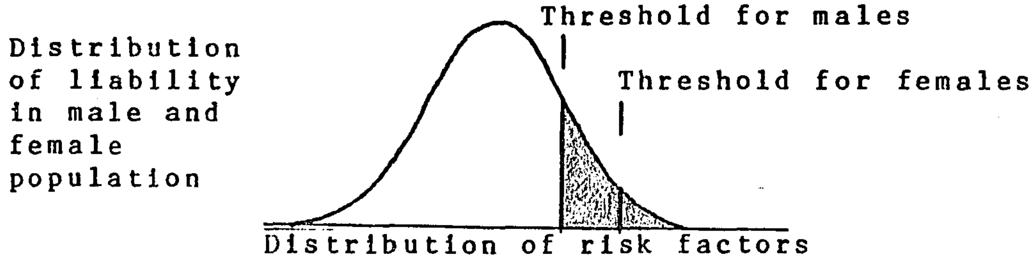


Fig. 1. Illustration of the threshold model when a separate threshold is defined for each sex.

relatives (males and females) of females are affected than relatives of males because of the higher number of predisposing factors.

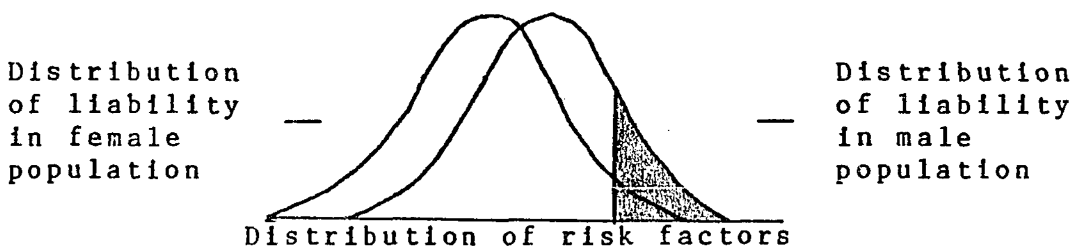


Fig. 2. Illustration of the threshold model with only one threshold for males and females.

The threshold model makes no assumptions about the relative importance of genetic and environmental factors in the etiology and transmission of a disorder. It does assume, however, that the relative importance of these factors is the same for both sexes.

Data compatible with this model have been reported for disorders with a presumed genetic component that show a marked sex difference in incidence. For example, pyloric stenosis is more frequent in males (5:1 ratios), but the incidence of pyloric stenosis is higher in relatives of female patients (18.9% of sons and 7% of daughters) than in relatives of male patients (5.5% and 2.4%, respectively) (Carter & Evans, 1969). Similarly, a higher incidence of affected relatives of female probands than of male probands has been reported for Tourette's Syndrome (26% vs. 21%) (Kidd, Prusoff & Cohen, 1980), stuttering (30% vs. 22%) (Kidd, Kidd & Records, 1978) and antisocial personality (Cloninger, Christiansen, Reich & Gottesman, 1978).

Preliminary data compatible with the threshold model are also available for ADHD. Families with more than one hyperactive individual present a higher incidence of hyperactivity (47% vs. 18%) and alcoholism (11.1% vs. 5.7%) than families with only one affected individual (Morrison & Stewart, 1973). Thus, this supports the assumption that the greater the number of affected individuals within a family, the higher the risk component in the family.

Moreover, ADHD girls have been found to have a higher proportion of relatives with attention and/or learning problems than ADD males (54% vs. 30%) (Pauls, Shaywitz, Kramer, Shaywitz & Cohen, 1983), which supports the presence of a higher threshold for females.

Unfortunately, the percentage of children with attention deficit disorder with and without hyperactivity, and the breakdown of problems in relatives was not specified in this study.

Rationale

Two experiments were conducted to examine sex differences in the manifestation of ADHD and to distinguish between referral biases and the existence of a differential threshold for the manifestation of symptoms in males and females.

The purpose of the first experiment was to examine gender differences in the symptomatology of ADHD using a non-referred population. Whereas difficulties of ADHD children in attention, impulsivity and motor overactivity are well documented, reports of gender differences in these areas are rare and inconclusive. On the one hand, there is considerable evidence to indicate that ADHD boys are more hyperactive and have more behavioral problems than ADHD girls (deHaas, 1986; McGee et al., 1987; Berry et al., 1985). In contrast, gender differences in attention and impulsivity are not well defined. Most investigators fail to observe differences in the severity of attention problems between ADHD boys and ADHD girls (Breen, 1988; deHaas, 1986; McGee et al., 1987), but others find girls to be more impaired (Zentall, 1985). Similarly, some reports indicate greater impulsivity in ADHD girls (Ackerman et al., 1983; deHaas, 1986) and others in ADHD boys (Berry et al., 1985).

Inconsistencies among studies may be due to the use of different tasks, differences in populations or differences in the likelihood of a referral. ADHD children referred to clinics may not be representative of the overall ADHD population or comparable to teacher-identified ADHD children. The aim of Experiment 1 was to examine gender differences in attention, impulsivity and motor overactivity in a non-referred sample. By using a school sample, it was hoped that a clearer view of the association between the manifestations of ADHD and gender could be established, eliminating possible referral biases.

The purpose of the second experiment was to distinguish the effects of referral biases from sex differences in affliction by comparing groups of teacher-identified ADHD boys and girls, clinic-referred ADHD boys and girls, and normal controls. These particular groups were selected to differentiate the effects of gender from identification biases. By comparing groups of teacher-identified ADHD children to clinic samples of ADHD children, it was possible, for example, to isolate the effects of potential referral biases. Similarly, normal children provided information about normal gender differences against which to examine sex differences in the ADHD groups.

Several investigators have attributed sex differences in ADHD to a differential threshold for males and females (Berry et al., 1985; Omenn, 1973). This conclusion is based on results from clinic studies in which ADHD girls are found to have more psychopathology in their families and to come from more disadvantaged backgrounds than ADHD boys (Ackerman et al., 1983; Berry et al., 1985; Kashani et al., 1979); suggesting that ADHD girls possess a higher number of risk factors.

The more severe impairments of ADHD girls in cognitive and academic functions have also been used as supportive evidence for the threshold model (Berry et al., 1985). However, there are several problems with this interpretation.

First, although the threshold model assumes that the more severely affected individuals possess a higher number of risk factors, it does not necessarily follow that individuals with more risk factors should be more impaired. Therefore, although females are expected to have more risk factors than males, they are not necessarily expected to be more severely affected.

Moreover, in the event that this prediction is true, it is not clear how it would manifest itself. One might expect that ADHD girls would show more severe deficits only on those symptoms that define the disorder. Alternatively, it is possible that ADHD girls would be more impaired in other areas instead of, or in addition to, their deficits in the primary symptom areas. Only the latter prediction is supported by the findings of clinic samples.

Second, studies of school samples find no differences between ADHD girls and ADHD boys in most functions (deHaas, 1986; McGee et al., 1987). It is therefore possible that ADHD girls are not more impaired than ADHD boys, but may only be referred when they have severe problems. ADHD girls may be less likely to be identified and referred for treatment because they are less behaviorally impaired. In fact, when ADHD girls are referred, it is usually because of academic and linguistic difficulties, not behavioral problems (Berry et al., 1985; Kashani et al., 1979). Unfortunately, the distinction between referral biases and real differences in affliction between the sexes cannot be made with the presently available data.

Experiment 2 aimed at distinguishing between these two possibilities by using groups of normal children, non-referred ADHD children, and referred ADHD children. These groups were compared on the main symptom areas of ADHD, associated cognitive and academic difficulties, and incidence of problems in relatives.

Experiment 1

Research on sex differences in ADHD suggest that there are differences in clinical symptomatology and cognitive profile between ADHD boys and girls. However, the precise nature of these differences is not clear. Studies of school samples of ADHD children report few gender differences (deHaas, 1986). In contrast, studies of clinic-referred children generally find ADHD girls to be more impaired in several domains (Berry et al., 1985; Kashani et al., 1979).

The present study was designed to further examine gender differences in attention, cognition and behavior using a non-referred sample. Specifically, the major objectives of the study were (1) to compare attentional, cognitive, academic and behavioral profiles of teacher-identified ADHD children and non-ADHD children, (2) to compare teacher-identified ADHD boys and ADHD girls in the above areas, and (3) to assess the relationship among attention, cognitive and behavior problems within each sex.

The specific hypotheses were:

1. Both ADHD boys and girls were expected to do worse on objective measures of attention and impulsivity, and to be rated as more behaviorally disturbed than their

non-ADHD peers.

2. ADHD children were expected to have more academic difficulties than normal controls. This prediction was based on reports of poorer academic achievement (Keogh, 1971) and a greater incidence of learning problems in ADHD children (Lambert & Sandoval, 1980).

3. ADHD boys and girls were expected not to differ from each other in severity of attention problems, based on previous studies of non-referred ADHD children (deHaas, 1986).

4. Consistent with previous research (Berry et al., 1985; deHaas, 1986), ADHD boys were expected to be more behaviorally disturbed than ADHD girls.

5. No specific predictions were made regarding differences in impulsivity between ADHD boys and girls. Previous findings in this area have been inconclusive, with some studies reporting more deficits in ADHD girls (Ackerman et al., 1983; deHaas, 1986) and others more deficits in ADHD boys (Berry et al., 1985).

6. No differences were predicted between normal boys and girls on attention, but boys were expected to be more impulsive and to have more behavioral problems than girls. This prediction was based on extensive research of gender differences in normal children (Maccoby & Jacklin, 1974).

Method

Subjects.

The initial sample consisted of eighty-five (42 boys and 43 girls) first to sixth grade children attending an inner-city parochial school. Approximately 57% of the school participated in the study. Those students who participated did not differ from their peers on standardized tests of reading [$t(124)=-0.76$, $p>.10$] and arithmetic [$t(124)=-0.78$, $p>.10$], and were felt to be representative of the school population. To the best of the author's knowledge, none of the children had obvious neurological problems, were receiving medication with known CNS effects, or were involved in any kind of treatment for behavioral or emotional problems at the time of the study. The children were primarily Hispanic (N=48) or Black (N=25), and came from a lower socioeconomic strata.

Subjects were included in the study only if they had parental permission to participate and were between the ages of 6 and 13 (mean=9.00, SD=1.62). This particular age group was selected because symptoms suggestive of ADHD are most clearly identified at this age, and the instruments used in the study have adequate norms for this age group.

The subjects were divided into two groups using the

Hyperactivity Index from the Revised Conners Teacher Questionnaire (Goyette et al., 1978). The Hyperactivity Index is comprised of ten items from the teacher questionnaire which sample inattention, impulsivity and behavioral problems. Each item is scored from zero to three; the Index is the average score of the ten items. The Revised Conners Teacher Questionnaire and the normative cut-off values for the Hyperactivity Index are shown in Appendix A.

Children rated at least two standard deviations above the mean for their age and sex on the Hyperactivity Index according to the published normative data (Goyette et al., 1978) were considered to have significant attention/ behavior problems. Children scoring below one standard deviation above the mean were considered to have no significant attention/behavior disturbance according to teachers. The distributions of scores on the Hyperactivity Index for boys and girls are shown on Figures 3 and 4, respectively.

Nineteen children (12 boys and 7 girls) were identified by teachers as presenting symptoms suggestive of ADHD. Fifty-two children (23 boys and 29 girls) were considered to have no significant attention/behavior problems. The remaining fourteen children (7 boys and 7 girls) scored between one and two standard deviations above the mean. These children were eliminated from the analyses of group differences, reducing the sample size to 71 (35 boys and 36 girls).

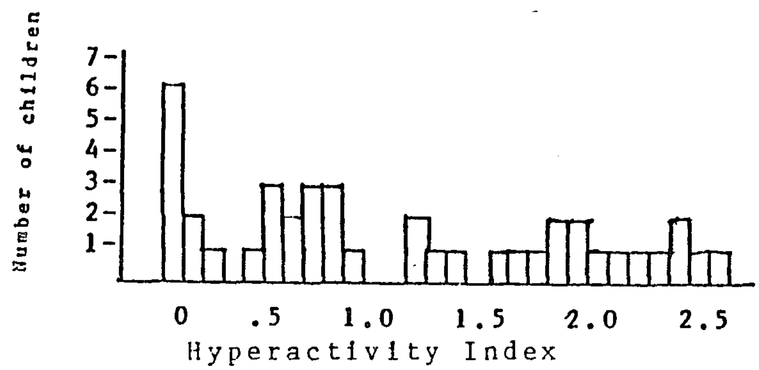


Fig. 3. Distribution of scores on the Hyperactivity Index of the teacher questionnaire for boys.

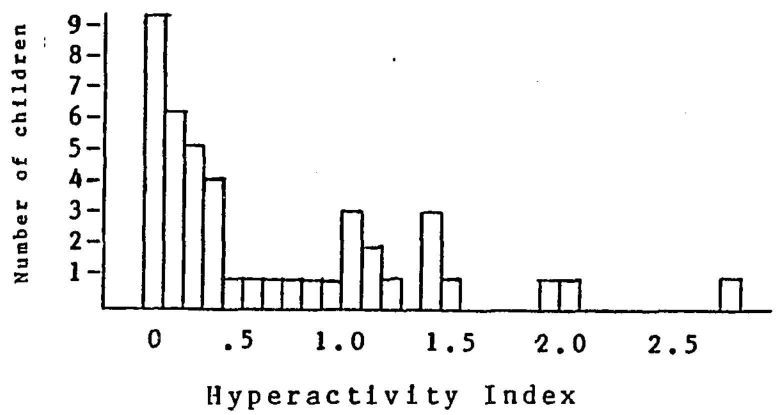


Fig. 4. Distribution of scores on the Hyperactivity Index of the teacher questionnaire for girls.

Although the cut-off values in the Hyperactivity Index varied depending on both age and gender, there was no overlap between ADHD and non-ADHD children. Values in the Hyperactivity Index ranged from 0 to .8 for normal girls, 1.1 to 2.6 for ADHD girls, 0 to .9 for normal boys, and 1.7 to 2.9 for ADHD boys.

For the sake of clarity, subjects with attention/behavior problems are referred to as teacher-identified ADHD children, although no attempt was made to determine if they met DSM-III-R criteria for ADHD. Teacher-identified ADHD children and non-ADHD children were equivalent in age and intelligence, as estimated by the Peabody Picture Vocabulary Test (PPVT) (Dunn & Dunn, 1981). The means (SD) of the selective and descriptive variables are presented in Table 1.

Table 1. Mean (SD) of Classificatory and Descriptive Variables

	Normal group		School ADHD group	
	Boys (N=23)	Girls (N=29)	Boys (N=12)	Girls (N=7)
Age (months)	112.00 (17.63)	110.48 (20.12)	103.17 (18.23)	109.57 (27.37)
PPVT (Stand.Score)	88.09 (19.58)	87.10 (18.03)	81.83 (14.53)	86.43 (10.39)
Hyperactivity Index***	.40 (.32)	.20 (.22)	2.39 (.39)	1.64 (.19)

***Significant interaction (p<.001)

Procedure

A consent form and a copy of the Revised Conners Parent Questionnaire (Goyette et al., 1978) was sent to the parents of all students in the school. The Revised Conners Parent Questionnaire samples a wide range of problem behaviors and is completed by either the mother or the father. It consists of 48 items which are rated on a 4-point scale from zero ("not at all" a problem) to three ("very much" a problem). The questionnaire yields five factors: Conduct Problems, Learning Problems, Psychosomatic Problems, Impulsivity-hyperactivity and Anxiety. These factors each consist of separate items and were derived from factor analyses (Goyette et al., 1978). In addition, the parent questionnaire yields the Hyperactivity Index which is comprised of items from the Impulsivity-overactivity, Learning Problems and Conduct Problems factors. The Revised Conners Parent Questionnaire as well as the item composition for the different factors is shown in Appendix A.

Teachers completed the Revised Conners Teacher Questionnaire (Goyette et al., 1978) for those students who had parental permission to participate in the study. The Revised Conners Teacher Questionnaire is a 28-item questionnaire that samples a wide range of problem behaviors which can be observed in the classroom (e.g., "disturbs other children", "fails to finish things that he starts"). Similar to the parent version, the teacher questionnaire is scored on a 4-point scale, with higher scores representing more deviant behavior. In addition to the Hyperactivity Index, three factors are derived from the Conners Teacher Questionnaire: Conduct problems factor, Inattention-passivity factor and Hyperactivity factor (see Appendix A).

All subjects were administered a brief test battery which lasted approximately one hour. The subjects were tested individually in their school during regular school hours. The tests were administered by two experimenters who were blind to group assignment. Each experimenter administered half the tests in a fixed order designed to minimize fatigue and boredom. The first experimenter administered the Peabody Picture Vocabulary Test and the Digit Span subtest of the WISC-R; the second administered the Matching Familiar Figures Test and the Continuous Performance Test. A description of each of these measures follows:

1) The continuous performance test (CPT). The CPT was modelled after the A-X paradigm described by Rosvold and colleagues (Rosvold et al., 1956) and was programmed to run on a Commodore 64 computer. Each child was

instructed to respond as quickly as possible by pressing a key whenever he/she saw an A followed by an X. The task consisted of a total of 400 stimuli, contained 40 targets, and lasted approximately 12 minutes. Individual letters were presented individually on the video screen for a duration of 200 msec., with a 150 msec. interstimulus interval.

Every effort was made to insure that all subjects understood the instructions and could identify letters. This was accomplished in two ways. First, children were asked to read a sequence of letters printed on a sheet of paper and identify the A-X sequence. Second, they were shown 20 practice stimuli on the video screen and asked to press the space bar whenever they saw an A followed by an X. None of the subjects made a considerable number of errors during the practice trials and, therefore, it was clear that they understood the task.

Several measures were derived from the CPT: number of misses (omission errors), number of false alarms (commission errors), reaction time for hits and variabilty of reaction times for hits. In addition, the four different types of commission errors were analyzed separately. Based on previous research with this instrument (Halperin, Wolf, Pascualvaca, et al., 1988; Halperin, Wolf & Young, 1989), misses and X-Only errors were conceptualized as measures of inattention whereas A-Not-X errors were conceptualized as measures of impulsivity. No specific hypotheses were made regarding the meaning of A-Only and Random errors.

2) The Matching Familiar Figures Test (MFFT) (Kagan, 1964). The MFFT is a matching to sample test which involves the presentation of a standard figure along with six highly similar figures; the child is instructed to select the figure that exactly matches the standard (see Appendix A). The test is untimed and consists of two practice trials and 12 test stimuli. Two measures were derived from the MFFT: mean latency to first response and total number of errors.

ADHD children have been found to make more errors and to have shorter latencies than normal controls on the MFFT (Messer, 1976). The MFFT, traditionally considered a measure of impulsivity, was included in the battery to determine if it differentiates the groups. Boys were found to make more errors and have shorter latencies than girls in the normative study. Therefore, the test has separate norms for boys and girls.

3) The Digit Span subtest of the WISC-R (Wechsler, 1974). On this task, the child is instructed to repeat a

sequence of numbers of increasing length. It consists of two parts. In the first part, the child has to repeat the sequence of numbers in its original form; in the second, he/she has to repeat them backwards. The Digit Span subtest has been traditionally used as a measure of attention. It was included in the battery to determine if it can distinguish between groups and gender.

4) The Peabody Picture Vocabulary Test - Form L (PPVT) (Dunn & Dunn, 1981). In the PPVT, the child is instructed to point to a picture that best describes a word given by the examiner. There are four pictures for each word (see Appendix A). Although the PPVT is considered a test of receptive vocabulary, it is highly correlated with more traditional and lengthy tests of intelligence, such as the WISC-R (mean r=.64) (Dunn & Dunn, 1981). Therefore, it was used in the present study as an estimate of intellectual functioning.

In addition, standardized reading and arithmetic scores from the Comprehensive Test of Basic Skills were obtained from the school records. The Comprehensive Test of Basic Skills is routinely administered to all students at the end of the academic year. Test scores were available for 64 of the total sample; the remaining 21 children were new in the school and had not been evaluated.

Data analyses. Data were subjected to 2 x 2 (group by gender) Analyses of Covariance (ANCOVA) using age as a covariate. Age was used as a covariate because scores on the CPT (Sykes et al., 1973), the MFFT (Kagan, 1964), and the Conners Questionnaires (Goyette et al., 1978) all improve with age. Exceptions to this were the PPVT and Digit Span for which age-scaled scores were used as dependent variables. Therefore, scores on the PPVT and digit span were analyzed using 2 x 2 (group by gender) Analyses of Variance (ANOVA). Significant effects were followed with Scheffe´s test to evaluate significant group effects.

Results

Group Differences

ADHD children were rated higher than non-ADHD children on the Hyperactivity [$F(1,66)=277.22$, $p<.0001$], Inattention/Passivity [$F(1,66)=87.58$, $p<.0001$] and Conduct Problems [$F(1,66)=157.01$, $p<.0001$] factors from the Conners Teacher Questionnaire (see Table 2). This was expected given that the Hyperactivity Index was used to define the groups, and this Index is comprised of items from the other three factors.

Table 2. Means (SD) of Factor Scores from the Revised Conners Teacher Questionnaire.

	Normal group		School ADD group	
	Boys (N=23)	Girls (N=29)	Boys (N=12)	Girls (N=29)
Hyperactivity***	.39 (.38)	.21 (.34)	2.46 (.44)	1.55 (.51)
Inattention/Passivity**	.46 (.48)	.28 (.34)	1.93 (.72)	1.46 (.82)
Conduct Problems*	.32 (.28)	.29 (.31)	2.11 (.62)	1.77 (1.06)

*Significant group effect (p<.01)
**Significant gender and group effect (P<.001)
***Significant interaction (p<.01)

Parents rated children much lower than teachers. These findings are consistent with previous reports (Goyette et al., 1978) and have been attributed to a number of factors including situational differences in children's behavior, parents' higher tolerance for inappropriate behaviors or poor understanding of age appropriate behaviors (Rutter, 1983).

Parent ratings also discriminated between ADHD and non-ADHD children (see Table 3). Parents rated ADHD children higher than non-ADHD children on the Impulsivity/Overactivity [F(1,66)=13.45, p<.0001] and Conduct Problems [F(1,66)=10.58, p<.005] factors.

Table 3. Means (SD) of the Factor Scores from the Revised Conners Parent Questionnaire

	Normal group		School ADD group	
	Boys (N=23)	Girls (N=29)	Boys (N=12)	Girls (N=7)
Impulsivity/Overactivity*	.62 (.61)	.59 (.52)	1.22 (.82)	1.38 (.75)
Conduct Problems*	.35 (.34)	.32 (.34)	.67 (.46)	.80 (.51)
Learning Problems	.59 (.61)	.48 (.61)	.96 (.71)	.83 (.68)
Anxiety	.43 (.53)	.43 (.41)	.33 (.25)	.38 (.34)
Psychosomatic Problems	.41 (.54)	.34 (.42)	.19 (.40)	.56 (.68)

*Significant group effect (p<.01)

Thus, the hypothesis that ADHD children are more behaviorally disturbed than normal children was supported by both teacher and parent ratings. In contrast, ADHD and normal children did not differ on parent ratings of anxiety [F(1,66)=.60, p>.10], psychosomatic problems

[F(1,66)=.21, p>.10] or learning problems [F(1,66)=2.7, p>.10]. This suggests that parents do not perceive ADHD children as being more impaired in all areas of functioning.

Ratings of inattention and impulsivity in ADHD children were confirmed by the objective measures. As predicted, ADHD children performed worse on the CPT than non-ADHD children (see Table 4). They made more false alarms [F(1,66)=5.90, p<.01], had more variable hit reaction times [F(1,66)=9.23, p<.005] and tended to make more misses [F(1,66)=3.76, p=.06] than normal children. A closer inspection of the different false alarm subtypes revealed that teacher-identified ADHD children made a greater number of A-Not-X [F(1,66)=5.50, p<.05] and Random [F(1,66)=4.36, p<.05] errors than normals, but the groups did not differ on number of A-Only [F(1,66)=2.87, p>.05] or X-Only [F(1,66)=1.27, p>.10] errors.

When using signal detection analyses of the CPT data, ADHD children were found to have lower d′ values [F(1,66)=6.05, p<.05] than normals, but did not differ in Beta [F(1,66)=.23, p>.10]. This suggests that perceptual sensitivity deficiency is not confounded by response strategy factors. Decreased d′ in the ADHD groups was expected given their lower hit rate (higher number of misses) and increased false alarm rate. The lack of

Table 4. Mean values (SD) of the Continuous Performance Test

	Normal group		School ADD group	
	Boys (N=23)	Girls (N=29)	Boys (N=12)	Girls (N=7)
Misses***	2.83 (4.88)	3.03 (2.83)	3.92 (4.68)	7.86 (7.33)
Hit RT (msec)	704.24 (125.58)	699.47 (132.50)	719.83 (82.76)	726.40 (203.37)
Hit SD (msec)*	144.28 (66.44)	150.01 (56.40)	192.08 (48.11)	214.28 (88.67)
False Alarms*	8.87 (14.55)	4.00 (6.37)	13.50 (14.78)	18.14 (16.21)
False Alarm subtypes				
A-not-X*	3.52 (6.24)	1.62 (2.98)	6.75 (6.75)	6.29 (6.94)
X-Only	2.74 (5.34)	1.41 (3.52)	2.83 (3.13)	4.57 (6.60)
A-Only	1.22 (2.70)	0.62 (1.57)	2.00 (3.41)	2.86 (4.34)
Random***	1.39 (3.34)	0.34 (1.01)	1.92 (3.29)	4.43 (7.00)
Signal detection paramaters				
d'*	3.74 (.94)	3.76 (.59)	3.36 (.93)	2.85 (1.00)
Beta**	2.16 (1.44)	4.76 (4.52)	3.47 (3.73)	4.47 (4.77)

*Significant group effect ($p<.05$)
**Significant sex effect ($p<.05$)
***Significant interaction ($p<.05$)

significant differences in Beta, or response criterion, is surprising because of the difficulty in impulse control characteristic of ADHD children, but consistent with previous findings (van der Meere & Sergeant, 1988b).

ADHD and non-ADHD children did not differ in the PPVT standard scores [$F(1,66)=.31$, $p>.10$] and were therefore considered to be of equivalent intellectual ability. Analyses of the academic achievement data revealed that ADHD children obtained lower reading scores [$F(1,50)=4.90$, $p<.05$] than normal children, but did not differ in arithmetic scores [$F(1,50)=2.29$, $p>.10$]. Thus, the hypothesis that ADHD children would have more academic difficulties than normal children was in part supported.

Other objective measures did not differentiate between the groups. ADHD and non-ADHD children obtained similar scores on the Digit Span [$F(1,66)=.29$, $p>.10$], and did not differ on number of errors [$F(1,66)=.21$, $p>.10$] or latency [$F(1,66)=1.76$, $p>.10$] on the MFFT. The means of the cognitive and academic measures by group and gender are presented on Table 5.

In sum, these results support the existence of attention and impulse control problems in ADHD children. However, not all measures discriminated ADHD from non-ADHD children. For example, the performance of ADHD children was comparable to that of normal children on the digit span and MFFT. Although these results do not support the hypotheses, they are consistent with previous studies which fail to find significant group differences using these measures (deHaas, 1986). These findings also indicate that different instruments purported to measure the same functions are not interchangeable (Wolf, Pascualvaca, Healey, Gerstman & Halperin, 1987).

Table 5. Means (SD) of the cognitive and achievement measures

	Normal group		School ADD group	
	Boys (N=23)	Girls (N=29)	Boys (N=12)	Girls (N=7)
Matching Familiar Figures				
Errors**	12.30 (5.04)	8.76 (4.32)	13.33 (4.39)	9.57 (3.31)
Latency (sec.)	8.50 (2.70)	10.92 (6.08)	7.58 (3.73)	8.71 (4.04)
Digit Span (WISC-R)	8.87 (2.72)	8.14 (2.92)	7.67 (2.19)	8.43 (1.90)
Academic Achievement				
Reading (%ile)*	50.12 (23.45)	57.00 (21.64)	37.63 (23.37)	39.00 (22.02)
Arithmetic (%ile)	51.82 (22.76)	57.54 (19.84)	46.13 (27.22)	43.14 (17.06)

*Significant main effect for group ($p<.05$)
**Significant main effect for gender ($p<.05$)

Gender Differences

On the average, teachers rated boys higher than girls on the Hyperactivity Index [F(1,66)=402.47, p<.001] used to define the groups. This was expected given that boys usually obtain higher, more deviant, scores on teacher rating scales (Goyette et al., 1978). However, this finding was not consistent across factors. A closer inspection of the separate factor scores revealed that boys were rated higher than girls on the Hyperactivy [F(1,66)=15.81, p<.0001] and Inattention/Passivity [F(1,66)=4.11, p<.05] factors, but failed to differ from girls on the Conduct Problems [F(1,66)=.93, p>.10] factor (see Table 2).

None of the factors from the Revised Conners Parent Questionnaire yielded significant gender differences. Boys and girls received similar ratings on the Impulsivity/ Overactivity [F(1,66)=.04, p>.10], Conduct Problems [F(1,66)=.04, p>.10], Learning Problems [F(1,66)=.82, p>.10], Psychosomatic Problems [F(1,66)=.04, p>.10] and Anxiety [F(1,66)=.00, p>.10) factors (see Table 3).

Objective measures of attention and impulsivity also yielded minimal gender differences (see Tables 4 and 5). In fact, boys and girls differed only on the MFFT. On this task, boys made significantly more errors than girls

[F(1,66)=11.78, p<.001], but boys and girls failed to differ in mean latency to first response [F(1,66)=3.58, p>.10]. Boys also obtained lower Beta [F(1,66)=6.23, p<.01] scores on the CPT. These findings are consistent with previous studies (Messer, 1976) and suggest that boys have a more impulsive cognitive style than girls.

There were no further sex differences for any of the CPT measures. Boys and girls obtained similar d′ values [F(1,66)=.53, p>.10], and made a comparable number of misses [F(1,66)=1.63, p>.10] and false alarms [F(1,66)=.69, p>.10]. They also had similar reaction times to hits [F(1,66)=0.00, p>.10] and hit reaction time variability [F(1,66)=.57, p>.10]. False alarm subtypes did not differentiate the sexes (p>.05).

Similarly, boys and girls did not differ in intellectual ability as measured by the PPVT [F(1,66)=.01, p>.10], and had similar reading [F(1,66)=.75, p>.10] and arithmetic [F(1,79)=.31, p>.10] scores.

In sum, gender differences emerged more clearly at a behavioral level, with boys being considered more impaired by teachers. As expected, there were no sex differences in intellectual functioning, academic achievement or attention, but boys were found to be more impulsive than girls.

<u>Group x Gender Interactions</u>

Among behavior ratings, group by gender interactions reached significance only for the Hyperactivity factor [$F(1,66)=10.97$, $p<.01$] from the Revised Conners Teacher Questionnaire (see Figure 5).

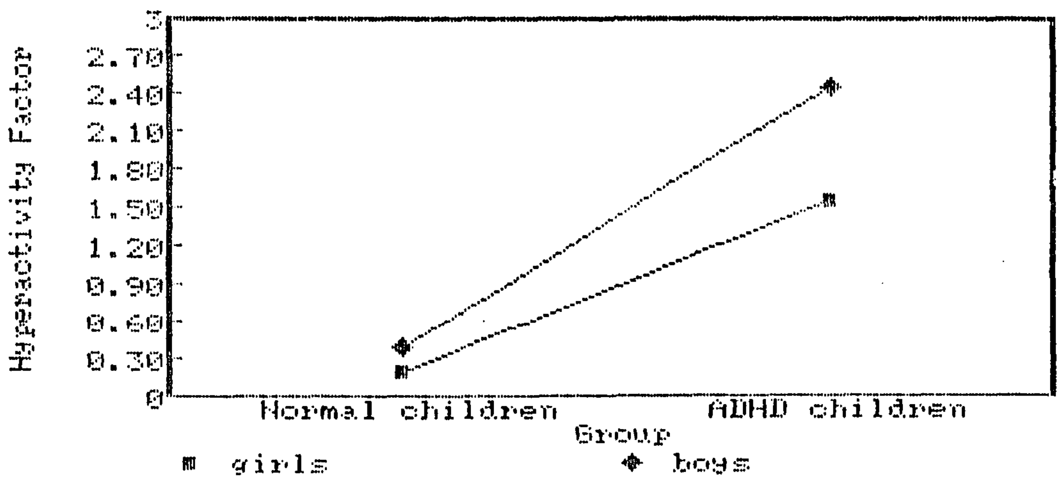


Fig. 5. Mean values of the Hyperactivity Factor of the Revised Conners Teacher Questionnaire by group and gender.

Post-hoc comparisons using Scheffe´s test revealed that ADHD boys were rated as being more hyperactive than ADHD girls and normal boys ($p<.001$). There were no significant group by gender interactions for any of the factors from the Revised Conners Parent Questionnaire.

Since the groups were selected through behavioral ratings, and boys had more pronounced behavioral problems than girls, ADHD boys were more deviant than ADHD girls on an absolute basis. Given this, one would predict ADHD girls to perform better on attentional and cognitive tasks. However, this hypothesis was not supported. In fact, ADHD girls tended to do worse on attentional tasks than the other groups.

Group by gender interactions were significant for number of misses [$F(1,66)=4.33$, $p<.05$] and random errors [$F(1,66)=5.40$, $p<.05$) on the CPT (see Figures 6 and 7).

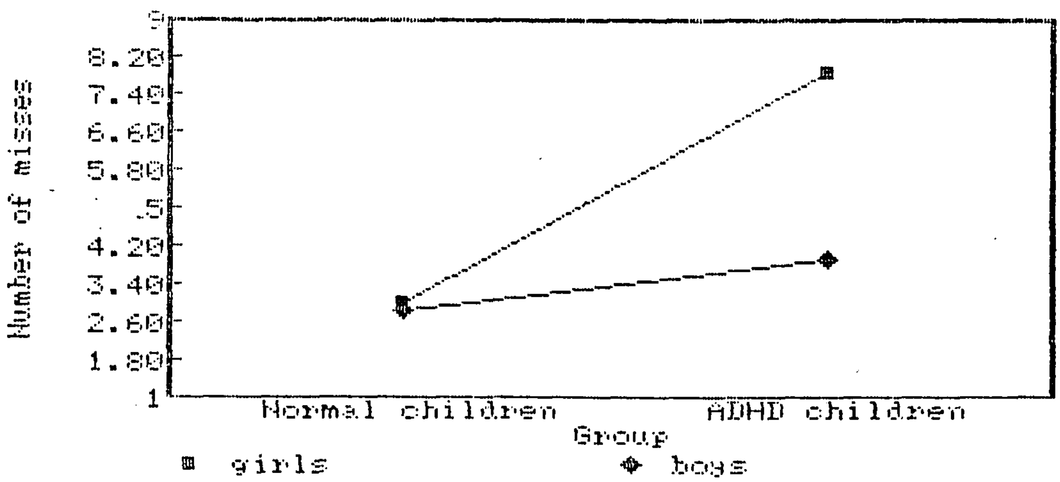


Fig. 6. Mean number of CPT misses by group and gender.

ADHD girls tended to make more misses (3.92 vs. 7.86) and random errors (1.92 vs. 4.43) than ADHD boys, although these differences did not reach significance. Moreover, ADHD girls made more misses (7.86 vs. 3.03) and random errors (4.43 vs. .34) than normal girls ($p<.01$), whereas ADHD boys did not differ from normal boys. These results suggest that ADHD girls are at least as impaired as ADHD boys in attention and cognitive functions.

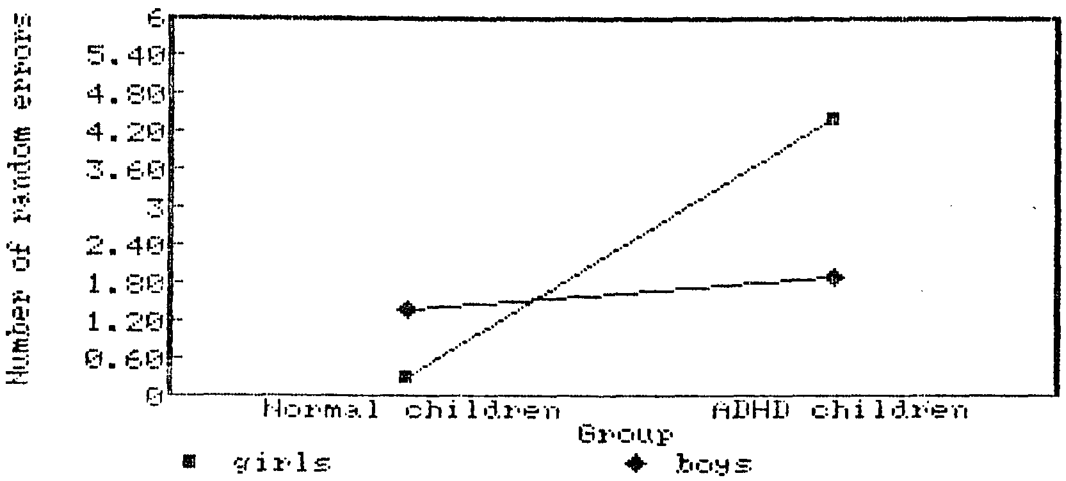


Fig. 7. Number of CPT random errors by group and gender.

Data were analyzed to examine the differential age gradients for behavioral and cognitive problems. Although disruptive behavior decreased with age in both boys and girls, there was no systematic trend for attention and cognitive problems. The small number of subjects in each group and the high variability was probably responsible for the lack of significant results.

Relationship Between Measures

Partial correlations controlling for age were calculated between measures separately for boys and girls. The entire sample (N=85, 42 boys and 43 girls) was used in these correlations because the small sample size in the various groups precluded the use of separate group analyses. Because of the large number of correlations computed, the Bonferroni t procedure was used to control for potential inflation of the type I error. Only those correlations with an alpha level below .001 were considered significant.

Behavioral ratings. Correlations among the factors from the Revised Conners Teacher Questionnaire were highly inter-correlated for both boys and girls ($p<.001$). An exception to this was the correlation between the Inattention/Passivity and Conduct Problems factors which was nonsignificant for girls ($r=0.31$, $p>.01$), but significant for boys ($r=0.79$, $p<.001$ for boys). These results suggest that girls can be inattentive without presenting serious behavioral problems; or alternatively, that boys may be perceived by teachers as being impaired in all areas because of their more severe behavioral problems. The latter possibility seems more likely given the results presented below.

Teacher and parent ratings were highly related for girls, but not boys (see Table 6). For example, teacher ratings of hyperactivity correlated with parent ratings of impulsivity ($r=0.50$, $p<.001$) and conduct problems ($r=0.60$, $p<.001$) for girls, not so for boys ($r=0.35$ and

0.34, respectively, p=.05). Similarly, teacher ratings

Table 6. Correlations between parent and teacher ratings

	Teacher Questionnaire			
	Hyperactivity Index	Hyperactivity	Inattention/ Passivity	Conduct Problems
Parent Questionnaire			Boys	
Hyperactivly Index	.24	.21	.12	.26
Impulsivity/ Overactivity	.37	.35	.23	.33
Conduct Problems	.38	.34	.25	.43
Learning Problems	.29	.23	.30	.32
Psychosomatic Problems	-.22	-.16	-.29	.16
Anxiety	.00	-.03	.07	.05
			Girls	
Hyperactivity Index	.36	.38	.38	.36
Impulsivity/ Overactivity	.46	.50*	.50*	.46
Conduct Problems	.51*	.62*	.13	.48
Learning Problems	.30	.30	.21	.19
Psychosomatic Problems	.25	.38	..00	.18
Anxiety	.05	-.13	.21	.03

*p<.001

of inattention correlated with parent ratings of impulsivity/ overactivity only for girls ($r=.50$, $p<.001$). Thus, it appears that when girls have problems, these problems are manifest both at the school and home settings. In contrast, boys may have difficulties in one setting, but not the other.

Behavioral and cognitive measures. Behavior ratings and objective measures were also highly related in girls, but not in boys (see Tables 7 and 8). For girls, the number of misses were correlated significantly with teacher ratings of inattention ($r=0.51$, $p<.001$), whereas the number of false alarms correlated significantly with parent and teacher ratings of conduct problems ($r=0.60$ and 0.52, respectively, $p<.001$). There were no significant correlations between objective and behavioral measures for boys.

Table 7. Correlations between teacher ratings and objective measures.

	Hyperactivity Factor	Inattention/ Passivity	Conduct Problems
		Boys	
Misses	.01	.11	.04
False Alarms	.09	.13	.08
MFF errors	.12	.14	.04
Digit Span	-.26	-.20	-.20
Reading	-.17	-.23	-.29
Arithmetic	-.15	-.28	-.19
		Girls	
Misses	.29	.51*	.04
False Alarms	.44	.19	.52*
MFF errors	.00	.36	.05
Digit Span	.10	-.01	.02
Reading	-.14	-.37	-.14
Arithmetic	-.16	-.38	-.08

*p<.001

Table 8. Correlations between parent ratings and objective measures

	Impulsivity/ Hyperactivity	Conduct Problems	Learning Problems	Psychosomatic Problems	Anxiety
			Boys		
Misses	-.06	-.02	.32	.02	.01
False Alarms	-.13	-.13	.14	-.34	-.09
MFF errors	-.20	-.10	.00	-.25	-.09
Digit Span	-.24	-.13	-.12	-.17	-.12
Reading	-.03	-.14	-.26	.03	-.19
Arithmetic	-.04	-.15	-.26	.07	-.12
			Girls		
Misses	.09	.08	.39	-.01	.05
False Alarms	.45*	.60*	.37	.33	.18
MFF errors	-.03	-.07	-.03	-.22	.23
Digit Span	.22	.26	.13	.24	.20
Reading	-.27	-.34	-.52	-.03	-.27
Arithmetic	-.22	-.20	-.25	.12	-.19

*p<.001

Discussion

This study indicates several similarities between girls and boys with attention and behavior problems. Teacher-identified ADHD girls and boys have more behavioral problems than their peers and perform worse on objective measures of attention and impulsivity. Their school performance tends to be poorer despite equivalent intellectual ability. These findings are consistent with previous studies of ADHD children and suggest a similar pattern of deficits in ADHD boys and girls.

Notwithstanding, several gender differences were identified. ADHD boys were more hyperactive than ADHD girls according to teachers. This was expected because ADHD boys are generally found to be more behaviorally disturbed than ADHD girls (Berry et al., 1985), and boys usually obtain more deviant scores on teacher rating scales (Goyette et al., 1978). However, these rating scale differences were not confirmed by objective measures. ADHD boys and girls did not differ from each other on any of the attentional or cognitive measures. In fact, for several measures, ADHD girls tended to do worse. This suggests that teacher-identified ADHD girls are less behaviorally impaired than ADHD boys, but have at least equally severe attention problems.

One needs to keep in mind that teacher-identified

ADHD children did not have a clinical diagnosis of ADHD, but were children who exhibitied ADHD-like behaviors. It is important to recognize the problems associated with using cut-off points since no natural cut-off point exists, as illustrated by the distribution of scores on teacher ratings. However, children identified in this manner were also considered more deviant by parents and performed poorly on objective measures. This finding indicates that teachers are good gaugers of problematic behavior in males and females.

Correlations between behavioral ratings and objective measures yielded notable differences between boys and girls. Teacher ratings were highly associated with parent ratings for girls, but not boys. Moreover, for girls, ratings of inattention correlated with objective measures of attention. Ratings of hyperactivity and of conduct problems, in turn, correlated with objective measures of impulsivity for girls but not for boys.

These results suggest that the symptoms of ADHD manifest differently in boys and girls, and that girls may be a more homogeneous group (Ackerman et al., 1983). When girls have behavioral problems at school, they are more likely to have similar problems at home. Furthermore, behavioral problems in girls are accompanied by attentional and cognitive difficulties. In contrast, for boys, behavior problems are not necessarily associated with attentional and cognitive problems. Boys tend to present with more severe behavioral problems than girls, but they often time exhibit these problems in the absence of attentional and cognitive deficits.

The present results are consistent with reports of more disruptive behaviors in ADHD boys, and may in part explain the more severe cognitive impairments found in clinic-referred ADHD girls (Ackerman et al., 1983; Berry et al., 1985). In the present study, ADHD girls and boys did not differ from each other in intellectual functioning or academic achievement. ADHD girls tended to do worse on attentional measures, but many of the differences failed to achieve significance. It is possible that the lack of statistical significance was the result of the small sample size. However, it is also possible that the more severe impairments reported in studies of clinic populations are due to referral biases. ADHD boys have more obvious behavior problems, and thus may be more likely to be noticed and referred for treatment than ADHD girls. However, these problems are not necessarily accompanied by serious attentional and cognitive deficits. Girls whose behavior problems are of sufficient severity to warrant intervention, on the other hand, are more likely to have problems in attention and cognition.

In order to distinguish between referral biases and sex differences in the manifestation of ADHD, it is necessary to compare clinic and school samples of ADHD children within the same study. This possibility was incorporated into Experiment 2.

Experiment 2

Some investigators have suggested that girls may have a higher threshold for the manifestation of ADHD and, as a result, may be more severely impaired than boys (Berry et al., 1985). This suggestion is based on results from clinic studies which find ADHD girls to be more limited intellectually and academically, and to come from more disadvantaged backgrounds than ADHD boys (Berry et al., 1985; Kashani et al., 1978). This interpretation is consistent with a pattern of affliction observed in disorders which favor one sex, where there is frequently a dissociation betwen incidence and severity. In other words, the less frequently afflicted sex usually shows the more severe deficits (Tsai & Beisler, 1983).

However, previous reports of greater impairments in ADHD girls are all based on clinic samples. It is therefore possible that these results are an artifact of the selection and referral processes. Given that ADHD girls are less behaviorally impaired than ADHD boys, they may not be as frequently identified; and those that are identified may not be representative of the general population of ADHD girls.

The second experiment aimed at distinguishing between referral biases and differences in manifestation using groups of teacher-identified ADHD children, clinic-referred ADHD children and normal controls.

It was hypothesized that:

A. If sex differences in manifestation, and possibly incidence, in ADHD are the result of referral biases, then:

1. Clinic-referred ADHD girls are expected to have more academic difficulties and be more limited intellectually than clinic-referred ADHD boys and than non-referred ADHD boys and girls. This prediction was based on the hypothesis that ADHD girls are referred mainly because of their academic and intellectual problems.

2. Clinic-referred ADHD girls are expected to have more severe attention deficits than ADHD boys. Although reports of gender differences in attention are inconclusive, it was hypothesized that the academic problems of ADHD girls that lead to their referral are accompanied by attention difficulties.

3. Clinic-referred ADHD boys are expected to be more hyperactive and to have more conduct problems than clinic-referred ADHD girls, and non-referred ADHD children. It was hypothesized that behavior and conduct problems result in the identification and referral of ADHD boys more frequently than ADHD girls.

B. If sex differences in manifestation and incidence of ADHD are the result of females having a higher threshold for the manifestation of the disorder, then:

1. A greater proportion of relatives of ADHD girls are expected to have been hyperactive as children compared to the relatives of ADHD boys. Given the relationship between hyperactivity and alcoholism (Morrison & Stewart, 1971), the incidence of these problems is also expected to be higher in the relatives of ADHD girls.

2. Male relatives of ADHD boys and girls are expected to have a higher incidence of ADHD and other disorders than female relatives. Though this finding may not be in itself conclusive, it would suggest that the sex ratio in incidence is real since there is no reason to believe that the informants (i.e., parents) would be more likely to report problems in one sex than the other.

No specific hypotheses were made regarding gender differences in severity. Some investigators have suggested that, in accordance with the threshold model, ADHD girls present the more severe manifestation of ADHD (Berry et al., 1985). However, as previously indicated, this prediction may not be well founded in the assumptions of the threshold model. Furthermore, it is not clear how one would define severity or the relative importance of the individual symptom areas (i.e., attention, impulsivity and hyperactivity).

Method

Subjects.

Three groups of subjects were assembled. The entire sample consisted of eighty-four subjects (40 boys and 44 girls) selected from a total of ninety-six children who had permission to participate in the study. Children were included only if they 1) were between the ages of 6 and 13 (mean=9.37 SD=1.86), and 2) had a WISC-R Full Scale IQ of at least 70 (range=71-143 mean=97.14 SD=14.49). All children were from either low or middle income families with a mean (SD) SES of 26.98 (11.34) according to the Four Factor Index of Social Status (Hollingshead, 1975).

Children were eliminated from the study if they 1) were taking medication with known CNS effects, 2) had a diagnosed neurological disorder or 3) met criteria for a major psychiatric disorder (e.g., schizophrenia, pervasive developmental disorder, major affective disorder). In addition, children were eliminated from the school sample if they scored between one and two standard deviations above the mean on the Hyperactivity Index from the Revised Conners Teacher Questionnaire

(Goyette et. al., 1978). Figures 8 and 9 show the distribution of scores on the Hyperactivity Index for boys and girls in the school sample, respectively.

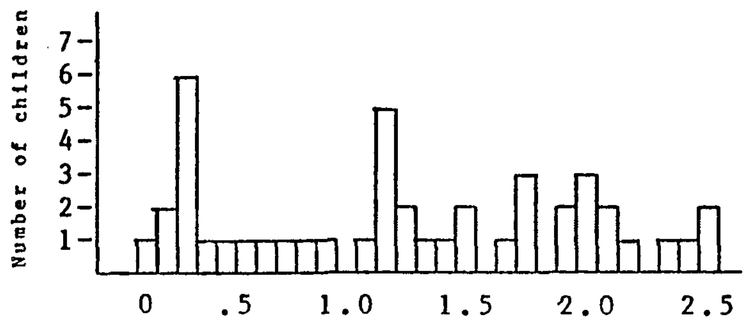


Fig. 8. Distribution of scores on the Hyperactivity Index of the teacher questionnaire for boys.

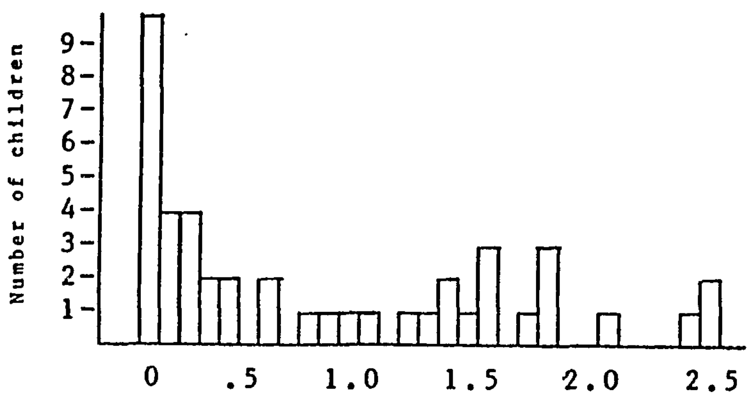


Fig. 9. Distribution of scores on the Hyperactivity Index of the teacher questionnaire for girls.

Exclusion criteria pertinent to the individual groups together with a brief description of each group follows:

1) Clinic-referred ADHD children (N=23, 16 boys and

9 girls). These children were recruited from referrals to a Child Psychiatry Department of an urban medical center. They were diagnosed by a team of psychiatrists, psychologists, and social workers as having an Attention Deficit Disorder according to DSM-III or DSM III-R criteria, and ADHD was the primary diagnosis in their clinic charts. Although children with additional diagnoses associated with ADHD (e.g., Specific Developmental Disorder or Conduct Disorder) were not eliminated from the study, these diagnoses were noted. Five children (3 boys and 2 girls) had an additional Axis I diagnosis of Conduct Disorder, and two boys and one girl had an Axis II diagnosis of Developmental Reading Disorder.

2) Teacher-identified ADHD children (N=18, 6 boys and 12 girls). These children were recruited and identified in a similar manner as those in Experiment 1, and were students from the same urban parochial school. In fact, 6 teacher-identified children (3 boys and 3 girls) also participated in the first study. Children in this group were rated at least two standard deviations above the mean for their age and sex on the Hyperactivity Index of the Revised Conners Teacher Questionnaire (Goyette et. al., 1978) and were, therefore, considered

to have significant attention/behavioral problems. Values in the Hyperactivity Index ranged from 2.1 to 2.8 for boys, and 1.3 to 2.8 for girls. None of the teacher-identified ADHD children were receiving any kind of treatment for behavioral or emotional problems.

3) Normal controls (N=41, 18 boys and 23 girls). Normal controls were recruited from the same school as teacher-identified ADHD children. Twenty-two normal children (10 boys and 12 girls) also participated in Experiment 1. Children in this group scored below one standard deviation above the mean for their age and sex on the Hyperactivity Index of the Revised Conners Teacher Questionnaire (Goyette et al., 1978). Hyperactivity Index scores ranged from 0 to 1.2 for boys, and 0 to .8 for girls. For the purpose of the present experiment, these children were considered to present no significant attention/ behavior problems.

Both groups of ADHD children were younger than normal children. By definition, ADHD children scored higher than normal children on the Hyperactivity Index from the teacher questionnaire. Table 9 shows the means (SD) of the descriptive and selective variables by group and gender.

Table 9. Means (SD) of the Selective and Descriptive Measures

	Normal group		School ADHD group		Clinic ADHD group	
	Boys (N=18)	Girls (N=23)	Boys (N=6)	Girls (N=12)	Boys (N=16)	Girls (N=9)
Age (months)*	118.89 (22.37)	127.26 (18.28)	107.67 (18.94)	104.92 (19.52)	109.56 (24.16)	98.33 (17.43)
Hyperactivity Index**	.47 (.40)	.20 (.23)	2.30 (.27)	1.81 (.42)	1.97 (.56)	1.85 (1.08)
FSIQ*	101.61 (14.14)	98.87 (16.64)	101.83 (12.77)	101.42 (10.56)	93.25 (12.05)	81.89 (8.72)
SES*	24.92 (11.88)	22.12 (11.34)	24.50 (7.59)	31.71 (7.54)	31.10 (12.19)	32.71 (10.92)

*Significant group effect ($p<.05$)
**Significant group and gender effect ($p<.05$)

Procedure:

All children were administered a test battery which lasted approximately two hours. Each child was tested individually in two sessions spaced approximately one week apart, either in their school or in the hospital. Clinic-referred ADHD children were tested as part of their initial evaluation to the clinic. A description of each of the measures follows:

1) Continuous performance test (CPT). The CPT used was similar to the one in Experiment 1. It differed from

the previous CPT in that the frequency of X's preceded by A's (targets), X's not preceded by A's, and A's not preceded by X's were all 10%. These percentages in the previous CPT were 10, 5, and 17, respectively. These changes were made in an attempt to even out the opportunities for making the various commission errors. The measures derived from the CPT were identical to those in Experiment 1. These included: number of misses, number of various false alarm subtypes, reaction time and reaction time variability, d', and Beta.

2) Wechsler Intelligence Scale for Children-Revised (WISC-R) (Wechsler, 1974). Although the PPVT was included in Experiment 1 as an estimate of intellectual functioning, it was felt that the WISC-R would provide a more accurate measure of intelligence and be useful in comparing the present results with those of other studies. The Picture Arrangement and Mazes subtests were eliminated from the WISC-R because of time constraints. The Performance IQ and Full Scale IQ were prorated based on the four Performance subtests administered.

3) Wide Range Achievement Test - Revised (WRAT-R) (Jastak & Wilkinson, 1984). The WRAT-R is a paper and pencil test of academic achievement. It consists of

three subtests: Reading (Word Decoding), Spelling and Arithmetic subtests. Because of the high correlations between the Reading and Spelling subtests (Jastak & Wilkinson, 1984), only the Reading and Arithmetic subtests were administered.

All teachers completed the Revised Conners Teacher Questionnaire (Goyette et al., 1978). A copy of this questionnaire was sent to the teachers of clinic-referred children with a letter requesting their cooperation. Teachers of the school sample children also completed a rating scale comprised of DSM-III and DSM-III-R criteria for ADDH (or ADHD) (see Appendix A). This scale has been shown to be an adequate instrument for screening non-referred children (Newcorn, Halperin, Healey et al., 1988). The DSM-III criteria was used since most of the children in the clinic sample were diagnosed according to these criteria.

Parents completed the Revised Conners Parent Questionnaire and a family history questionnaire (see Appendix A). Both questionnaires were sent to the parents of children in the school sample. Parents of children in the clinic group completed these questionnaires while their children were being evaluated. A description of the family history questionnaire follows:

(1) Information regarding parents' education and present occupation were included to estimate the family's socioeconomic status according to the Four Factor Index of Social Status (Hollingshead, 1975). This scale rates social status based upon education, occupation, sex and marital status of the parents. It yields a score from 8 to 66 which is grouped into five categories, ranging from unskilled laborers to major professionals.

(2) Information about family history of behavioral and academic problems, and developmental history were obtained from all subjects. Items from the Yale Neuropsycho-educational Assessment Scales (Shaywitz, 1982) were included to examine the incidence of psychiatric, academic and behavioral problems in relatives of the child. In addition, the questionnaire included information about pre- and perinatal events, as well as developmental and medical history of the child. Only data pertinent to family history of psychiatric, academic and behavioral problems will be reported here.

Items from the family history questionnaire were categorized into four dimensions: 1) hyperactivity ("was distractible, inattentive", "was hyperactive, overactive"), 2) academic problems ("had trouble learning", "was held back a year"), 3) substance abuse problems ("had drinking problems", "had drug problems"), and 4) other emotional problems ("became depressed, suicidal", "had a nervous breakdown"). Relatives rated positive in at least one area within a given dimension were deemed to have problems in that dimension.

Data analyses. Data were analyzed using 3x2 (group x gender) Analyses of Covariance (ANCOVA) using age as a covariate. For those variables that were already age corrected such as IQ scores and standard scores from the WRAT-R, the data were analyzed using Analyses of Variance (ANOVA). Significant effects were followed using Scheffe´s test to evaluate differences among means. An alpha level of .05 was considered significant in all the analyses.

Results

Behavioral Ratings (Conners Questionnaires)

The Revised Conners Teacher and Parent Questionnaires and the DSM-III/DSM-III-R rating scale were available for all of the children from the school sample. Parent and teacher ratings were missing for six (4 girls and 2 boys) clinic-referred ADHD children. Four of these children did not return to the clinic to complete the evaluation; the other two did not return the questionnaires despite numerous reminders. Behavioral ratings were available for forty-one (18 boys and 23 girls) normal children, nineteen (6 boys and 12 girls) teacher-identified ADHD children, and nineteen (14 boys and 5 girls) clinic-referred ADHD children.

Of the eighteen teacher-identified ADHD children (6 boys and 12 girls), only eight (4 boys and 4 girls) met DSM-III criteria for ADD.

Group differences. Teachers rated the groups differently on the Inattention/Passivity [$F(2,71)=34.40$, $p<.0001$], Hyperactivity [$F(2,71)=93.18$, $p<.0001$] and Conduct Problems [$F(2,71)=56.05$, $p<.0001$] factors (see Table 10).

Table 10. Mean Values (SD) of the Factors from the Revised Conners Teacher Questionnaire

	Normal group		School ADHD group		Clinic ADHD group	
	Boys (N=18)	Girls (N=23)	Boys (N=6)	Girls (N=12)	Boys (N=16)	Girls (N=9)
Hyperactivity**	0.32 (0.31)	0.11 (0.17)	2.55 (0.42)	1.80 (0.83)	2.14 (0.62)	1.91 (1.05)
Inattention/ Passivity**	0.66 (0.49)	0.29 (0.37)	1.85 (0.60)	1.52 (0.65)	1.83 (0.60)	1.41 (0.87)
Conduct Problems*	0.33 (0.35)	0.28 (0.30)	2.08 (0.57)	1.98 (0.69)	1.74 (0.81)	1.87 (1.12)

*Significant group effect (p<.001)
**Significant group and gender effect (p<.001)

Post-hoc comparisons using Scheffe's test revealed that normal children received significantly lower ratings than both teacher-identified and clinic-referred ADHD children on all the factors ($p<.01$). However, there was no difference between the two groups of ADHD children. An exception to this was the Hyperactivity Index used to define the groups in which clinic-referred ADHD children were rated as more impaired than teacher-identified ADHD children. Thus, for the most part, teachers perceived all ADHD children as similar, but as being more behaviorally disturbed than their normal peers.

Parent ratings also discriminated among the groups, although a different pattern of results emerged. Parents rated all three groups differently on the Conduct Problems [$F(2,71)=22.40$, $p<.0001$], Learning Problems [$F(2,71)=33.30$, $p<.0001$], and Impulsivity [$F(2,71)=26.74$, $p<.0001$] factors, but not in the Anxiety [$F(2,71)=2.29$, $P>.10$] and Psychosomatic Problems [$F(2,71)=.93$, $p>.10$] factors (see Table 11).

Unlike teachers, parents rated clinic-referred ADHD children as being more impulsive, and as having more learning and conduct problems than teacher-identified ADHD children. Moreover, parents rated teacher-identified ADHD children as more impaired than normals in all these factors. Thus, it seems that parents' perception of problematic behavior is more important than teachers' in the child's referral to the clinic.

Table 11. Mean Values (SD) of the Factors from the Revised Conners Parent Questionnaire.

	Normal group		School ADHD group		Clinic ADHD group	
	Boys (N=18)	Girls (N=23)	Boys (N=6)	Girls (N=12)	Boys (N=16)	Girls (N=9)
Impulsivity/ Overactivity*	.62 (0.65)	0.43 (0.41)	0.92 (0.66)	1.17 (0.82)	2.06 (0.62)	2.08 (1.10)
Conduct Problems*	0.26 (0.22)	0.23 (0.29)	0.78 (0.32)	0.65 (0.50)	1.08 (0.64)	1.28 (0.69)
Learning Problems*	0.47 (0.54)	0.34 (0.43)	0.83 (0.58)	0.94 (0.58)	1.85 (0.74)	1.89 (0.84)
Psychosomatic Problems	0.32 (0.39)	0.40 (0.39)	0.20 (0.31)	0.53 (0.36)	0.45 (0.52)	0.23 (0.32)
Anxiety	0.35 (0.30)	0.70 (0.46)	0.50 (0.84)	0.54 (0.60)	0.81 (0.67)	0.79 (.75)

*Significant group effect (p<.05).

Gender differences. Teachers rated boys higher than girls on the Inattention/Overactivity [F(1,71)=8.42, p<.005] and Hyperactivity [F(1,71)=7.75, p<.001] factors, but boys and girls received similar ratings in the Conduct Problems [F(1,71)=1.02, p>.10] factor.

Consistent with the results of Experiment 1, parents did not rate boys and girls differently on any of the factors. Boys and girls received similar ratings on the

Impulsivity $[F(1,71)=.07, p>.10]$, Learning Problems $[F(1,71)=.10, p>.10]$, Conduct Problems $[F(1,71)=.00, p>.10]$, Psychosomatic Problems $[F(1,71)=.48, p>.10]$ and Anxiety $[F(1,71)=2.40, p>.10]$ factors.

Group by gender interactions. None of the interactions from the Conners Teacher or Parent Questionnaires reached significance ($p>.05$). According to teachers, both groups of ADHD children are more behaviorally disturbed than normals, and boys more disturbed than girls. Although teachers rated boys as being more disruptive than girls, they considered referred girls to be as behaviorally disturbed as referred boys and, therefore, more deviant relative to normal girls.

Parents rated all clinic-referred children as being more impaired than teacher-identified ADHD children, but did not differentiate between boys and girls. Therefore, the prediction that clinic-referred ADHD boys would be more behaviorally disturbed than clinic-referred ADHD girls and that teacher-identified ADHD boys was not supported.

Attention and impulsivity (CPT)

The continuous performance test was available for the entire sample except for one clinic-referred girl who did not return to the clinic to complete the evaluation. Therefore, the total sample included 41 normal children (18 boys, 23 girls), 19 teacher-identified ADHD children (6 boys, 12 girls) and 23 (16 boys and 7 girls) clinic-referred ADHD children.

As previously indicated, the number of misses and X-Only errors in the CPT were conceptualized as measures of inattention, whereas A-Not-X errors were conceptualized as measures of impulsivity. Less specific hypothesis were made regarding the meaning of random and A-Only errors. However, Random errors occur more frequently in inpatient than outpatient populations and are hypothesized to reflect more serious psychopathology (Halperin, Wolf & Young, 1989).

Group Differences. Analyses of the CPT measures yielded similar results to those obtained in Experiment 1. There was a significant group effect for number of misses [$F(2,75)=11.67$, $p<.0001$], false alarms [$F(2,75)=16.64$, $p<.0001$], and reaction time variability [$F(2,75)=3.09$, $p<.05$]. Analyses of the different false alarm subtypes also yielded significant differences among the groups for A-Only [$F(2,75)=8.32$, $p<.001$], A-not-X [$F(2,75)=8.66$, $p<.001$], and Random [$F(2,75)=14.88$, $p<.0001$] errors. No significant differences were found for number of X-Only errors [$F(2,75)=2.95$, $p>.05$]. The means (SD) of the CPT measures are shown on Table 12.

Table 12. Mean Values (SD) of the Continuous Performance Test

	Normal group		School ADHD group		Clinic ADHD group	
	Boys (N=18)	Girls (N=23)	Boys (N=6)	Girls (N=12)	Boys (N=16)	Girls (N=9)
Misses*	1.89 (4.18)	1.74 (3.49)	7.67 (7.55)	3.17 (4.28)	8.81 (5.72)	12.25 (8.94)
Hit RT (msec)	606.50 (106.22)	627.74 (101.84)	764.17 (111.47)	706.00 (95.63)	659.40 (102.63)	767.88 (107.89)
Hit SD (msec)*	132.94 (47.79)	149.22 (56.31)	217.17 (82.36)	187.58 (53.53)	199.40 (91.59)	235.87 (51.44)
False Alarms*	3.28 (4.20)	1.52 (1.81)	8.17 (11.03)	3.75 (3.44)	15.37 (14.48)	24.35 (21.39)
A-Only**	0.78 (1.90)	0.30 (.56)	1.67 (1.97)	0.50 (1.17)	2.75 (3.77)	7.29 (8.18)
X-Only**	0.11 (0.32)	0.56 (0.79)	3.67 (5.64)	0.67 (0.98)	1.25 (2.18)	5.57 (6.90)
A-not-X*	2.39 (3.01)	0.56 (1.24)	1.00 (2.00)	1.67 (1.87)	8.69 (10.65)	5.43 (4.58)
Random**	0.00 (0.00)	0.04 (.21)	1.83 (2.56)	0.92 (1.50)	2.69 (3.48)	7.86 (6.94)
d′*	4.17 (0.71)	4.24 (.54)	3.25 (.88)	3.87 (0.60)	2.67 (0.81))	2.20 (0.73)
Beta	2.35 (1.66)	3.06 (3.29)	6.90 (6.08)	4.42 (3.55)	6.53 (6.38)	3.88 (3. 32)

*Significant group effect (p<.001)
**Significant interaction (p<.05)

Consistent with the results of Experiment 1, the groups were found to differ in d′ [F(2,75)=32.42, p<.0001], but not in Beta [F(2,75)=2.55, p>.05]. Subjects in both studies were very effective in discriminating signal from noise and adopted a liberal criteria. In other words, they tended to respond when only limited evidence was available as indicated by the high incidence of false alarms.

Post-hoc comparisons among the three groups disclosed a consistent pattern of results. Clinic-referred ADHD children performed worse than teacher-identified ADHD children and normal controls on all the CPT measures, but teacher-identified ADHD children failed to differ from normal children. An exception to this was in the measure of d′, in which all groups differed significantly, with referred children exhibiting the lowest d′s and normal children the highest. These results suggest that clinic-referred ADHD children are generally more inattentive and impulsive than both teacher-identified ADHD children and normals.

Although these results are consistent with those of Experiment 1, several differences were noted. First, teacher-identified ADHD children failed to differ from normals on most CPT measures; and second, subjects in Experiment 2 performed considerably better on the CPT than subjects in Experiment 1. These differences could be the result of the changes made in the CPT or, alternatively, to differences between the samples. In order to examine possible sample differences, subjects who participated in the first study were compared with the new subjects.

T-tests comparing the old and new subjects on all the CPT measures, behavioral ratings and other objective measures yielded non-significant results ($p>.05$). Therefore, the two samples appeared to be equivalent. The hypothesis that the differences are due to changes in the CPT is supported by comparisons of subjects who participated in both studies. These comparisons made clear that the performance of children who participated in both studies improved only on the CPT.

The lack of significant differences between teacher-identified ADHD children and normals can also be attributed to the differences between the two CPTs. Overall, subjects made considerably fewer misses and false alarms in Experiment 2 and, therefore, the discriminative ability of the CPT decreased. In fact, d', which takes into account both hit and false alarm rates, was the only CPT measure which discriminated between normals and teacher-identified ADHD children in experiment 2.

<u>Gender differences</u>. Boys and girls failed to differ

from each other on any of the measures derived from the CPT (see Table 12). They made a comparable number of misses [$F(1,75)=.02$, $p>.10$], false alarms [$F(1,75)=.02$, $p>.10$] and had similar reaction times [$F(1,75)=1.89$, $p>.10$] and reaction time variability [$F(1,75)=1.01$, $p>.10$]. Analyses of the various false alarm subtypes did not yield any significant gender differences ($p>.05$). Similarly, there were no gender differences in d′ [$F(1,75)=.07$, $p>.10$] or Beta [$F(1,75)=.91$, $p>.10$].

<u>Group by gender interactions</u>. Group by gender interactions reached significance for A-Only [$F(2,75)=4.35$, $p<.05$], X-Only [$F(2,75)=7.62$, $p<.01$] and Random errors [$F(2,75)=6.52$, $p<.01$] (see Figures 10, 11 and 12).

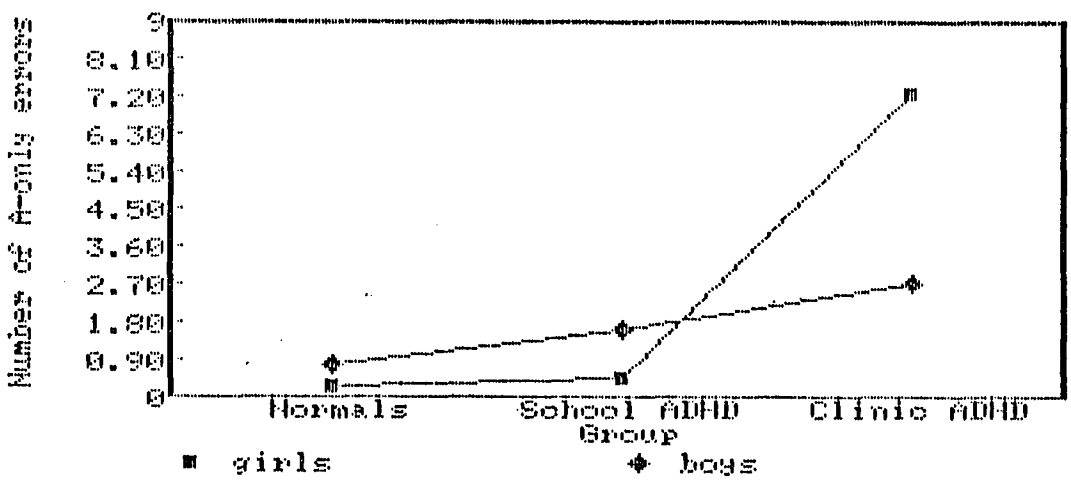


Fig. 10. Number of CPT A-only errors.

Comparisons of the various groups made clear that clinic-referred ADHD girls performed worse than any other group. Clinic-referred ADHD girls made significantly more X-Only (5.57 vs. 1.25) and Random (7.86 vs. 2.69) errors than clinic-referred boys. They also made more A-only, X-only and random errors than teacher-identified ADHD girls.

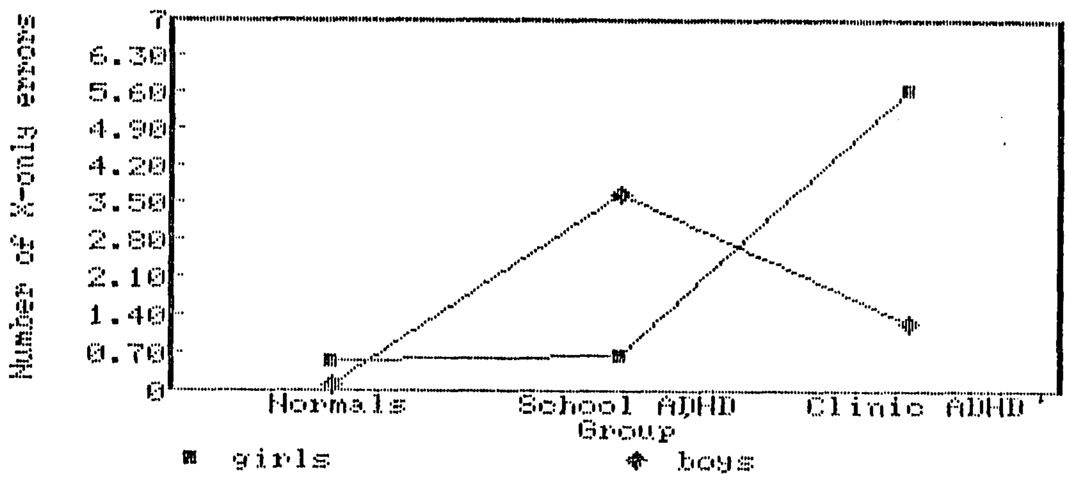


Fig. 11. Number of CPT X-only errors by group and gender.

In contrast, clinic-referred ADHD boys did not differ from teacher-identified ADHD boys on any of the commission error subtypes. These results support the hypothesis that girls referred for treatment are more inattentive and, perhaps, more impaired in other areas relative to boys.

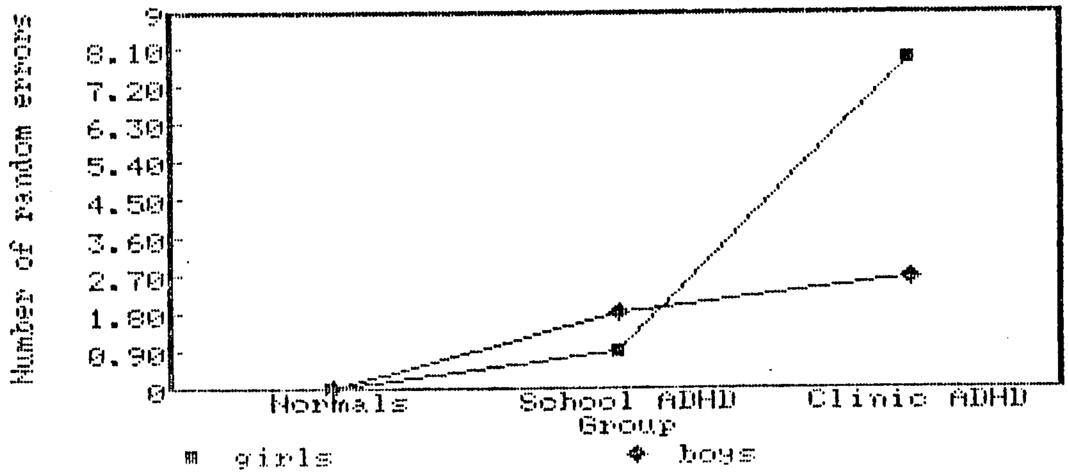


Fig. 12. Number of CPT random errors by group and gender.

In fact, even when the interactions failed to reach significance, clinic-ADHD girls obtained more deviant scores. For example, compared to clinic-referred ADHD boys, ADHD girls tended to make more misses (12.25 vs. 9.13, respectively) and false alarms (24.38 vs. 16.40). A similar trend was not observed between teacher-identified ADHD boys and girls (see Table 12). In fact, contrary to the results of Experiment 1, teacher-identified ADHD boys seemed to be doing worse on the CPT. Given the lack of significant results in both studies and the small sample sizes, one can conclude that teacher-identified ADHD girls do not differ from boys on attention and impulse control.

Intellectual Functioning (WISC-R)

WISC-R scores were available for all subjects. The IQ scores by group and sex are shown on Table 13.

There was a significant group effect for Verbal IQ (VIQ) [F(2,78)=4.98, p<.01], Performance IQ (PIQ) [F(2,78)=5.80, p<.01] and Full Scale IQ (FSIQ) [F(2,78)=7.21, p<.001].

Table 13. Means (SD) of the WISC-R IQ scores

	Normal group		School ADHD group		Clinic ADHD group	
	Boys (N=18)	Girls (N=23)	Boys (N=6)	Girls (N=12)	Boys (N=16)	Girls (N=9)
VIQ*	98.94 (11.71)	96.39 (17.12)	104.00 (16.41)	97.92 (15.34)	92.94 (14.41)	81.33 (9.54)
PIQ*	104.67 (18.23)	102.17 (18.00)	99.67 (9.89)	97.33 (13.03)	94.87 (11.07)	85.56 (10.84)
FSIQ*	101.61 (14.14)	98.87 (16.64)	101.82 (12.77)	101.42 (10.56)	93.25 (12.05)	81.89 (8.72)

*Significant group effect (p<.01)

Although all children had FSIQs within normal limits, clinic-referred ADHD children had lower FSIQs and PIQs than teacher-identified ADHD children and normal children. Teacher-identified ADHD children and normals did not differ from each other on VIQ, PIQ or FSIQ.

Table 14. Means (SD) of the Verbal and Performance subtest scores of the WISC-R

	Normal group		School ADHD group		Clinic ADHD group	
	Boys (N=18)	Girls (N=23)	Boys (N=6)	Girls (N=12)	Boys (N=16)	Girls (N=9)
Verbal Subtests (SS)						
Information**	9.00 (2.61)	8.17 (3.54)	10.83 (3.37)	8.33 (3.05)	8.60 (2.69)	5.22 (2.54)
Similarities	10.78 (3.73)	10.17 (3.33)	10.17 (4.66)	10.67 (2.93)	9.20 (3.49)	7.67 (4.06)
Arithmetic*	9.50 (2.38)	9.65 (3.04)	10.33 (1.97)	9.75 (2.22)	8.50 (2.42)	6.67 (1.94)
Vocabulary	10.28 (2.95)	9.26 (3.15)	10.83 (3.12)	9.92 (2.87)	9.14 (3.76)	7.56 (1.33)
Comprehension	9.56 (2.23)	9.87 (2.82)	10.67 (3.44)	9.67 (2.39)	9.71 (3.07)	7.56 (3.57)
Digit Span*	8.83 (2.57)	9.00 (2.80)	11.50 (2.43)	8.92 (1.93)	7.79 (2.50)	8.11 (2.80)
Performance Subtests (SS)						
Pic. Comp.	10.33 (2.47)	9.57 (3.01)	9.50 (2.95)	10.50 (2.84)	9.00 (1.94)	9.22 (2.22)
Block Design	10.28 (3.92)	9.30 (3.35)	11.17 (4.79)	10.50 (2.15)	9.53 (2.02)	7.56 (3.32)
Obj.Assembly	10.56 (3.22)	9.39 (3.71)	9.67 (2.42)	10.33 (2.71)	10.29 (2.68)	7.89 (2.42)
Coding*	11.44 (2.73)	12.91 (2.73)	11.17 (1.72)	11.92 (2.35)	8.00 (2.37)	8.33 (3.35)

* Significant group effect ($p<.05$)
** Significant gender effect ($p<.05$)

Analyses of the different subtests revealed a significant group effect for the Information [F(2,78)=3.36, p<.05], Arithmetic [F(1,78)=6.49, p<.01] and Coding [F(1,78)=16.55, p<.001] subtests. In all cases, the performance of clinic-referred ADHD children was poorer than that of teacher-identified ADHD children and normal controls (see Table 14).

There were no significant gender differences on VIQ [F(1,78)=3.53, p>.05], PIQ [F(1,78)=.69, p>.10] or FSIQ [F(1,78)=2.46, p>.10]. None of the two-way interactions between group and gender approached significance for any of the WISC-R measures (p>.10). The lack of significant interactions was surprising given that clinic-referred ADHD girls generally had lower IQs´than the other groups. For example, there was an eleven-point discrepancy between clinic-referred ADHD boys and girls in VIQ (92.94 vs. 81.33, respectively) and FSIQ (93.25 vs. 81.89), and a nine-point difference in PIQ (94.88 vs. 85.56) (See Table 13).

Moreover, when the number of children in the various IQ ranges was examined, the same pattern of results was observed. For example, 89% (8/9) clinic-referred ADHD girls had FSIQs within the low average or borderline range of intellectual functioning, and only one had a FSIQ within the average range. In contrast, 56% (9/16) clinic-referred ADHD boys had FSIQs within the average and high average range, and the remainder had FSIQs within the low average or borderline range (see Table 15).

Table 15. Number of children at various IQ ranges

	Normal group		School ADHD		Clinic group	
	Boys (N=18)	Girls (N=23)	Boys (N=6)	Girls (N=12)	Boys (N=16)	Girls (N=9)
Borderline (70-79)	1	2	-	-	2	3
Low Average (80-89)	2	4	2	2	5	5
Average (90-109)	11	12	2	7	7	1
High Average (110-119)	2	2	2	2	2	-
Superior (120-129)	1	2	-	1	-	-
Very Superior (>130)	1	1	-	-	-	-

A Yates' corrected chi square comparing the number of clinic-referred boys and girls above and below the mean showed that more girls than boys tended to be in the lower IQ ranges (χ^2 =3.19, p=.07). A similar trend was not observed in the other two groups (p>.10). These results suggest that girls referred for treatment are more limited intellectually than boys. However, a large sample size might be necessary to confirm such a trend.

Academic Achievement (WRAT-R)

The groups differed significantly on the Reading [$F(1,77)=13.70$, $p<.0001$] and Arithmetic [$F(1,77)=9.63$, $p<.0001$] subtests of the WRAT-R (see Table 16). Clinic-referred children scored significantly lower than teacher-identified ADHD children and normals on both academic subjects, but teacher-identified ADHD children and normal children did not differ from each other.

Table 16. Mean Standard Scores (SD) of the Wide Range Achievement Test

	Normal group		School ADHD		Clinic group	
	Boys (N=18)	Girls (N=23)	Boys (N=6)	Girls (N=12)	Boys (N=16)	Girls (N=9)
Reading*	96.11 (12.19)	96.00 (15.03)	93.67 (13.54)	97.67 (13.21)	82.93 (22.90)	66.22 (13.95)
Arithmetic	101.39 (15.86)	99.87 (17.51)	87.00 (14.23)	97.92 (15.34)	88.00 (22.90)	72.44 (20.46)

*Significant group effect ($p<.005$)

There were no gender differences in reading [$F(1,77)=1.22$, $p>.10$] or arithmetic [$F(1,76)=.90$ $p>.10$] scores. Group by gender interactions approached significance for both reading [$F(2,76)=2.76$, $p=.08$] and arithmetic [$F(2,76)=3.03$, $p=.052$], with clinic-referred girls demonstrating poorer achievement than the other children.

Furthermore, the proportion of children with reading problems differed among the groups (see Table 17). A

Table 17. Breakdown of children with a learning disability

	Normal group		School ADHD		Clinic group	
	Boys (N=18)	Girls (N=23)	Boys (N=6)	Girls (N=12)	Boys (N=16)	Girls (N=9)
Reading	2	-	1	2	7	6
Arithmetic	1	1	2	1	2	4

child was considered to have a reading or arithmetic disability if his/her academic performance was at least one standard deviation below the mean for his/her age (i.e., standard score below 85) and intelligence (i.e., FSIQ minus standard score was greater than 15).

Using this strict definition, 67% (6/9) clinic-referred ADHD girls had a reading disability compared to 44% (7/16) clinic-referred ADHD boys. This difference failed to reach significance using a Yates' corrected Chi Square ($p>.05$). However, there were more clinic-referred ADHD girls than teacher-identified ADHD girls with a reading disability (67%; 6/9 vs. 20%; 2/10) ($\chi^2=3.54$, p<.05). In contrast, there was no association between group and reading problems for boys (p>.10).

Family history questionnaire data

The family history questionnaire was available for a total of 56 subjects; twenty-eight normal controls (14 boys and 14 girls), twelve teacher-identified ADHD children (4 boys and 8 girls), and sixteen clinic-referred ADHD children (10 boys and 6 girls). The remaining twenty-eight subjects did not return the questionnaire despite numerous requests. Only incidence of problems in parents, grandparents and siblings was included in the analyses.

Subjects were divided in two categories; those with a given condition and those without it. Data were analyzed using chi-square tests when all expected frequencies were at least five. The Yates' correction was used when the smallest expected frequency was less than five. The Fisher exact probability test was used for analyses with less than 21 observations.

ADHD vs. non-ADHD children. Relatives of teacher-identified and clinic-referred ADHD children did not differ in the incidence of behavioral, academic or emotional problems (p>.10). Therefore, both groups of ADHD children were combined in the analyses presented below. Combining both groups yielded a total of 28 ADHD children and 28 normal controls.

More relatives of ADHD children than of normal children had symptoms suggestive of ADHD as youngsters (12.25% vs. 4.37%) (χ^2=10.30, p<.005) (see Figure 13).

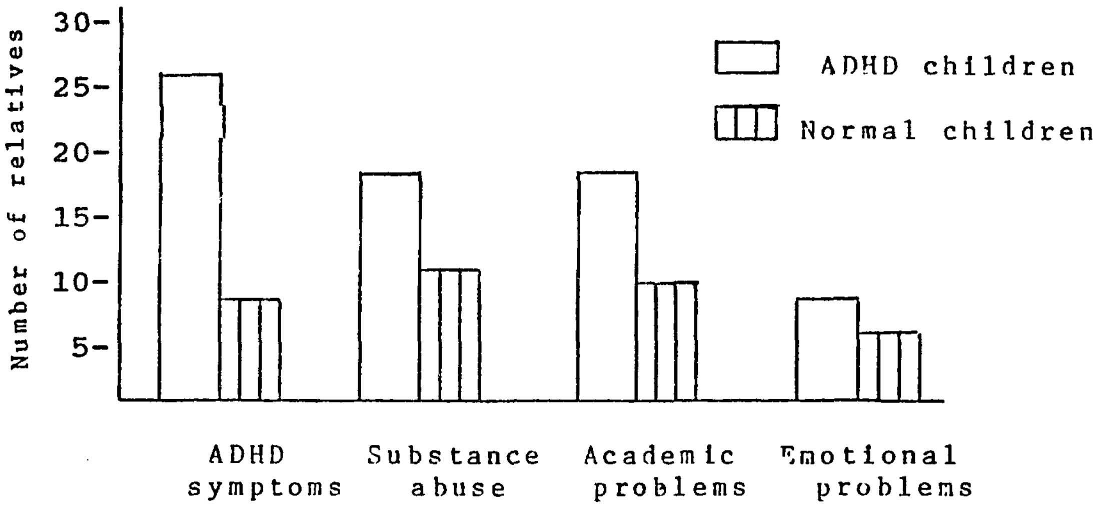


Fig. 13. Number of affected relatives of ADHD children and normal children.

In contrast, relatives of ADHD children appeared as likely as relatives of normal children to have a history of substance abuse (χ^2=1.44, p>.10), academic difficulties (χ^2=2.02, p>.10) and other emotional problems such as depression (χ^2=.25, p>.10).

These results are consistent with previous studies which find a higher prevalence of hyperactivity in the relatives of ADHD children than of controls (Cantwell, 1972; Morrison & Stewart, 1971). No other disorders were found to have an increased prevalence in the relatives of ADHD children. Therefore, relatives of ADHD children were not found to be generally more impaired than relatives of non-ADHD children. The prevalence of hyperactivity, substance abuse problems, academic difficulties and emotional problems broken down by relatives is presented in Appendix B.

In addition, there were more ADHD children than normal children with affected relatives (see Figure 14).

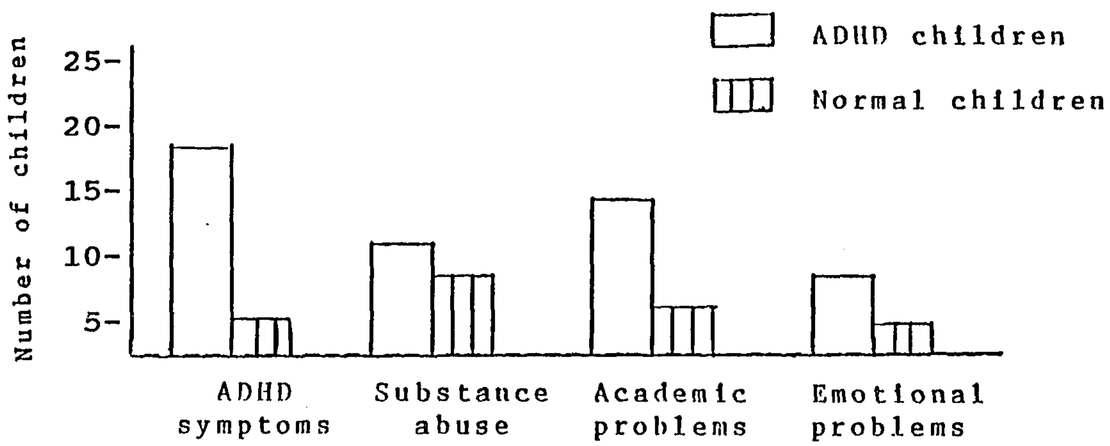


Fig. 14. Number of ADHD and non-ADHD children with affected relatives.

Compared to normal children, ADHD children were more likely to have relatives with a history of hyperactivity/ADHD (χ^2 = 8.93, p<.01) and of school difficulties (χ^2=4.79, p<.05).

Male relatives vs. female relatives.

More male than female relatives had a history of hyperactivity/ADHD (11.06% vs. 5.44%) (χ^2=5.01, p<.05) and of substance abuse problems (12.02% vs. 1.48%) (χ^2=19.25, p<.01) (see Figure 15).

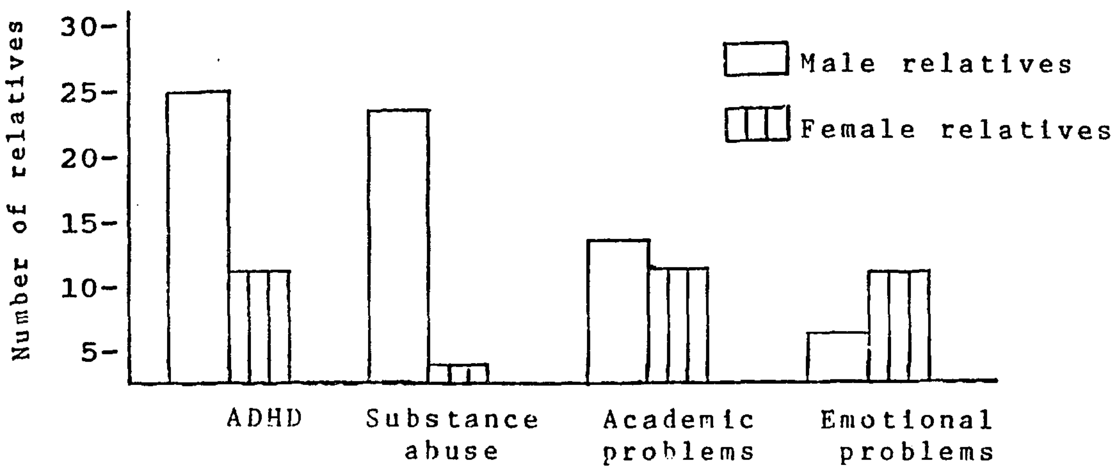


Fig. 15. Number of affected relatives by gender.

In contrast, male and female relatives were as likely to have a history of academic difficulties (χ^2=.46, p>.10) and other emotional problems such as depression and attempted suicide (χ^2=.81, p>.10). The number of affected family members broken down by relatives is shown in Appendix B.

The finding that more male than female relatives had a history of hyperactivity intimates that the sex ratio in ADHD is real, and not merely the result of identification and referral biases. This is based on the assumption that reporters (most frequently the mother) would be as likely to identify problems in an opposite-sex than in a same-sex child. Since males were as likely to have other problems according to mothers, this further suggests that sex differences in the incidence of ADHD are real.

<u>ADHD girls vs. ADHD boys</u>. Relatives of ADHD girls were as likely to have a history of hyperactivity as relatives of ADHD boys (χ^2=1.03, p>.10) (see Figure 16).

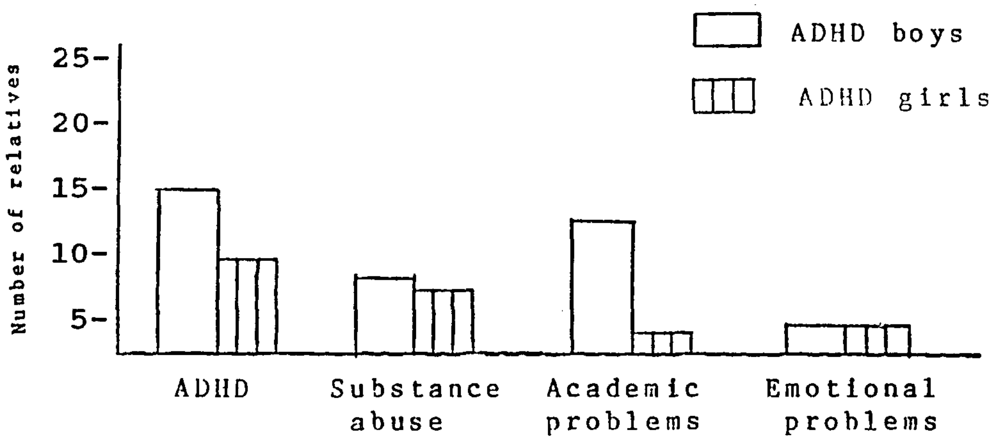


Fig. 16. Number of affected relatives of ADHD boys and girls.

Nine percent of relatives of ADHD girls presented symptoms suggestive of ADHD; this compares to 14.56% relatives of ADHD boys. Moreover, relatives of ADHD girls and boys did not differ in the prevalence of alcohol/drug abuse (7.92% vs. 8.74%) (χ^2=.04, p>.10), and other emotional problems (4.95% vs. 5.35%) (χ^2=.00, p>.10) whereas boys were more likely to have relatives with a history of academic difficulties (χ^2=5.25, p<.05).

These results are presented in Appendix B.

In addition, a similar number of female and male probands had one or more affected relatives (see Figure 17).

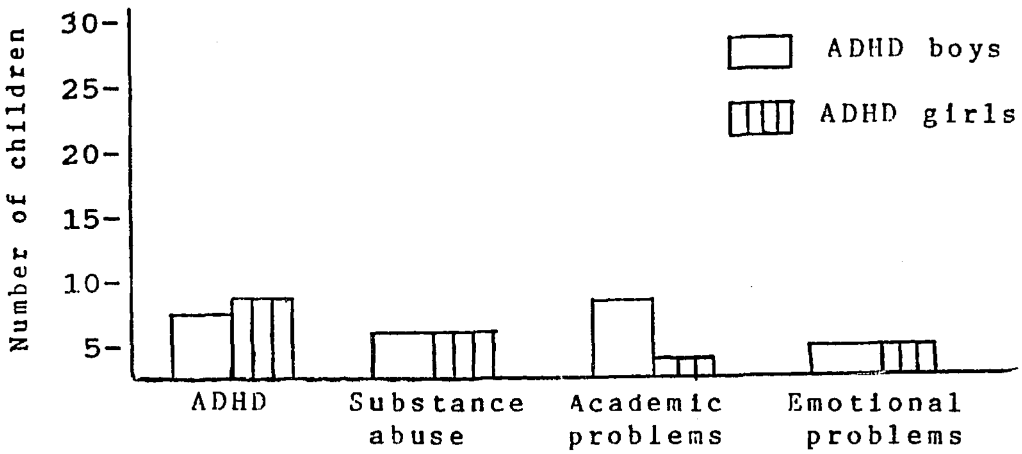


Fig. 17. Number of ADHD boys and girls with affected relatives.

These results do not support the hypothesis that ADHD girls would have more affected relatives than ADHD boys because of their higher threshold for the manifestation of ADHD. These findings are also inconsistent with studies of clinic-referred ADHD children which report a higher incidence of affected relatives in the families of female probands (Berry et al., 1985, Kashani et al., 1979).

In order to examine the possibility that ADHD girls referred for treatment are not comparable in family history to ADHD girls selected from school samples, both groups of ADHD girls were compared to each other. However, the findings were inconsistent with this hypothesis. Clinic-referred ADHD girls did not differ from teacher-identified ADHD girls in number of relatives with behavioral, emotional or academic problems ($p>.10$). In fact, as previously indicated, clinic-referred ADHD children did not have more affected relatives than teacher-identified ADHD children.

In addition, ADHD girls and boys came from similar backgrounds. Six ADHD boys and 5 ADHD girls lived with a single parent or other relatives. There was no difference in family composition between clinic-referred and teacher-identified ADHD girls.

Discussion

Overall, the results of the second experiment indicate that ADHD children referred to professionals are not equivalent to those selected from school populations. Referred ADHD children tend to be more disruptive, inattentive, and are more likely to have academic problems; their difficulties are, on the average, more pronounced. However, there are other factors that come into play, namely, the sex of the child and the perception of the various raters.

Parents perceive clinic-referred ADHD children as more unmanageable and disruptive. Teachers, on the other hand, do not differentiate between ADHD children who are referred for treatment and those who are not. It is possible that referred children indeed present more difficulties at home. There is also the possibility that parents deny problems obviously present in their children until they ultimately seek professional help. In any case, it appears that parents take the initiative in the referral process, because their own perception of the severity of their child's problems is more important than the perception of teachers. It is not clear whether this impression precedes the referral or is a consequence of the confirmation of problems by professionals.

Previous studies have found that ADHD boys are referred for treatment more frequently because of hyperactivity and behavioral problems (Berry et al., 1985; Kashani et al., 1979). It was hypothesized that boys are referred precisely because of their more severe behavioral problems and, therefore, that clinic-referred ADHD boys would be more behaviorally disturbed than other ADHD children. However, the results were inconsistent with this hypothesis. The present findings indicate that both ADHD boys and girls are brought for treatment by their parents when they present more serious behavioral problems. Teachers rate boys as more behaviorally disturbed than girls. However, they consider referred ADHD girls to be as disruptive as referred boys and, thus, more deviant from normal girls.

In addition to the more serious behavioral problems that generally characterize clinic-referred ADHD boys and girls, the girls were found to be more inattentive and impulsive relative to the boys and teacher-identified ADHD children. Compared to other ADHD children, clinic-referred ADHD girls were also more impaired cognitively and academically; they tended to have lower IQs, poorer academic achievement, and were more likely to have a reading disability. Clinic-referred ADHD boys were not only less impaired than referred girls, but also did not differ from teacher-identified ADHD boys on measures of attention, intelligence or academic achievement. Therefore, the more severe impairments found in clinic-referred children seem to be primarily attributable to the girls.

Given these findings, it would be incorrect to conclude that ADHD children referred for treatment are simply more severely impaired than ADHD children selected from school samples, without taking gender into consideration. These results support the hypothesis that biases affect the referral of ADHD girls and boys. ADHD girls who present behavioral problems severe enough to be referred, are more impaired intellectually, academically, and cognitively than referred boys and non-referred ADHD girls. These findings are consistent with studies of clinic samples (Ackerman et al., 1983; Berry et al., 1985; Kashani et al., 1979) and could explain the lack of significant differences between ADHD boys and girls reported in community-based studies (deHaas, 1986; McGee, Williams & Silva, 1987).

Analyses of the family data did not support the hypothesis that ADHD girls would have a higher threshold for the manifestation of the disorder (Falconer, 1965). ADHD girls did not have a higher proportion of affected relatives than ADHD boys, counter to the model's prediction. The girls' relatives were as likely to exhibit ADHD-like behaviors as youngsters, and to have a history of academic problems and substance abuse. These results are inconsistent with previous studies of clinic samples which report a higher incidence of hyperactivity and alcoholism in relatives of ADHD girls (Berry et al., 1985; Kashani et al., 1979).

There are several possible reasons for the above discrepancy. First, the ability of the informant to report childhood problems in themselves and relatives has obvious limitations. In addition, approximately one third of the children were living with single mothers or with other relatives, and the responder's knowledge of the paternal family would likely have been limited.

Second, the present results could have been influenced by socioeconomic factors. It is a well documented phenomenon that ADHD is more common in low income populations (Langsdorf, Anderson, Walchter, Madrigal & Juarez, 1979) such as the present subject sample, and this could have obscured other, perhaps more subtle effects. On the other hand, the results of previous studies could be attributed to socioeconomic factors. Studies of referred children which find more psychopathology in the girls' families also find girls to come from lower SES backgrounds than boys (Berry et al., 1985).

Third, the lack of differences could be an artifact of the small size of the sample, which was a limitation of this study. One cannot rule out the possibility that subtle differences could have been detected had larger samples been studied.

The hypothesis that ADHD children would have more relatives with a history of hyperactivity than non-ADHD children was supported. Twelve percent of relatives of ADHD children had symptoms suggestive of ADHD, compared to four percent of relatives of controls. Furthermore, more ADHD children than controls had one or more affected relatives (60.7% vs. 21.43%). Other conditions commonly associated with ADHD such as alcoholism (Cantwell, 1972; Morrison & Stewart, 1971) were not found to differ between the relatives of ADHD children and those of controls.

As expected, more male than female relatives had a history of hyperactivity (11.06% vs. 5.44%). This suggests that the sex ratio is real, since relatives were identified only by the presence or absence of ADHD in the index case. Male relatives were also found to have a higher incidence of alcohol/drug abuse which is typically seen more frequently among males (Cloninger, Christiansen, Reich & Gottesman, 1978).

In summary, the results of this study do not support the threshold model which hypothesizes that ADHD girls have a higher threshold for the manifestation of ADHD. ADHD girls were not found to have more psychopathology in their families or to come from more disadvantaged backgrounds. The family history data does support the notion that ADHD has a strong familial component and that boys are more likely to be affected than girls.

These results also support the existence of referral biases. Both clinic-referred ADHD boys and girls present more serious behavioral problems than ADHD children selected from school populations. However, only referred girls are more seriously impaired in attentional, cognitive and academic functions. This supports the hypothesis that ADHD girls are referred for treatment only when severely impaired behaviorally, cognitively and academically, whereas boys are referred when they present serious behavioral difficulties.

General Discussion

The present research indicates that it is possible to identify a significant number of school-age girls with symptoms suggestive of ADHD relative to their same sex peers. These girls present serious attentional and cognitive problems; yet, most of them do not come to the attention of professionals.

A sex ratio closer to unity was found in the non-referred sample. This sex ratio is much lower than reported on clinical studies (Ackerman et al., 1983; Berry et al., 1985; Kashani et al., 1979), but this finding is not unique in the sex differences literature. In fact, lower male:female ratios are usually reported in studies which use objective measures to identify problematic children. For example, deHaas (1986) found that 7% of all girls and 5% of all boys in the third, fourth and fifth grades were identifed as having problems suggestive of ADHD. Similarly, studies of learning disabled children find much lower sex ratios in non-referred samples than in samples from clinics and special education programs (Critchley, 1970; Finucci & Childs, 1981; Holborrow & Berry, 1986). One can conclude from all these studies that the sex ratios in ADHD, and other disorders which favor males, depend on the population under study and on methods of subject selection used. It will become clear that other factors such as the reference group (i.e., disordered males vs. normal females) and the type of symptoms (i.e., inattention vs. hyperactivity) are also likely to influence the estimates of prevalence of ADHD in females.

Overall, the prevalence of attention and behavior problems was much higher in the present study than in previous studies (Bosco & Robin, 1980). However, these results must be interpreted cautiously. The present studies were not intended to be population surveys and, therefore, one has to keep in mind biases inherent in the selection of subjects. For example, parents of problematic children may be more inclined to have their children evaluated than parents of normal children; this could lead to an over-representation of children with problems in the school sample. Low socioeconomic status could have also resulted in an inflation of the incidence rate (Langsdorf et al., 1979).

The present findings indicate that teachers are able to identify both girls and boys with symptoms suggestive of ADHD. This finding is particularly important as it pertains to girls since girls are less behaviorally impaired relative to boys. However, teachers appear to compare girls with sex-referenced standards for girls, not with boys via gender-independent standards. Therefore, teachers are able to identify girls that are deviant compared to their same-sex peers, but less impaired than boys. Previous studies have demonstrated that teacher rating scales are adequate gauges of problematic behavior in boys (Brown & Wynne, 1982); the present findings indicate that these scales are useful instruments in identifying problems in both sexes. The possible interaction between sex of the teacher and sex of the child (Brophy, 1985; Kilpatrick & Duncan, 1985) cannot be addressed here because the sampling of teachers of both sexes is limited.

But, the question remains are ADHD boys and girls alike? The present results indicate that, overall, both sexes present a similar pattern of deficits. ADHD boys and girls were both more inattentive, impulsive and disruptive than their peers; they were also more limited intellectually, tended to have poorer academic achievement, and had a higher incidence of reading problems.

However, there are manifestation differences between ADHD boys and girls. First, behavioral problems are highly associated with attention and cognitive problems in girls but not in boys. Second, boys are more hyperactive and disruptive than girls, but both are equally inattentive, impulsive and intellectually limited. Boys were sometimes perceived as more inattentive, but this is likely to be a function of their associated behavioral problems. Teachers' perception of the severity of problems in boys seems to be influenced by the presence of disruptive behavior (McGee, Williams & Silva, 1987; Schachar, Sandberg & Rutter, 1986) since none of the objective measures differentiated between the sexes. The finding that ADHD girls are as impulsive as boys, and are as likely to have a reading disability is especially striking given that sex differences in normal populations go in the opposite direction.

Given that ADHD boys and girls present equally severe attention deficits, focusing on inattention rather than hyperactivity may lead to the identification of more girls (McGee, Williams & Silva, 1987). This finding also points out the need to review the relative importance of inattention and hyperactivity in ADHD. Whereas DSM-III and DSM-III-R attribute a central role for an attentional dysfunction in ADHD children, these data suggest that this may only be true for girls. Boys commonly present serious behavioral problems in the absence of serious attentional and cognitive deficits.

These studies indicate that ADHD girls are referred for treatment only when they present serious behavioral, cognitive and academic difficulties, whereas referred

ADHD boys differ little from their non-referred school peers. Referred girls are, on the average, more severely impaired cognitively, intellectually and academically than referred boys and non-referred ADHD children. Therefore, the hypothesis that ADHD girls would show the more severe deficits of the disorder (Berry et al., 1985; Kashani et al., 1979) was not supported. Only ADHD girls that come to the attention of professionals are more impaired. ADHD girls who are disruptive enough to be referred, are more likely to be impaired in other areas because of their more homogeneous presentation. As such, the results of clinic studies cannot be generalized to the population at large. These findings suggest weaknesses inherent in clinic studies of disorders which favor one sex. It is certainly possible that children with more severe and debilitating disorders (e.g., autism, Down's Syndrome) are referred for similar reasons regardless of sex. However, in less severe developmental and learning disorders, differences in manifestation may be confounded by referral biases, masking real gender differences.

If ADHD girls are identified by teachers, why aren't they being referred? The most likely explanation is that girls are less disruptive and, as a result, do not pose a significant management problem to parents who take the lead in the referral process. Boys are more non-compliant with parents and demand more adult intervention, possibly influencing parents' willingness to seek professional help. In fact, mothers of ADHD children express greater concern about boys than girls, even after they bring child in for assessment (Befera & Barkley, 1985). Only girls that pose as serious management problems as boys come to the clinician's attention, even though they are more impaired relative to normal girls.

Furthermore, it is likely that girls with attention and behavior problems would not be diagnosed as having ADHD as frequently as boys. Only 4 out 12 teacher-identified ADHD girls met DSM-III criteria for an attention deficit disorder; this figure compares to 4 out of 6 boys. This raises questions about the sensitivity of current diagnostic procedures to identify ADHD girls since the same diagnostic criteria are used for both sexes. When the diagnosis is made based on the presence of certain symptoms, boys are more likely to meet the criteria, simply because of their more severe behavioral problems. This difficulty is magnified with the DSM-III-R since children who are inattentive but not severely hyperactive are not likely to be diagnosed ADHD (Newcorn et al., 1989). The problems associated with using the same cut-off points for boys and girls in teacher rating scales have been identified (McGee et al., 1987). Similar problems may also be applicable to current diagnostic procedures.

One could question the significance of identifying girls who would otherwise be unnoticed. ADHD girls are under-identified simply because they show less disruptive behaviors than boys. However, they have as severe attention deficits, weaker cognitive skills, and poorer academic performance. Thus, although girls are more manageable than boys, they are certainly at a high risk for developing later academic and professional difficulties. The fact that inattention, rather than hyperactivity, has been associated with poor cognitive skills (McGee, Williams & Silva, 1985) and later academic failure (Howell, Huessy & Hassuk, 1985) underscores girls' potential difficulties.

At a more practical level, knowing how ADHD boys and girls differ will help in the development of appropriate screening, diagnostic and treatment procedures for each sex. It is of outmost importance to develop screening and diagnostic instruments that are geared to each sex; in this way, girls who have behavioral and cognitive problems relative to normal girls can be properly identified and treated. Further research is necessary to study the incidence of ADHD in girls, the developmental changes of the primary symptoms of the disorder and the efficacy of various treatment modalities.

Appendix A

Instruments included in the study.

1) <u>The Revised Conners Teacher Questionnaire</u> (Goyette et al., 1978). Below is a copy of the Questionnaire, indicating the item composition of various factors.

1. Restless in the "squirmy" sense.
2. Makes inappropriate noises when he shouldn't.
3. Demands must be met immediately.
4. Acts "smart" (impudent or sassy).
5. Temper outbursts and unpredictable behavior.
6. Overly sensitive to criticism.
7. Distractibility or attention span a problem.

8. Disturbs other children.
9. Daydreams.
10. Pouts and sulks.
11. Mood changes quickly and drastically.
12. Quarrelsome.
13. Submissive attitude toward authority.
14. Restless, always "up and on the go".

15. Excitable, impulsive.
16. Excessive demands for teacher's attention.
17. Appears to be unaccepted by group.
18. Appears to be easily led by other children.
19. No sense of fair play.
20. Appears to lack leadership.
21. Fails to finish things that he starts.

22. Childish and immature.
23. Denies mistakes or blames others.
24. Does not get along well with other children.
25. Uncooperative with classmates.
26. Easily frustrated in efforts.
27. Uncooperative with teacher.
28. Difficulty in learning.

Conduct problems factor: 4, 5, 6, 10, 11, 12, 23, and 27.
Hyperactivity factor: 1, 2, 3, 8, 14, 15, and 16.
Inattention/passivity factor:7, 9, 18, 20, 21, 22, 26, 28
Hyperactivity index: 1, 5, 7, 8, 10, 11, 14, 15, 21, 26

2) Hyperactivity Index - Normative data of the Hyperactivity Index from the Revised Conners Teacher Questionnaire (Goyette et al., 1979)

	Males		Females	
Age	Mean	SD	Mean	SD
3-5	.81	.96	.74	.67
6-8	.58	.61	.36	.45
9-11	.67	.65	.38	.48
12-14	.44	.43	.13	.24
15-17	.41	.45	.36	.62

3) Revised Conners Parent Questionnaire (Goyette et al., 1978). Below is a copy of the Revised Conners Parent Questionnaire and the item composition of the various factors.

1. Picks at things (nails, fingers, hair, clothing).
2. Sassy to grown-ups.
3. Problems with making or keeping friends.
4. Excitable, impulsive.
5. Wants to run things.
6. Sucks or chews (thumb; clothing; blankets).

7. Cries easily or often.
8. Carries a chip on his shoulder.
9. Daydreams.
10. Difficulty in learning.
11. Restless in the "squirmy" sense.
12. Fearful (of new situations; new people or places; going to school).

13. Restless, always up and on the go.
14. Destructive.
15. Tells lies or stories that aren't true.
16. Shy.
17. Gets into more trouble than others same age.
18. Speaks differently from others same age (baby talk; stuttering; hard to understand).

19. Denies mistakes or blames others.
20. Quarrelsome.
21. Pouts and sulks.
22. Steals.
23. Disobedient or obeys but resentfully.
24. Worries more than others (about being alone; illness or death).

25. Fails to finish things.
26. Feelings easily hurt.
27. Bullies others.
28. Unable to stop a repetitive activity.
29. Cruel.
30. Childish or immature (wants help he shouldn't need; clings; needs constant reassurance).

3) continued

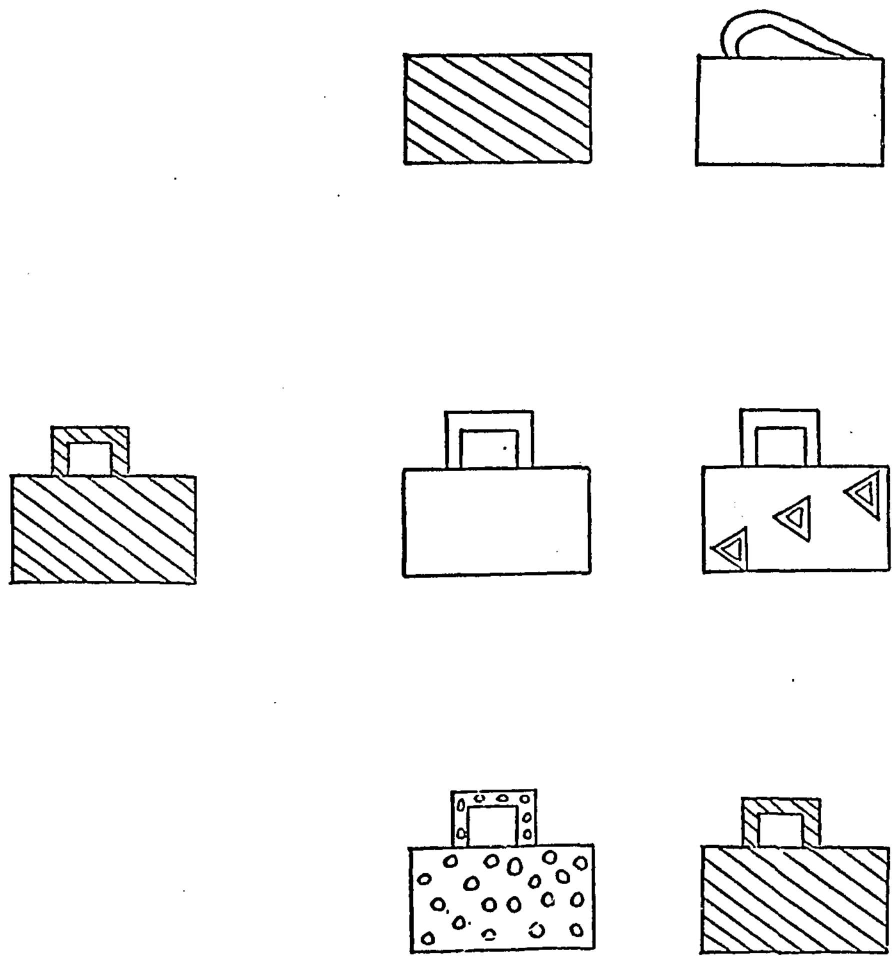
31. Distractibility or attention span a problem.
32. Headaches.
33. Mood changes quickly and drastically.
34. Doesn't like or doesn't folow rules or restrictions.
35. Fights constantly.
36. Doesn't get along well with brothers or sisters.

37. Easily frustrated in efforts.
38. Disturbs other children.
39. Basically an unhappy child.
40. Problems with eating (poor appetite; up between bites).
41. Stomach aches.
42. Problems with slepp (can't fall asleep; up too early; up in the night).

43. Other aches and pains.
44. Vomiting or nausea.
45. Feels cheated in family circle.
46. Boasts and brags.
47. Lets self be pushed around.
48. Bowel problems (frequently loose; irregular habits; constipation).

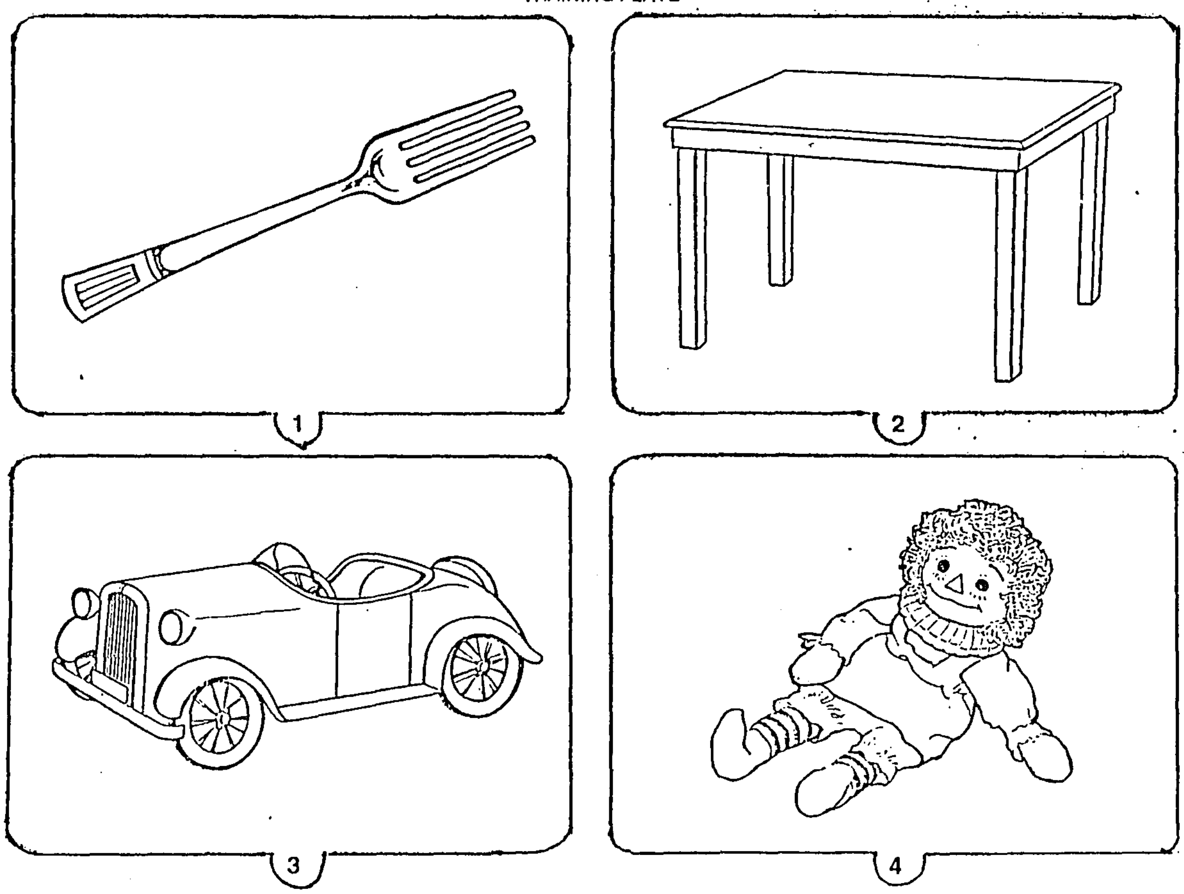
Learning problems factor: 10, 25, 31, and 37.
Conduct prob:2, 8, 14, 19, 20, 21, 22, 23, 27, 33, 34, 39
Learning problems factor: 10, 25, 31, and 37.
Psychosomatic problems factor: 32, 41, 43, 44, and 48.
Impulsivity-hyperactivity factor: 4, 5, 11, and 13.
Anxiety factor: 12, 16, 24, and 47.
Hyperactivity index: 4, 7, 11, 13, 14, 25, 31, 33, 37, 38

4) Matching Familiar Figures Test (Kagan, 1964). Sample item.



5) <u>Peabody Picture Vocabulary Test</u> (Dunn & Dunn, 1981). Sample items (fork, table, car and doll).

TRAINING PLATE



A

6) DSM-III/DSM-III-R rating scale.

1. Is easily distracted by extraneous stimuli.
2. Engages in physically dangerous activities without considering the possible consequences.
3. Needs a lot of supervision.
4. Frequently complains of physical symptoms; i.e., headache, stomachache.
5. Often loses things necessary for tasks.
6. Has difficulty organizing work.
7. Often argues with adults.

8. Runs about or clims on things excessively.
9. Difficulty following through on instructions.
10. Difficulty awaiting turn on group situations.
11. Often acts before thinking.
12. Often talks excessively.
13. Deliberately does things to annoy others.
14. Fidgets with hands/feet or squirms in seat.

15. Often swears or uses obscene language.
16. Does not listen to what is said to him or her.
17. Shifts from one uncompleted activity to another.
18. Blurts out answers to questions before completed.
19. Often interrupts or intrudes on others.
20. Has difficulty playing quietly.
21. Frequently fatigued or low energy level.

22. Often loses temper.
23. Difficulty sustaining attention to tasks.
24. Often spiteful or vindictive.
25. Often blames others for his/her own mistakes.
26. Often angry and resentful.
27. Depressed or irritable mood most days.
28. Often touchy or easily annoyed by others.

29. Excessive concern about competence in one or more areas.
30. Excessive need for reassurance.
31. Decreased interest or pleasure in most daily activities.
32. Has difficulty remaining seated when required.
33. Always "on the go" or acts as if "driven by a motor".
34. Difficulty concentrating on school work.
35. Actively defies/refuses adult requests or rules.

7) Family and developmental history questionnaire.

Child's Personal Data Inventory

Child's Sex — Male ____ Female ____

Child's Birthdate __/__/__ Age:___yrs ___mos.

Child's Background — Caucasian ____ Hispanic ____ Black ____ Other ____

This child lives with — Both parents ____ Single parent ____ Mo. and stepfather ____ Fa. and stepmother ____ Other relatives ____

Was this child adopted? — Yes ____ No ____

Child's siblings	Age year	Sex M	Sex F	Full	Adop.	Half	Step
	____	____	____	____	____	____	____
	____	____	____	____	____	____	____
	____	____	____	____	____	____	____
	____	____	____	____	____	____	____
	____	____	____	____	____	____	____

When did you first notice these problems?

____ years
____ N/A

Mother: Highest grade completed in school ______________
Occupation ______________

Father: Highest grade completed in school ______________
Occupation ______________

To **mother:** Please check (✓) the items that apply to your child

Child's General Medical History

Has your child ever had?

Encephalitis	______
Measles	______
Meningitis	______
Poisoning or overdose	______
Coma	______
Convulsions, epilepsy	______
Head injuries	______
Migraine Headaches	______
Anemia	______
Asthma	______
Frequent ear infections	______
Pneumonia	______
Allergies	______
Operations	______
Frequent urination	______
Other (specify)	______

Child's Developmental History

When did your child?

Sit alone	______months
Stand unsupported	______months
Walk without assistanc(	______months
Speak first words	______months
Speak sentences	______months
Get toilet trained	______months

Child's Prenatal and Birth History

Birthweight _____lbs._____ozs.

How old was the mother when this child was born? ___ ___ years

How old was the father when this child was born? ___ ___ years

To **Mother:** Please check (✓) the items that apply to your child.

Did any of the following occur during pregnancy?		
	Bleeding from vagina	______
	Premature contractions	______
	Incompatible Rh factor	______
	Toxemia	______
	Rubella	______
	Diabetes	______
	Anemia	______
	Serious injury	______
	Weight gain less 10 lbs.	______
	Weight gain over 25 lbs.	______
	Threatened abortion	______
	Premature contractions	______
	High blood pressure	______
	Stay in bed over 3 days	______
	Emotional problems	______

Did you have any of the following during your pregnancy with this child?		
	Tranquilizers	______
	Antibiotics	______
	More than 10 cigs./day	______
	Two or more drinks/day	______
	Three or more coffees	______
	Marijuana	______
	Cocaine	______
	Heroin	______
	Other (specify)	______

Did you have any of the following during labor and delivery?		
	Premature delivery	______
	Late delivery (more 2 weeks)	______
	Induced labor	______
	Caesarean section	
	planned	______
	unplanned	______
	Breech delivery	______
	Use of forceps	______
	Rupture of membranes	______
	Cord around the neck	______
	Blue at birth	______
	Placed in incubator	______
	Didn't breathe at first	______
	Required blood transfusion	______
	Infant had jaundice	______
	Infant required oxygen	______

Did any of the following happen during previous pregnancies?	Premature birth	____
	Stillbirth	____
	Neonatal death	____
	Spontaneous abortion	____
	Miscarriage	____

Mother's Family History

To **Mother:** Please check (√) if yourself or anyone in your family:

Note: Mother here refers to yourself (child's mother). Grandparents (G.Mo. and G.Fa.) here refer to your parents, and aunts and uncles to your brothers and sisters.

	uncles	aunts
Specify number of uncles and aunts	____	____

	Mo.	G.Mo.	G.Fa.	Unc.	Aunt
Had asthma					
Had migraine					
Had thyroid problems					
Had diabetes					
Had seizures					
Had high blood pressure					
Had allergies					
Had trouble learning					
Had trouble speaking					
Was held back a year					
Was distractible, inattentive					
Was hyperactive, restless					
Was arrested					
Was expelled from school					
Had employment problems					
Had drinking problems					
Had drug problems					
Became depressed, suicidal					
Had a nervous breakdown					
Had other emotional problem					

Father's Family History

To **Father:** Please check (√) if yourself or anyone in your family:

Note: Father here refers to yourself (child's father). Grandparents (G.Mo. and G.Fa.) here refer to your parents, and aunts and uncles to your brothers and sisters.

Specify number of uncles and aunts — uncles _____ aunts _____

	Mo.	G.Mo.	G.Fa.	Unc.	Aunt
Had asthma	____	____	____	____	____
Had migraine	____	____	____	____	____
Had thyroid problems	____	____	____	____	____
Had diabetes	____	____	____	____	____
Had seizures	____	____	____	____	____
Had high blood pressure	____	____	____	____	____
Had allergies	____	____	____	____	____
Had trouble learning	____	____	____	____	____
Had trouble speaking	____	____	____	____	____
Was held back a year	____	____	____	____	____
Was distractible,inattentive	____	____	____	____	____
Was hyperactive, restless	____	____	____	____	____
Was arrested	____	____	____	____	____
Was expelled from school	____	____	____	____	____
Had employment problems	____	____	____	____	____
Had drinking problems	____	____	____	____	____
Had drug problems	____	____	____	____	____
Became depressed, suicidal	____	____	____	____	____
Had a nervous breakdown	____	____	____	____	____
Had other emotional problem	____	____	____	____	____

Brothers and Sisters of the Child

To **Mother:** Please write in your children's ages and check (✓) if any of the following apply.

	Brothers			Sisters	
Ages	____	____	____	____	____
Had asthma	____	____	____	____	____
Had migraine	____	____	____	____	____
Had thyroid problems	____	____	____	____	____
Had diabetes	____	____	____	____	____
Had seizures	____	____	____	____	____
Had high blood pressure	____	____	____	____	____
Had allergies	____	____	____	____	____
Had trouble learning	____	____	____	____	____
Had trouble speaking	____	____	____	____	____
Was held back a year	____	____	____	____	____
Was distractible,inattentive	____	____	____	____	____
Was hyperactive, restless	____	____	____	____	____
Was arrested	____	____	____	____	____
Was expelled from school	____	____	____	____	____
Had employment problems	____	____	____	____	____
Had drinking problems	____	____	____	____	____
Had drug problems	____	____	____	____	____
Became depressed, suicidal	____	____	____	____	____
Had a nervous breakdown	____	____	____	____	____
Had other emotional problem	____	____	____	____	____

Appendix B

Family history data broken down by relatives.

Table 1

Number of relatives of ADHD and normal children with symptoms suggestive of ADHD.

	ADHD children			Normal children		
	Total Number	Number Affected	%	Total Number	Number Affected	%
Mothers	28	7	25.0	28	1	3.6
Fathers	28	7	25.0	28	4	14.3
Sisters	16	1	6.3	18	1	5.6
Brothers	20	8	40.0	20	3	15.0
Grandmothers	56	1	1.8	56	0	-
Grandfathers	56	1	1.8	56	0	-
Total	204	25	12.3	206	9	4.4

Table 2

Number of relatives of ADHD and normal children with a history of alcohol/drug abuse

	ADHD children			Normal children		
	Total Number	Number Affected	%	Total Number	Number Affected	%
Mothers	28	2	7.1	28	0	-
Fathers	28	10	35.7	28	7	25.0
Sisters	16	0	-	18	0	-
Brothers	20	0	-	20	0	-
Grandmothers	56	1	1.8	56	0	-
Grandfathers	56	4	7.1	56	4	7.1
Total	204	17	8.3	206	11	5.3

Table 3

Number of relatives of ADHD and normal children with academic problems

	ADHD children			Normal children		
	Total Number	Number Affected	%	Total Number	Number Affected	%
Mothers	28	5	17.9	28	2	7.1
Fathers	28	4	14.3	28	1	3.6
Sisters	16	2	12.5	18	1	5.5
Brothers	20	4	20.0	20	5	25.0
Grandmothers	56	1	1.8	56	1	1.8
Grandfathers	56	1	1.8	56	0	-
Total	204	17	8.3	206	10	4.8

Table 4

Number of relatives of ADHD and normal children with other emotional problems such as depression and attempted suicide

	ADHD children			Normal children		
	Total Number	Number Affected	%	Total Number	Number Affected	%
Mothers	28	2	7.1	28	4	14.3
Fathers	28	3	10.7	28	0	-
Sisters	16	0	-	18	0	-
Brothers	20	0	-	20	2	10.0
Grandmothers	56	3	5.4	56	2	3.6
Grandfathers	56	2	3.6	56	0	-
Total	204	10	4.9	206	8	3.9

Table 5

Number of affected male and female relatives

	Hyperactivity		Academic Problems		Substance Abuse		Emotional Problems	
	Number affected	%	Number affected	%	Number affected	%	Number affected	%
Female relatives								
Mothers (N=56)	8	14.3	7	12.5	2	3.6	6	10.7
Sisters (N=34)	2	5.9	3	8.8	0	-	0	-
Grandmo.(N=112)	1	.9	2	1.8	1	.9	5	4.5
Total (N=202)	11	5.4	12	5.9	3	1.5	11	5.4
Male relatives								
Fathers (N=56)	11	19.6	5	8.9	1	30.4	3	5.4
Brothers(N=40)	11	27.5	9	22.5	0	-	2	5.0
Grandfa.(N=112)	1	.9	1	.9	8	7.1	2	1.8
Total (N=208)	23	11.1	15	7.2	25	12.0	7	3.4

Table 6

Number of relatives of ADHD males and ADHD females with symptoms suggestive of ADHD

	ADHD males			ADHD females		
	Total Number	Number Affected	%	Total Number	Number Affected	%
Mothers	14	3	21.4	14	4	28.6
Fathers	14	5	28.6	14	2	14.3
Sisters	7	0	-	9	1	11.1
Brothers	12	5	41.7	8	3	37.5
Grandmothers	28	1	3.6	28	0	-
Grandfathers	28	1	3.6	28	0	-
Total	103	15	14.6	101	10	9.9

Table 7

Number of relatives of ADHD males and ADHD females with a history of alcohol/drug abuse problems

	ADHD males			ADHD females		
	Total Number	Number Affected	%	Total Number	Number Affected	%
Mothers	14	0	-	14	2	14.3
Fathers	14	6	42.8	14	4	28.6
Sisters	7	0	-	9	0	-
Brothers	12	0	-	8	0	-
Grandmothers	28	1	3.6	28	0	-
Grandfathers	28	2	7.1	28	2	7.1
Total	103	9	8.7	101	8	7.9

Table 8

Number of relatives of ADHD males and ADHD females with a history of academic problems

	ADHD males			ADHD females		
	Total Number	Number Affected	%	Total Number	Number Affected	%
Mothers	14	5	35.71	14	0	-
Fathers	14	3	21.43	14	1	7.1
Sisters	7	1	14.28	9	1	11.1
Brothers	12	3	25.00	8	1	12.5
Grandmothers	28	1	3.6	28	0	-
Grandfathers	28	1	3.6	28	0	-
Total	103	14	13.6	101	3	2.9

Table 9

Number of relatives of ADHD males and ADHD females with other emotional problems

	ADHD males			ADHD females		
	Total Number	Number Affected	%	Total Number	Number Affected	%
Mothers	14	1	7.14	14	1	7.1
Fathers	14	1	7.14	14	2	14.3
Sisters	7	0	-	9	0	-
Brothers	12	0	-	8	0	-
Grandmothers	28	1	3.6	28	2	7.1
Grandfathers	28	2	7.1	28	0	-
Total	103	5	4.9	101	5	4.9

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