A META-ANALYTIC STUDY OF THE EFFECTIVENESS OF TREATING ADHD CHILDREN WITH MEDICATION

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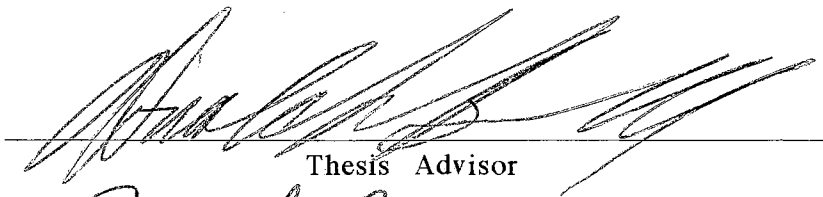

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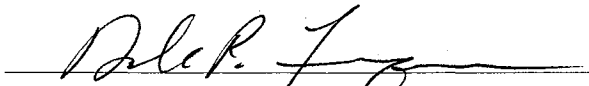

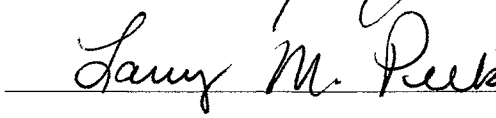

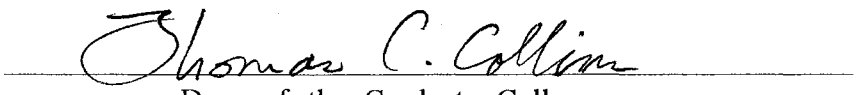

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CHAPTER ONE

Attention-deficit Hyperactive Disorder (ADHD) is the most common childhood psychiatric disorder and accounts for at least half of all referrals to child guidance centers in the United States (Taylor, 1990). Research indicates that among the general population between 2% and 10% of the children suffer from ADHD. Clinical experience supports a much higher incidence in the population, closer to 20% (Taylor, 1990). Several studies found that approximately 3% of the children in the United States are medicated for ADHD (Taylor, 1990; Bosco & Robin, 1980; Sandoval, Lambert & Sassone,1980). Safer and Krager (1988) conducted nine surveys and found a number of interesting facts: (a) Every four to seven years the rate of medication for elementary age children is doubling; in 1987, it reached nearly 6%; (b) the diagnosis of ADHD is 6 to 8 times more common among males than females (Dulcan 1986); (c) ADHD is estimated to occur in 6% of the US. Population: 10% of the males and 2% of the females; (d) children with ADHD constitute 30 to 50% of the child psychiatric outpatients and 40 to 70% of the inpatients; (e) other disorders frequently coexist with ADHD, particularly conduct disorders (up to 70%) and developmental learning disorders (20-70%), and (f) children with autism, Tourette's syndrome and mental retardation will also have serious ADHD symptoms more than 25% of the time.

The treatment of ADHD children is extremely controversial and many times the treatment is not based upon empirical or theoretical principles. The treatments that are most frequently used include medication, parent training, social skills training for the children, counseling for the children or families, educational interventions, behavior management and finally combinations of

these treatments. The use of medication is particularly controversial and has come under attack from zealous groups that purport to represent the children's rights. The use of psychopharmacological treatments for children is still so new that there is a noticeable absence of long-term studies (Barkley, 1991b). Psychopharmacological treatment is by far the most widely researched type of treatment for ADHD, with over 900 studies since 1983 (Wilens & Biederman, 1992).

A meta-analytical review of the treatments for ADHD has not been performed to date. Moreover, there are only a few reviews of treatment for ADHD but they take a very general approach and are descriptive in nature. None of the reviews investigate the multiple types of dependent variables in order to measure which areas of the child's life show improvement after treatment. Educational research has a particular problem in producing so many conflicting results that it is difficult if not impossible to determine trends and draw conclusions (Bangert-Drowns, 1991). Meta-analysis is especially helpful in placing results from many studies into a common metric and then exploring the relationships between the various studies and their findings. More specifically, a meta-analytic review of pychopharmacological treatment of ADHD is needed.

There are three classes of medication for the treatment of ADHD; within two of the classes, there are many specific medications that are used. The three general classes of medication include stimulants, antidepressants and antihypertensives. Within the stimulant class, pemoline (Cylert), methylphenidate (MPH; Ritalin) and d-amphetamine (Dexedrine) are three that are commonly used. Within the antidepressants, the most commonly used are imipramine (Tofranil), desipramine (Norpramine) and fluoxetine (Prozac).

The only medication that has been used with any regularity in the antihypertensive class is clonidine (Catapres) and even though it has been used for many years for controlling high blood pressure, it has only recently been used in the treatment of ADHD children.

As previously stated, the use of medication for treating ADHD children is the most widely researched type of treatment, with more than 900 published articles since 1983 (Wilens & Biederman, 1992). Wilens and Biederman (1992) reviewed more than 230 articles that evaluated the efficacy of stimulant medication and concluded for children of all ages, stimulants were effective in 65-75% of the children, while other scientists have found the success rate at 75% when based upon teacher's ratings (Greenhill, 1992; Forness, Swanson, Cantwell, Youpa & Hanna, 1992).

The previous research investigating the efficacy of medication in treating ADHD children has not compared the various classes of medication in order to determine which is most effective. Comparing the different types of medication to each other is important, especially in order to separate what part of the child's life is most improved by the different types of medications and with which type of child.

The study of treatment effectiveness for ADHD children is confused by the multiple dependent measures that are commonly used to assess treatment effectiveness. To a large extent, effectiveness is determined by the way one chooses to measure it. Some of the general categories that are frequently used to measure effectiveness include parent behavior ratings, teacher behavior ratings, miscellaneous behavior ratings, academic achievement, standardized assessments, direct observation, measurement of social interactions, self-esteem and self-ratings. Within each of these categories there are multiple

more specific measures to assess treatment effectiveness. The way the dependent measures are set up makes a meaningful statement about the nature of the body of research that has been performed in this field. Virtually all of the measures are short-term in nature and do not measure long-term outcome, as well as fail to consider developmental factors that have consistently been shown to have significant impact on all aspects of a child's life.

It is important when using meta-analytic procedures to also take into account both subject characteristics and study characteristics. Both factors can potentially influence the outcome of each study. Study variables that will be considered in this project include the rigor of criteria used to define the treatment subjects, the number of weeks exposed to treatment, and sample size of the treatment group. The subject variables that will be considered include age of the subjects and IQ of the subjects which received treatment.

Purpose of Study

The purpose of this study is to determine the effectiveness of using medication for the treatment of children and adolescents who have ADHD. Meta-analysis will be used on selected published studies to determine which medication is most effective and at what dosage rate Additionally, this study should determine which dependent measures are most improved by which medication and at what dose. By separating and measuring some of the extraneous variables within the studies, It is hoped that some of the confusion that surrounds the treatment with medication of ADHD will be clarified.

Research Questions

Given the aforementioned purpose, the following research questions are addressed and when applicable, null hypotheses are listed.

1. Does the use of medication significantly improve the overall performance as measured by the average of all measures of ADHD children and adolescents when compared to the placebo treatment?
2. Does the use of medication significantly improve parent behavior ratings of the ADHD children when compared to the placebo treatment?
3. Does the use of medication significantly improve teacher behavior ratings of the ADHD children when compared to the placebo treatment?
4. Does the use of medication significantly improve the academic achievement of ADHD children when compared to the placebo treatment?
5. Does the use of medication significantly improve performance of the ADHD children on standardized assessments when compared to the placebo treatment?
6. Does the use of medication significantly improve the behavior of ADHD children when compared to the placebo treatment as measured by direct observation of their behavior?
7. Does the use of medication significantly improve the social interactions of the ADHD children when compared to the placebo treatment?
8. Does the use of medication significantly improve the self-esteem ratings of ADHD children when compared to the placebo treatment?

9. Does the use of medication significantly improve the self-ratings of ADHD children in various areas when compared to the placebo treatment?
10. Does the use of medication improve the behavior ratings of people other than teachers and parents as compared to the placebo treatment?
11. Will there be differences in the overall effectiveness between stimulants and antidepressants?
12. Will there be differences between the low, medium, and high dosage levels for methylphenidate MPH as measured by the ten outcome categories?
13. What is the relationship between the IQ of the subjects and their response to medication as measured by the ten outcome categories?
14. What is the relationship between the age of the subjects and their response to medication as measured by the ten outcome categories?
15. What is the relationship between the level of rigor which the studies used to select subjects and the ten outcome categories?
16. What is the relationship between the number of subjects in the studies and the ten outcome categories for all medications?
17. What is the relationship between the number of weeks exposed to treatment and the global improvements?
18. Are there any differences between the different types of stimulant medication as measured by the average of the nine outcome categories?

Assumptions

It is assumed that ADHD constitutes a unidimensional disorder, which includes inattention, impulsivity and hyperactivity, and that it is distinct from any other disorder listed in the DSM III-R (American Psychological

Association, 1987; APA). It is further assumed that proper diligence and care were taken to collect the data in the studies that are included for analysis in this study. Furthermore, it is assumed that prudent design principles guided the procedures in the studies including sample selection, statistical analysis, and reporting of the results.

Limitations

A major limitation of this study is the generalizability to all experimental treatments that have been performed but not published and those which do not appear on the Psychscan and Medline computer search data bases. Dissertations and theses were excluded because of the inconsistency in the rigor of design and statistical analysis. There is a publication bias (Hedges, 1987) which occurs when only published studies are selected, and Hedges explains that, "There is considerable empirical evidence that the published literature contains fewer statistically insignificant results than would be expected from the complete collection of all studies actually conducted" (p. 365). There is a rigorous selection procedure that takes place before a study is published, which could cause a systematic bias. There is an alternative argument that posits that this selection procedure improves the rigor and excludes poorly designed studies that could cause less accurate results and greater experimental error.

Another limitation which all meta-analyses have is dependence on the dependent measures which the studies utilized. Rather than selecting dependent variables which would be most appropriate, this study was confined to using only the measures which were available within the body of literature that met the inclusion criterion.

A final limitation of this study which is critically important is that this study only looked at the positive benefits of medication. There is a brief description of the potential side effects of medication in this study but this study does not propose to provide equal information on the negative side of the argument. For more detailed information regarding the negative aspects of giving medication to ADHD children, other sources will need to be researched. All factors need to be considered, both negative and positive, before a decision to place a child on medicine is made. Additionally, there are many other forms of treatment for ADHD children which do not use medication and this study did address each of those adequately but in no way does this imply that other treatments should not be pursued. It is hoped that future research will look at other types of treatment or combinations of treatment with ADHD children.

Definition of Terms

Relevant terms used in classifying the dependent variables from the studies that are included for analysis in this study are defined in the following way:

Parent behavior ratings: There are many different forms of behavior ratings that are completed by parents for the child's behavior. The behavior rating form includes questions about the frequency of certain problem behaviors and typically the various questions are combined to form factor scores, which have been standardized and normed. The behavior ratings do not include direct observation of behavior or counting the number of times a behavior occurs within a specified time period.

Teacher behavior ratings: These are similar to the parent ratings but are completed by teachers or counselors that observe the child in a school setting. Some of the teacher behavior rating forms have the same questions as the parent forms and some of them have questions that are specific to the

school setting. These behavior ratings do not include direct observation of the child's behavior or counting the number of times a specific behavior occurs within a specified time period.

Miscellaneous behavior ratings: This includes any type of behavior rating of the child by someone other than a parent or teacher. Examples could include hospital workers, clinicians or camp counselors.

Academic achievement: This includes all types of academic achievements such as math, reading or listening comprehension and could include such items as number of items answered correctly, the number of items completed, or the time to complete the test. It may include standardized school achievement tests or any type of specialized school related assessment.

Standardized assessments: This includes such tasks as continuous performance tests (CPT), matching figures among many similar items, and matching colored items with different shapes and sizes. All of the assessment tools are used to measure an aspect of sustained attention, vigilance, distractibility or impulse control.

Direct observation: This involves counting or coding behavior while it is occurring and could include such items as percentage of on task behavior, percentage of time the child is in his/her seat during the performance of a task, the number of times the child wiggles or fidgets or the number of times the child talks. The direct observations include all settings such as home, school, summer camp, hospitals or clinics.

Social interactions: This includes coding the behavior of the ADHD child while he/she interacts with other children and usually includes measuring the amount prosocial or antisocial behavior. It also includes behavior such as

compliance with rules, amount of arguing with peers and ratings by peers or mental health experts. If the ratings include direct observation of the ADHD child interacting with peers, it will be included in this category rather than the direct observation category. Furthermore, if the dependent measure includes a behavior rating but is based upon peer interaction, it will be included in this category rather than behavior ratings.

Self rating: This includes all measures completed by the child on himself. It measures how he/she is perceived to be doing in some area such as behavior compliance or efficacy on a task.

Self-Esteem: This category is used for all types of self-esteem assessments. It may include standardized ratings completed by others or by the child. If the assessment instrument is for self- esteem, it will be placed in this category rather than the self-rating category.

Effect Size: It is a metric-free index that measures the effectiveness of treatment and can be conceptualized as the difference between population means (Δ). If the treatment and placebo means are equal, then the effect size is zero. There are many ways to compute the effect size but this study used the method developed by Glass (1981) which subtracts the difference in the means for the placebo and treatment groups and divides the result by the standard deviation of the placebo group. Because there is typically greater variability in the placebo treatment, this method of computing effect sizes usually results in a conservative estimate (Cooper & Hedges, 1994).

Attention-deficit Hyperactivity Disorder: is a disorder of behavior that has as its primary components impulsivity, inattentiveness and hyperactivity. Impulsivity involves acting upon impulse rather than thought. Inattention

involves the concentration of mental powers upon an object (Morris, 1969). Hyperactivity involves an excessive or abnormal level of activity.

Meta-Analysis: is "any literature review that makes explicit use of quantitative methods to express the results of studies or to combine those results across studies" (Hedges, 1987, p. 353). Meta-analysis involves the analytical review of multiple studies using different dependent variables and different scales, and statistically measuring trends of effectiveness and the strength of those trends.

CHAPTER TWO

Review of Literature

Nature and Diagnosis of ADHD

Historical View

The core symptoms that have defined attention problems and excessive motor activity have changed as frequently as the names for the disorder have changed. The way we define disorders is more than an academic exercise because the way children's problems are categorized, influences to a large extent, the way they are treated by practitioners and caretakers and determines their eligibility for services. The way a disorder is categorized has everything to do with the way its causes, correlates, developmental courses and consequences are formulated (Henker & Whalen, 1991a). The earliest emphasis by Still in 1902 placed the key features on the moral character of the children and to some extent he emphasized behavioral disinhibition (Barkley, 1991a). For the next several decades, there was little interest in research and the research that was conducted placed the emphasis upon hyperactivity and conduct disturbance.

In the middle part of the nineteenth century, there was an increased interest in ADHD research by Strauss and Lehtinen (1947) who wrote an article that created enthusiasm among many scientists. They placed an emphasis on inattention and restlessness and hypothesized that it was due to brain damage since previous findings indicated that people that had suffered brain trauma exhibited the same symptoms. Consequently, even though there was no history of brain injury, it was surmised there must be minimal brain damage. This began the concept of "minimal brain damage" shortened to MBD. The emphasis upon distractibility had educational implications that usually called

for removing all potential distracting stimuli from the classroom and making the environment as bland and sterile as possible. Eventually when no brain damage could be located, the label was changed to "minimal brain dysfunction" and researchers tried to find psychometric evidence that the brain was not functioning properly. Continued research did not provide any solid support for neurological damage and a new diagnostic term became popular. The disorder became known as "Hyperkinetic Reaction in Childhood" (DSM III, APA, 1968) and placed the greatest emphasis upon the excessive motor activity. In the middle part of the 1970s, research provided support for acute and chronic problems with inattention and impulsivity, as well as the problems with hyperactivity (Douglass, 1972). Douglass (cited in Mash & Barkley, 1989, p. 40) conducted research that argued that children that were called hyperactive, actually had deficits in four primary areas: "(a) investment, organization and maintenance of attention, (b) the inhibition of impulsive responding, (c) the modulation of arousal levels to meet situational demands; and (d) a strong tendency to seek immediate reinforcement." This definition relegated hyperactivity to an equal status with inattention and impulsivity. Douglass provided enough persuasive evidence for a syndromal approach that the DSM III (APA, 1983) formed two distinct categories called Attention-deficit Disorder with Hyperactivity (ADD-H) and Attention-deficit Disorder without Hyperactivity (ADD). Both category names removed the emphasis from hyperactivity and upon the problems with attention.

The scientific community in Britain placed their emphasis on symptoms of conduct disturbance and in fact doesn't recognize the diagnosis of attention deficit to be distinct from conduct disorders. Current research using factor analysis has clearly yielded distinct but overlapping factors of

defiant/aggressive behavior and hyperactivity (Barkley, 1989). Additionally, research has shown hyperactive children to differ from conduct disordered children because they exhibit more developmental delays in language and motor skills, pervasiveness of overactivity across settings, and difficulties in sustained attention to boring, repetitive tasks (Milich, Loney, & Landau, 1982; Werry, Reeves, & Elkind, 1987).

Associated Features of ADHD

Research has consistently supported a multitude of symptoms beyond the core symptoms, previously discussed. Many scientists believe that the associated or secondary deficits pose more lasting and pervasive problems for the ADHD child than the primary symptoms (Mash & Barkley, 1989). A partial list of the secondary symptoms that is supported by research includes impairment in the following areas: cognition and memory, academic and learning disabilities, speech and language development, sensory and motor delays, minor physical anomalies, sleep patterns, emotional disorders, conduct and behavioral disturbance, social relationship problems and parent-child conflicts. There is a far greater volume of research done with ADHD males than ADHD females. Frequently, clinical lore reports that ADHD males exhibit more behavior problems, academic problems and in general, exhibit more of the core symptoms of ADHD than do females. Breen (1989) compared ADHD males and females on a large number of problem areas and he found that ADHD boys and girls did not differ from each other on any of the performance or behavior rating scales but both differed from normal subjects significantly. This study indicates that gender does not play a significant role in determining the degree of problems or the need for intervention that an ADHD child will need.

Intelligence, Cognition and Memory

There is much controversy over whether ADHD children actually have lower IQs or whether their inattention, impulsivity and hyperactivity hamper their performance on an IQ test. Several studies have indicated that ADHD children score an average of 7 to 15 points lower on standardized intelligence tests than non-ADHD children (Fischer, Barkley, Edelbrock & Smallish, 1991; Tarver-Behring, Barkley & Karlsson, 1985; Barkley, 1990); however, other studies have not found any significant difference in the Full Scale IQ on the Wechsler but have found various subtests to accurately differentiate ADHD children from normals (Phelps, Rosso & Falasco, 1985; Sutter, Bishop & Battin, 1987; Grant, Ilai, Nussbaum & Bigler, 1990; Carlson, Lahey, & Neeper, 1986; Lufi, Cohen & Parish-Plass, 1990). Another potential explanation for poor performance by ADHD children on intelligence tests is due to their poor academic performance, which precipitates low expectancy and low effort during the IQ test.

The term pervasive ADHD is used in the literature to indicate when a child exhibits ADHD symptoms in all settings such as school and home, whereas situational ADHD is when a child exhibits symptoms in only one setting. Boudreault, Thivierge, Cote, Boutin, Yves and Bergeron (1988) compared pervasive ADHD, situational ADHD and normal children on several key cognitive variables and found that pervasive ADHD children were significantly lower than normal children on verbal IQ, non-verbal IQ, global IQ, and the distractibility factor. The situational ADHD children were significantly lower than the normals on verbal IQ and global IQ only. The only

measure in which the two ADHD groups differed was on verbal IQ, with the pervasive ADHD group scoring about 8 points lower than the situational group.

ADHD children have not only experienced difficulty intellectually but consistently have trouble with problem-solving strategies and organization skills (Hamlett, Pellegrini & Conner, 1987; Tant & Douglass, 1982). They also seem to apply fewer strategies in solving memory tasks (Voelker, Carter, Sprague, Gdowski & Lachar, 1989). The problems they experience don't seem to be the result of skill deficits in organizing or the knowledge of how to organize, but rather they don't utilize or put into action what they know (Barkley, 1990). Barkley (1990, p. 78-79) summarized the results from several studies involving the ways ADHD children solve problems and process information. He concluded the following: (a) ADHD children have difficulty communicating their problem solving strategy to others, (b) ADHD children have greater difficulty with "rule-governed behavior including problem-solving or self-generating rules that get in the way of tasks that require rule discovery and communication of those rules to others," (c) ADHD children have "significant deficits in executive processes such as strategies or mechanisms used by individuals to orchestrate or organize and monitor their own thoughts."

Neurocognitive impairment is thought to be caused by maturational delays in the brain (Rourke, 1982). Some of the most common areas of impairment that typically constitute neurocognitive impairment includes: language, visual-perceptual functioning, motor coordination, and problem solving skills (Szatmari, Offord, Siegel, Finlayson & Tuff, 1989). ADHD children reportedly suffer from a much higher incidence of neurocognitive impairments than normal children or even children with other psychiatric

disorders (Szatmari et al., 1989). Szatmari et al. took a sample of clinic referred children and gave them multiple test instruments that measure neurocognitive impairment. They wanted to compare the results of the testing with the diagnosis that the children were given to see if particular disorders would be associated with certain impairment. They were able to place all of the children into either an ADHD-conduct disordered group or anxiety-affective disordered group. A discriminant function was conducted and they found three tests that accurately separated the two groups 79% of the time (93% of the ADHD-conduct group and 41% of those with anxiety-affective disorder). The three tests that discriminated the ADHD-conduct group from the anxiety-affective group included the perceptual organization and verbal comprehension on the Wechsler (WISC-R), and the Pegs test that measures vigilance or attention. The ADHD-conduct group performed lower on all three measures.

Academic and Learning Disabilities

One of the primary areas of difficulties that the ADHD children suffer is with academic achievement and performance. Almost all ADHD children who are referred to clinics are performing poorly in school and typically underachieve (math, spelling & reading) relative to their known cognitive abilities based on intelligence tests (Barkley, 1991; 1992b; Barkley, Anastopoulos, Guevremont & Fletcher, 1991; Barkley, Guevremont & Fletcher, 1991). Up to 25% of the ADHD children have specific learning disabilities and ADHD children score between 7 and 15 standardized points lower than their peers on national academic achievement tests. Up to 40% of the ADHD children will be placed in some type of special education program for behavior or academic problems. Between 20 and 35% will be retained in at least one grade

before reaching high school (Barkley, 1992b). The most common areas of disability are math, spelling and reading (especially in comprehension). ADHD children are about twice as likely to have expressive language problems compared to normal children (Barkley, 1992). Monoz-Millan and Casteel (1989) found that hyperactive adolescents are, on the average, two grades behind their peers in academic performance. They hypothesize that it is due both to poor learning strategies and poor learning behavior in the classroom.

There are a number of methods used to determine whether a child qualifies for LD services. Barkley (1990) found that 26% of the ADHD children qualified for LD by using a narrowly defined method of inclusion. Other studies have found the percentage of ADHD children to qualify for LD closer to 50%. Currently a diagnosis of ADHD does not qualify a child for any special services in school. A child with ADHD must concurrently have a specific learning disability to qualify. Cambell and Cohen (1990) found only 3 out of 51 states provided special services for ADHD children who were experiencing academic underachievement. In 1976 (Federal Register) a law (PL 94-142) was passed which guides all services for special education. This law does not specifically mention ADHD as a qualifying disability, consequently many ADHD children do not get the school services they need.

Kataria, Hall, Wong, and Keys (1992) compared ADHD children with and without learning disabilities and found that ADHD-LD children experienced more difficulty with information processing and transferring information from immediate to short-term or long-term memory, when the information was auditorily presented. Furthermore, they found a deficit in sequential processing.

ADHD children consistently make more errors in their school work than normal children (Sergeant & Van Der Meere, 1988). It seems that ADHD children fail to adjust their response speed when tasks become increasingly more difficult; therefore, when the material increases in difficulty, the number of errors made by the ADHD children increases dramatically (Sergeant & van der Meere, 1988). An important component for school success is to accurately assess one's own ability, and the degree of difficulty of the task to be undertaken. This seems to be a deficit for both LD and ADHD children. Feldman, Levine and Fenton (1986) compared ADHD children with normal children on their ability to accurately assess their performance on a number of tasks. The results of their study included the following important points: (a) ADHD children performed more poorly on two functional domains, rote memory and language comprehension, (b) there was a significant difference between the control group and ADHD group on estimating their own personal performance, (c) the ADHD subjects overestimated their performance or degree of success, which is what younger students typically do, (d) there was a greater discrepancy between the predicted and actual performance for the clinic referred subjects, and (e) all subjects were able to more accurately predict their motor skills than their cognitive skills.

Comparisons made between ADHD and normal children during effortful processing and memory tasks indicate that ADHD children have greater difficulty remembering new information because they are unable to integrate the new information into their existing schema (Ackerman, Anhalt, Dykman & Holcomb, 1986). Ackerman et al. found that normal children improve memory skills if the words are related in some meaningful way, but ADHD children

improved only slightly when the words were changed from unrelated to related.

Research indicates that there is a high degree of overlap between reading disabilities (RD) and ADHD (Levine, Busch & Aufsuser, 1982) and some researchers question whether they are distinct disorders or one common syndrome (Felton, Wood, Brown & Cambell, 1987). A group of more than 600 children that were referred for academic problems were subsequently assessed as having primary attentional problems (Felton et al., 1987). A sample of ADHD children was assessed for information processing deficiencies, which is typically used to diagnose learning disabilities and 66% of them showed substantial deficits. Levine et al. (1982) compared ADHD only, with LD only, on several demographic and cognitive variables. The only differences between the groups included more behavior problems, and a higher incidence of language deficits including word finding problems among the ADHD children. Felton et al. (1987, p. 172) summarized the confusion about reading disabled children and attention deficit children,

> Thus the literature and common clinical experience agree: while RD and ADHD are not identical symptoms, they do seem to overlap far more than would be expected from independent random distribution of these disorders. As a practical matter, this suggests that empirical characterization of either disorder is likely to be confounded by the presence of the other disorder.

Torgeson (1985) summarized results of several studies and concluded that reading disabled children seem to have a primary deficit with encoding and retrieval of linguistic material. Torgeson elaborated by explaining that the primary difference between reading disabled children and normal

children is a basic deficiency in accessing verbal information in long-term memory of the reading disabled children. Comparing RD and ADHD children yielded several distinct differences but about 50% overlap in the two groups (Felton, Wood, Brown & Cambell, 1987).

Emotional Disturbance

"Comorbidity of ADHD with other behavioral and emotional disorders is generally quite common, with up to 44% having at least one other psychiatric disorder, 32% having two others, and 11% having at least three disorders" (Barkley, 1990, p. 82). Breen and Barkley (1983) compared the average profile scores by using the Personality Inventory for Children (PIC; Lachar, 1982; Wirt, Lachar, Klinedinst & Seat, 1987). They compared 26 ADHD children with 26 normal children and the entire profile was about 20 T points higher for the ADHD children. ADHD children seemed to be at particular risk for affective problems such as depression and anxiety (Barkley, 1992b). Not only do more children meet the criteria for a diagnosis of anxiety, dysthymia and depression but those which do not meet the full criteria experience above average levels of affective problems (Barkley, 1990). It has been noted that ADHD children also have much greater somatic complaints compared to normal children (Barkley, Dupaul & Murray, 1990).

Gottschalk and Gleser (1969) designed a test instrument to objectively measure the speech patterns of children on six scales of personality characteristics. Gottschalk, Swanson, Hoigaard-Martin, Gilbert and Fiore (1984) used the Gottschalk-Gleser content analysis scale to measure whether ADHD children differed from normal children in their speech patterns. Gottschalk et al. found that ADHD children scored significantly higher than the control group for cognitive impairment, social alienation-personal

disorganization, and total depression. There were several subscales of depression in which the ADHD group was found to be significantly higher than the control group including: hopelessness, self-accusation and psychomotor retardation.

Studies that include adult ADHD subjects have found a very high incidence of long-term depression (dysthymia) which has been present since childhood (Wender, Reimherr & Wood, 1981). Some of the overlapping symptoms that are commonly associated with both ADHD and dysthymia are poor concentration, problems sleeping, low self-esteem, psycho-motor agitation and mood instability. Jensen, Burke & Garfinkel (1988) wanted to assess the overlap and differences between major depressive disorder (MDD) and ADHD on several personality characteristics. They found that MDD was quite distinct from ADHD but a high percentage of the ADHD children exhibited significant signs of dysthymia.

There is a higher than expected incidence of ADHD children with parents experiencing depression. Furthermore, among ADHD children there is higher than expected rate of depression in their first degree relatives (Biederman, Newcorn & Sprich, 1991). Adopted children had a higher incidence of depression among their biological relatives than among their adoptive relatives and compared to a normal population. Biederman, Faraone, Keenan, Knee & Tsung (1990) posited that the same etiological genetic risk factors that contribute to ADHD problems also cause family members to be at high risk for depression as well. They hypothesize that the two genotypes of ADHD and depression share a common genotype.

Fergusson and Horwood (1993) assessed the stability over a five year period of attention/hyperactivity problems and depression/anxiety problems.

They found both to be very stable based on the ratings of parents and teachers. During this five year period, they also found a correlation for attention/hyperactivity and depression/anxiety problems at between .35 and .31. They found slightly lower but significant correlation between conduct/oppositional behavior and depression/anxiety problems.

Conduct or Behavioral Problems

Probably one of the most consistent areas which ADHD children are deviant when compared to normal children is in their oppositional behavior (Barkley, 1990). More than 65% of the children referred to clinics for ADHD problems will also exhibit problems with oppositional behavior such as stubbornness, defiance, noncompliance, temper tantrums, and verbal hostility toward other people (Loney & Milich, 1982). Fergusson and Horwood (1993) found correlation of .84 to .80 over a five year period between attention/hyperactivity problems and conduct/oppositional problems. Barkley et al. (1990) found that 21 to 45% of ADHD children and 44 to 50% of the ADHD adolescents will be diagnosed as having a serious problem of conduct sufficient to meet the criteria for Conduct Disorder (CD) as defined in the DSM III-R (APA, 1987). In the same study, they also found that up to 40% of the ADHD children and 65% of the ADHD adolescents will meet the criteria for Oppositional Defiant Disorder (ODD) (APA, 1987). There is such a significant overlap between ADHD and conduct problems that some researchers questioned whether they are actually distinct disorders. Recent research has indicated that there are many pure examples of both disorders, and there seems to be different correlates and outcomes for both disorders (Barkley, 1990). Purely conduct disordered children will have a higher prevalence of psychiatric disorders among first level relatives than pure ADHD children and

children with CD will also come from backgrounds with much higher degree of social adversity. ADHD children are more likely to exhibit developmental delays, and cognitive immaturities than CD children (Barkley, 1990). Those children that exhibit both ADHD and CD problems will present a complex and difficult pattern of behavior that is likely to be difficult to successfully treat.

Biederman et al. (1991) summarized the research comparing ADHD and CD children. Family studies confirm that CD children are positively associated with parental antisocial behaviors and alcoholism but among ADHD children without CD, those factors do not occur at a higher rate than expected. ADHD children without CD are associated with academic and cognitive problems but CD children are not as significantly impaired (Biederman et al., 1990).

Social Relationship Problems

Breen and Barkley (1983) used the Personality Inventory for Children and found that mothers rated problems with social skills of their ADHD children 25 T points higher than did mothers of normal children. Furthermore, research indicates that more than 50% of ADHD children will have significant problems with peer relationships (cited in Barkley, Pelham & Bender, 1982). Many studies have found ADHD children to have a host of social problems, because they exhibit significantly more aggressive, disruptive, domineering, intrusive, and noisy behaviors. Clinical experience indicates that ADHD children show a marked deficit in reading social cues and seem to be oblivious to most of the subtle verbal and nonverbal communication patterns. It is not certain whether this is due to their impulsiveness or inattention but it is clear that ADHD children interact with their peers in a more hostile and combative way. ADHD children have been shown to have less knowledge of

social norms and what constitutes appropriate behavior with others (Grenell, Glass & Katz, 1987).

Research that utilized direct observations of peer interactions of ADHD children, found they exhibit much more aggressive, disruptive, off-task, immature and provocative behaviors, and this elicits a pattern of controlling and directive behaviors from their peers in those circumstances in which they must work together (Clark, Cheyne, Cunningham & Siegel, 1988).

ADHD children in general tend to have a greater external locus of control than normal children (Linn & Hodge, 1982). Locus of control involves viewing events that happened to them as being caused by forces outside of their personal control, such as luck or fate. Children with an external locus of control view school success or failure, behavior problems, etc. as outside their influence and therefore they are not likely to take steps toward solving a problem.

Parent-Child Interaction Problems

The multiple problems with conduct disturbance which ADHD children experience has previously been discussed. The oppositional behavior is most often carried out within the parent-child interactions and this creates significant stress in the relationship. It is important to understand the cybernetic principles (Danforth, Barkley & Stokes, 1991) of "systems theory" of family interactions. When looking at parent-child interactions a distorted picture will be presented if the problem is viewed from a linear position. Danforth et al. (1991, p. 704) wrote that "functional analysis of behavioral interactions show how behavior of one changes systematically according to the behavioral parameters of the other." It is important to remember that a key component in assessing a child's ADHD symptoms must always include

behavioral elements. A child's behavior does not occur within a vacuum or in isolation but within a family system. The importance of understanding the familial-social context when analyzing a child's behavior cannot be overstated. Research consistently shows that interactions of ADHD children with their parents and siblings are quite different from that of normal children (Barkley, 1990). Another important facet to consider is that the families of ADHD children are more likely than normal children to experience psychiatric disorders and this is likely to place additional stress upon the family.

Cunningham and Barkley (1979) performed important research to measure the interactions between mothers and their ADHD children, and compared it to the interactions of normal children. They found that hyperactive children were "less compliant, more negative, more off task, and less able to sustain compliance than were normal children; in turn, their mothers were more commanding and negative, and less responsive to positive or neutral communications from their children than mothers of normal children" (cited in Barkley, 1990, p. 133). It was also shown that as the children matured and exhibited fewer behavioral problems, the mothers changed their interactions with their ADHD children to be more positive. Despite the improvement, the ADHD parent-child interactions were far more conflictual than normals, even into adolescence. Research has consistently shown that when children are placed on medicine, their behavior improves and the parent interactions with the child are more positive, supportive, and less intrusive (Barkley, 1990; Cunningham & Barkley, 1979). If we look at parents who have an ADHD child and compare how they interact with their ADHD child, and to their normal child, it becomes obvious the interactions are

qualitatively different. The ADHD parents interact with their non-ADHD children in typically normal ways but they interact with their ADHD children in negative, directive, punitive and impatient ways.

Etiological Factors

There is general agreement among the experts in this field that ADHD has many causes (Barkley, 1992). Initially, brain damage was believed to cause ADHD, but most of the children which exhibited ADHD symptoms had no history of brain damage. There are many factors which positively correlate with a higher incidence of ADHD, but care must be taken because correlation is quite different than causation. For example, there is a higher incidence of ADHD among children of mothers which smoke, but since ADHD adults are more likely to smoke, it is uncertain whether genetics or smoking is the key factor. "Our knowledge of the final common neurological pathway through which these factors produce their effects on behavior has been significantly increased by converging lines of evidence from cerebral blood flow studies, studies of brain electrical activity using computer-averaging techniques, and studies using neuropsychological tests sensitive to frontal lobe dysfunction" (Barkley, 1990, p. 95).

Researchers have found a number of birth related factors which occur more frequently for ADHD children than normals. These factors include: extended labor, premature delivery, young maternal age, toxemia, fetal distress, low birth weight, and low forceps delivery. Even though there is solid evidence for these neurological factors, they only account for about 5% of the total ADHD cases (Barkley, 1990).

The most solid empirically based evidence which differentiates ADHD adults from normal adults was conducted by Zametkin et al. (1990). They used a PET scan to measure brain activity and found that the ADHD adults showed significantly lower metabolism in certain parts of the brain. There has been an effort to identify neurotransmitter deficits in ADHD children. Some direct and indirect evidence has been found to support deficiencies in dopamine and norepinephrine (Shekim, Sinclair, Glasser, Horwitz, Javaid & Bylund, 1987; Barkley, 1990; Raskin, Shaywitz, Shaywitz, Anderson & Cohen, 1984; Lou, Henriksen, Bruhn, Borner & Nielsen, 1989).

The most consistent findings of several studies point to the central nervous system dysfunction as the cause of ADHD (Zametkin, 1988). The most likely area of dysfunction is in the connections between the prefrontal areas and the limbic system, especially in the striatum (Zametkin & Rapoport, 1986). These areas of the brain are known to underlie response inhibition, inattention, and incentive learning or sensitivity to reinforcement (Barkley, 1990). "They are also some of the most dopamine-rich areas of the human brain, and so a hypothesis of selective dopamine depletion would be consistent with these other findings" (Barkley, 1990, p. 98).

The area of greatest interest and that which provides the most compelling etiological argument for ADHD is genetic transmission (Barkley, 1990). There have been many studies which confirm a higher incidence of ADHD in the biological relatives of children who have been diagnosed with ADHD. Many of the studies have been confounded with other disorders concurrent to ADHD such as CD, depression or anxiety. Other studies have used samples which were too small for good statistical reliability or validity. The most precise way to separate genetic contribution to any disorder is by

comparing monozygotic twins to see how high the concordance rate is for the twins. Two studies which compared identical twins found 100% concordance among the identical twins and one of the studies found 17% among the fraternal twins (Heffron, Martin, & Welsh, 1984; Lopez, 1965). Both studies used such small samples that care should be taken when interpreting the results.

A much larger study was conducted by Goodman and Stevenson (1989) which compared 127 monozygotic twins and 111 dizygotic twins for hyperactivity. They found concordance among the monozygotic twins at 51% and among the dizygotic twins at 33%. This study provides clear and unambiguous support that genetic contribution for ADHD is between 30 and 50%. The most likely contribution that environment makes toward ADHD is between 0 and 30% (Barkley, 1990).

Biederman, Faraone, Keenan, Knee and Tsuang (1990) assessed a group of children with ADHD, a control group and a group of children with a psychiatric disorder. They found among the relatives of children with ADHD, there was a diagnosis of ADHD in 25.1% of the relatives. This is compared to a control group which found 4.6% of their relatives had ADHD. The group of psychiatrically disordered children had a 5.3% rate of ADHD among their relatives, which did not differ significantly from the general population. Biederman et al. found the risk for the relative of an ADHD child, to also have ADHD was 7.6 times greater than for the control group. About 64.8% of the ADHD probands had at least one relative with ADHD, compared to 15.4% of the controls. Among the ADD proband families, 44% of the fathers had ADHD, compared to 8% for the normals. It was also true for mothers, because 19% of the ADHD proband mothers had ADHD, compared to 0% for the normals.

Controlling for differences in SES, within the ADHD proband families yielded no significant differences between low, middle and upper income families regarding the incidence of ADHD. Biederman et al. concluded that "neither intactness of family nor high social class protected against familial risk for ADHD. In other words, the risk for ADHD among relatives of ADHD probands was as high in families with psychological advantage as in those with disadvantage." (p. 532).

A study investigating behavior problems in biological relatives of boys with ADHD was conducted by Frick, Lahey, Christ, Loeber and Green (1991). They found that 20% of the mothers of ADHD children had ADHD, 36% had ADHD plus CD compared to 11% of the control group. Among the biological fathers, they found 40% had ADHD, 48% had ADHD plus CD compared to 22% of the controls. Both ADHD and CD disorders have a strong familial component, but they still seem to clearly have different familial patterns.

Goldstein and Goldstein (1992) state that relatives of a child with ADHD are four times more likely than the general population to also have ADHD. The confounding variable in their finding is that relatives share common environmental and social factors as well as genetic factors. To separate the influence of the environmental factors, adoption studies supply valuable information. Goldstein et al. (1992) found that for adopted children their biological relatives were four times more likely than the general population to have ADHD.

Russell Barkley, a leading expert in the field of ADHD research, (1990) summarized his conclusions regarding the etiology of ADHD.

> Most investigators in this area endorse a biological predisposition to the disorder, much like that of mental retardation, in which a variety of

> neurological etiologies (e.g., pregnancy and birth complications, acquired brain damage, toxins, infections, and heredity) can give rise to the disorder through some disturbance in a final common pathway in the nervous system. In the case of ADHD, it would seem that heredity factors play the largest role in the occurrence of these symptoms in children. It may be that what is transmitted genetically is a tendency toward dopamine depletion in, or at least underactivity of, the prefrontal-striatal-limbic regions and their rich interconnections. The condition can be exacerbated by pregnancy complications, exposure to toxins, or neurological disease, and by social factors (such as environmental and family adversity, dysfunctional child rearing and management or educational environment). Cases of ADHD can also arise without a genetic predisposition to the disorder, provided the child is exposed to significant disruption or neurological injury to this final common neurological pathway; however, this would seem to account for a small minority of ADHD children. By contrast, little evidence supports the notion that ADHD can arise purely out of social or environmental factors, such as poverty, family chaos, diet, or poor parent management of children (p. 104-105).

Psychopharmacological Treatment

In order to provide effective treatment, it is vitally important to have a clear understanding of the nature and etiology of ADHD. Great pains have been taken in the present study, to clearly lay a path which will provide for the reader a map for effective treatment. The treatment of ADHD children is probably more controversial than any other area of the disorder. Many times the treatments have not been based upon empirical or theoretical

underpinnings and the treatment research is confusing and does not provide consistent answers. This is primarily because of poor research design due to small samples, poorly selected treatment groups, lack of a control group, and in general, not controlling nuisance variables. The treatment area which will be reviewed in this study is focused upon medication.

The use of medicine for the treatment of ADHD children has been criticized and has come under attack from groups which profess to represent children's rights. The whole subject of the psychopharmacological treatment of children is complex and is influenced by many factors. The use of psychopharmacological treatments for children is still so new that there is a noticeable absence of long-term studies (Barkley, 1991b). There are two primary groups of medication which are typically used for the treatment of ADHD children: stimulants and antidepressants. (Biederman & Steingard, 1989). In addition, there are some medications which are used infrequently such antihypertensives, antipsychotic and anorectic medications. The individual chemistry of each child will determine which medicine works most effectively, as well as the side effects each of the medications might cause. Another factor that will impact which specific medicine works most effectively in treating ADHD is the existence of others disorders such as anxiety, depression, conduct disorder or Tourette's.

Stimulant Medication

Stimulant medication and specifically methylphenidate (MPH) is the most commonly prescribed psychotropic treatment for children in the United States . Since 1983 there have more than 900 research articles written about the use of stimulant medication for the treatment of ADHD (Wilens & Biederman, 1992). It is probably the most researched type of medication of any

kind, yet the use of stimulants for ADHD children remains controversial and it still faces intense opposition. The opposition has vehemently criticized giving children medication even though the scientific research demonstrates unequivocally the safety and efficacy of their use (Wilens & Biederman, 1992). Wilens and Biederman reviewed over 230 studies which evaluated the efficacy of stimulant medication for children of all ages and concluded that 65-75% of the children respond favorably. Other scientists have found a success rate for MPH at around 75%, when judged by teachers rating scales (Greenhill, 1992; Forness, Cantwell, Youpa & Hanna, 1992).

Historically, the first documented use of stimulant medication for children is attributed to Charles Bradley in 1937 (Barkley, 1990; Wilens & Biederman, 1992; Weiss & Hechtman, 1993). He used amphetamines to treat children who were hospitalized for behavior problems and they experienced rapid improvements in both their behavior and school performance. There was not any further mention in the literature of stimulant medicine until the late 1950's when it seems the scientists rediscovered Bradley's work. The increased interest may have coincided with the commercial release of Ritalin in 1957.

Safer and Krager (1988) conducted a comprehensive review of the ADHD research and found that by 1987 about 6% of the elementary school age children were taking stimulant medication which amounted to 1.6 million children. They also found that every four to seven years the rate of children being medicated for ADHD doubles. During the time from 1980 until 1987, the use of stimulant medication increased from 76% to 90% of the total medicine prescribed for ADHD. During this same time, MPH comprised more than 93% of the total stimulant market (Wilens & Biederman, 1992).

Stimulants get their name from the arousing effect they have on the central nervous system (CNS). It is believed that stimulants have multiple effects on the chemistry of the brain. In some cases they increase the production of neurotransmitters and in other cases, they slow down the re-uptake of the unused neurotransmitters at the synaptic cleft, which effectively makes more available (Wilens & Biederman, 1992). It is still not clearly understood just how stimulants do their work, but it is hypothesized that they work primarily on dopamine and norepinephrine levels and to a lesser extent serotonin.

> Most effective drugs alter both noradrenergic and dopaminergic neurochemical systems, but in different ways. It is becoming clear that neurochemical systems do not function in isolation, and therefore no drug is absolutely specific in its effects on one neurotransmitter. Given the growing list of agents efficacious in treatment and their biochemical heterogeneity, single neurotransmitter hypotheses appear untenable at this time; however, dopamine and norepinephrine are clearly involved (Zametkin & Borcherding, 1989, p.449).

There are three primary types of stimulant medications used for ADHD children: d-amphetamine (Dexedrine), methylphenidate (MPH; Ritalin) and pemoline (Cylert). Ritalin is used in 90% of the cases where stimulant medicine is prescribed (Wilens & Biederman, 1992). Dexedrine and Ritalin are chemically very closely related and act in the same basic way within the body. Cylert is much the same in its effects but is quite different in chemical structure from the other two. Cylert tends to last longer than Dexedrine or Ritalin but does not produce its positive effects nearly as quickly (Barkley, 1990). It is not clearly understood how psychostimulants perform their work

but animal studies provide support for the theory that "the absorption phase parallels the acute release of neurotransmitters into synaptic clefts, providing support for the hypothesis that alteration of monoaminergic transmission in critical brain regions may be the basis for stimulant action in ADHD" (Wilens & Biederman, 1992, p. 193). There are many theories as to what region of the brain the stimulants work, but recent research seems to indicate that it increases the activity level and blood flow of the striatum and the connections between the orbital-frontal and limbic regions (Barkley, 1990).

The most popular brand of MPH is Ritalin and is manufactured by Ciba-Geigy. Ritalin is available as an oral dosage in the following tablet sizes: 5 mg, 10 mg, 20 mg and SR 20 mg (slow-release version). It is typically taken daily, in the morning and noon, and some children take a half dose after school. The dosage range of Ritalin is from 2.5 mg to 25 mg. per day (Greenhill, 1992). A primary reason why Ritalin is so popular is the short half-life it has in the body, which is typically between 2 and 4 hours. "MPH is metabolized rapidly because it is not highly bound to plasma protein, nor does it disappear into fat stores" (Greenhill, 1992, p. 7). Because MPH is metabolized so quickly in the body, its impact on symptom improvement is usually not more than 4-5 hours, with the peak benefits being at about two hours (Barkley, 1990) MPH is not easily monitored in the child's body because it is used in such small quantities and because it rapidly disappears from the plasma. This prevents the use of physiological monitoring to determine the most therapeutically effective levels within the child, and forces a lot of guessing in order to adjust dosages to their proper levels.

MPH is one of the safest medications used in the treatment of children, with a 100:1 margin of safety (Greenhill, 1992). MPH has minimal potential for

abuse, and the addiction liability is quite low because it does not provide any noticeable euphoria (Wilens & Biederman, 1992; Greenhill, 1992). MPH is preferred over its cousin Dexedrine for several reasons. First, it produces less euphoric mood elevation; therefore, it seems to provide a smaller risk for addiction. Second, it is used in the majority of the research because it is quick-acting, has a short half life, provides noticeable improvement on global behavior rating forms and has minimal side effects (Greenhill, 1992). Since there is so much research to support its use, clinicians feel safer in prescribing it.

Even though MPH is considered very safe, it still has some potential side effects. The most common side effects which are mentioned in clinics include: insomnia, decreased appetite, weight loss, headaches, heart rate elevation at rest, minor increases in systolic blood pressure, dizziness, irritability, growth impairment, dysphoria, rebound, and increased crying (Greenhill, 1992; Wilens & Biederman, 1992). Most of the time, the side effects are minor and can be managed by altering the time when the medicine is taken or changing the dosage rate. Sometimes it becomes necessary to stop the medicine for a few weeks and then start it again, which can alleviate the side effects when the medicine is re-instituted. There is some evidence that mentally retarded children experience more side effects than children of average intelligence (Handen, Feldman, Gosling, Breaux & McAuliffe, 1991). Handen et al. assessed ADHD children with IQs between 48 and 74 and found a higher incidence of motor tics and social withdrawal, and concluded that mentally retarded ADHD children may present a higher risk than non retarded children for side effects.

Rebound is one of the most common side effects mentioned through clinical lore but there has been very little empirical investigation of rebound. Rebound effects are defined as a "deterioration in behavior that occurs in the late afternoon and evening following daytime administrations of medication. This deterioration is said to exceed that expected from baseline or placebo levels of behavior" (Johnston, Pelham, Hoza & Sturges, 1988, p. 806). Johnston et al. measured the evening behavior of latency aged boys after taking a placebo some days and MPH other days. They found only slight differences in the parent ratings between the placebo and two different dose levels of MPH. There was so much variation within the groups, that the statistical significance was found on only one measure. The data indicates that rebound for the majority of children is neither large nor clinically significant and in no cases was it high enough to alter the dosage rate.

Another side-effect of stimulant medication which is listed in the literature (Robbins & Sahakian, 1979; Swanson, Kinsbourne, Roberts & Zucker, 1978) is over-focusing. The term over-focusing is defined in the following way: (a) decreased ability to shift mental state, (b) repeated scanning of a restricted domain of stimuli without improving performance, (c) difficulty with divergent thinking, and (d) the emergence of tics or other stereotypic behavior (Tannock, Schachar & Logan, 1993). The problems encountered with over-focusing are usually related to high levels of MPH and there are no incidences of over-focusing using normal therapeutic dosages. Tannock et al. studied the effects of two doses (.3 & 1.0 mg/kg) of MPH on ADHD children by using a cued reaction time paradigm. They found that stimulant effects on focused attention are dose-dependent and time-dependent but they did not find any indication of over-focusing. The MPH improved attention only at the 1.0

dosage rate and it was not significant until 2.5 hours after the medicine was taken.

A potential non physiological side-effect of MPH is in the area of attribution. Exactly what "message" a child gets when he/she takes medicine to improve his/her behavior is a question asked by many scientists (Whalen & Henker, 1991b). Some children and parents view the use of medication as a "magic pill" which gives all the credit to the medicine and removes any responsibility or credit for the improvement from the child. It is not the focus of this study, but for many years it has been consistently shown that an external attributional belief system will place a person at higher risk for many social, academic and behavioral problems (Whalen & Henker, 1991a). Pelham et al. (1992) performed two studies trying to assess the attributional attitudes of ADHD children who were taking medication. They found in the both studies that ADHD children who were effectively helped by medicine attributed the improvement to their own effort and when it did not work, they blamed the failure on the medicine or to counselors. Carefully setting realistic expectations needs to be done when medication is instituted, so that medication is seen in a more realistic context. Both parents and children need to view the medicine as a helper for the child to accomplish what he/she want to do but previously has been unable to do.

Motor or vocal tics are not a common side-effect but are worth mentioning because of their severe nature. About 1% of the children who take stimulant medication will develop tics (Gadow & Sverd, 1990). Most all cases of tic development can be reversed upon cessation of the medication. There tends to be an exacerbation of existing tics when stimulant medication is implemented; however, there is an almost equal number of children taking

MPH who have a lessening of tics. Gadow and Sverd assess the relative risk of all medication which is typically given for ADHD treatment and conclude that the relative risk of using stimulants is comparable to antidepressants and neuroleptics, especially when the risk of all side-effects is considered.

Exactly which primary area of behavioral disturbance in the ADHD child is most problematic will impact the pharmacological decisions. Many studies have concluded that the optimum dosage of MPH should be determined by which area of disturbance is of primary importance. Several studies have found that the optimum cognitive dosage rate is lower than the optimum social dosage (Barkley, 1990). Each of the ADHD symptoms are not treated optimally by medicine at the same dosage rate; therefore, it should always be recognized that what is most effective for group treatment is highly variable when it is applied to an individual case. Some doctors calibrate their dosage based upon the size of the child (mg/kg), while others use an absolute dosage rate (Greenhill, 1992). People who try to predict the particular response of each child based upon any formula will find it an elusive adventure.

The physiological side effects of MPH have been researched sparingly. The primary findings of this research is that MPH may slow down the rate of growth slightly, but does not have any long term inhibition on growth (Barkley, 1990). It is not known exactly how it might effect growth, but the most likely reason for suppression of weight gain is the reduced caloric intake, which has been supported by research. A few studies have proposed an increase in the systolic and diastolic blood pressure but there are so many factors which influences blood pressure, that no unambiguous evidence exists for this increase (Barkley, 1990). Barkley theorized after studying the

literature that MPH does heighten the background electrical activity of the CNS and it seems to heighten the excitatory brain mechanisms.

More than ten years ago, Barkley and Cunningham (1978) reviewed the literature on the effects of MPH on academic performance. It was clear from their review that classroom behavior was significantly improved but there did not seem to be an improvement in academic performance or learning in any measurable way. In particular, researchers have been puzzled as to why there is a lack of improvement on standardized tests after taking stimulant medication (Brown, Jaffe, Silverstein & Magee, 1991). Some have hypothesized that subject compliance with dosages may explain part of the discrepancy (Brown, Borden, Wynne, Spunt & Clingerman, 1987), while others indicate that the problem is the brief intervention periods between medication and measurement (Brown et al., 1991). Another criticism of previous findings is that the academic achievements are not sufficiently sensitive to detect the changes over such a short period of time (Brown et al., 1991). More recent scientists have taken exception to the early research conclusions that MPH does not improve academic achievement (Swanson, Cantwell, Lerner, McBurnett & Hanna, 1991). Swanson et al. posits that the early research design had several flaws such as poorly defined groups, small samples, not controlling for comorbid disorders such as learning disabilities, and failure to titrate the dosage until the most effective rate was achieved. More recent studies show improvements in academic achievement between 25% and 40% after taking MPH (Swanson et al., 1991).

Swanson et al. (1991) wanted to investigate the effects of MPH on learning and concluded that the question was too complex for a simple yes or no answer. Some areas of learning and academic performance seemed to be

helped more than others and in different studies, different types of academic performance are improved by medication (Pelham, Vodde-Hamilton, Murphy, Greenstein & Vallano, 1991). A significant problem in assessing the most effective dosage is that cognitive improvement seems to be maximized at lower doses than behavioral maximized doses. In fact, the higher rate of dosage which maximizes behavioral problems may have a negative effect on learning (Brown, Jaffe, Silverstein & Magee, 1991) but it is usually the behavioral issues which bring the client in for treatment and therefore the motivation is stronger for emphasizing this area. Another problem in researching the effects of MPH on learning is that each subject has a dosage level which is most effective and when dosage rates are controlled by group membership, there will be a high degree of within group variance. The third problem which Swanson et al. discusses is that a certain number of subjects will be non-responders to medicine and this will confound the results of any tests, because the non-responders will under estimate the treatment effectiveness of MPH.

Carlson, Pelham, Swanson and Wagner (1991) studied the effects of MPH on arithmetic performance of ADHD grade school age males and found that MPH improves arithmetic performance of ADHD children. The children not only solved more problems accurately, but also spent less time solving the problem and moved on to the next problem more quickly. This study supports the idea that faster performance of children while on medication is a factor of both decreased time answering the problems and also being able to focus more effectively in order to move on to the next problem. Carlson et al. posits that rather than an increase in overall attention, the MPH allowed the subjects to allocate the existing attention more efficiently.

Brown, Jaffe, Silverstein and Magee (1991) looked at the effect of MPH on ADHD adolescents with conduct disorder. They compared the academic performance, behavior in the classroom and impulsivity of adolescents before and after taking medication. They also compared pure CD and ADHD plus CD, for all of the measures previously mentioned. Some of the significant findings of their study include: (a) that MPH significantly improved arithmetic performance with an effect size of .91, (b) adolescents with pure CD improved both their classroom behavior and arithmetic performance by taking MPH, (c) the doses for maximum school improvement were 10 mg, while the doses for maximum behavior improvement were 20 mg., and (d) overall, the CD adolescents showed improvement at higher doses than the CD + ADHD adolescents.

To answer the criticism of previous studies, Forness, Swanson, Cantwell, Youpa and Hanna (1992) designed a study to examine the effects of sustained treatment as opposed to short-term treatment with MPH. They controlled for the presence of learning disabilities, and conduct or oppositional disorder and used reading performance as the dependent variable. They also screened out drug non-responders and prior to treatment, they determined the most effective dosage for each subject. Comparisons were made for pure ADHD, and mixed ADHD/CD or ODD on several cognitive pre-treatment measures, and the only measure which was significant was for reading comprehension in which the mixed disorder group performed more poorly. They measured two types of reading skills: reading fluency and reading comprehension. The results of the study found that only the mixed ADHD group significantly improved their reading performance on reading comprehension. This was probably due in part to their low pre-treatment scores on reading comprehension which

allowed them more room for improvement. The authors speculated that the combination of ADHD and conduct disorder worked additively to diminish concentration on a more complex task such as reading comprehension. It seems that experiencing both attentional problems and environmental adversity, work in combination to place the ADHD child with a mixed behavioral disorder at greater risk for reading problems.

The belief that mentally retarded children would not respond effectively to MPH has been in the clinical lore for years but there have been few studies to empirically assess its validity. A recent study was designed to answer some of the questions about the efficacy of stimulant medication for mentally retarded (48 to 74 IQ) children who also had ADHD (Handen, Breaux, Janosky, McAuliffe, Feldman & Gosling, 1992). Handen et al. found significant improvement in on-task behavior and attentional skills when compared to the placebo; however, they found no improvement on learning or social interactions. Based upon this study and previous work by the same authors, they concluded that mentally retarded children respond (64%) to medication at about the same rate as non retarded children. The lack of improvement in learning and academic tasks is probably indicative of intellectual limitations rather than attentional problems from ADHD.

Barkley (1988) measured the interactions between hyperactive preschool children and their mothers to see how the use of Ritalin would effect the high level of conflict which they typically experience. He placed the children on two levels of Ritalin (.15 mg/kg and .5 mg/kg) and compared the interactions between the ADHD preschoolers and their mothers. He found that ADHD children did not have significant behavioral problems in free play situations. It was only when demands and restrictions were placed upon the

children that their behavior became deviant. He found that when the preschoolers were placed on MPH, as compared to the placebo, the mothers were more positive and supportive in their interactions with the children. As the children's compliance increased, the mothers responded by less controlling behavior, fewer criticisms and more compliments. There are a number of studies which have found these same results in older children, but this is the first to measure preschool children. It has previously been proposed that children under the age of six will not respond to stimulant medication, but in this study Barkley found that children between the ages of 2.5 and four years of age, do respond positively to medication.

There seems to be two universal truths regarding the social interactions of ADHD children. The first is that the vast majority of ADHD children will have serious social problems that are pervasive in all areas of their lives and that they experience a high level of conflict and confrontation. Secondly, their social problems exhibit a high level of variability in both form, as well as intensity (Whalen & Henker, 1991a). There are various explanations as to whether the social problems are due to limitations of ability or of application. Whalen and Henker propose a possible social learning disability much like academic learning disabilities in which the ADHD child lacks the ability to master "the subtle yet perceptual decoding, enactment, self-monitoring, and fine-tuning required for effective interpersonal exchange" (p. 231). One thing is for certain, that aggressive behavior is the main source of peer problems and that ADHD children and adolescents are more aggressive in their interactions (Hinshaw, 1991).

Probably the most readily identifiable social problem which ADHD children experience is an elevated level of disruptive behavior and conflictual

peer exchanges (Whalen & Henker, 1991a). This disruptive behavior is the area in which stimulant medication most effectively produces improvement (Abikoff & Gittelman, 1985). Abikoff and Gittelman found that ADHD children treated with MPH became indistinguishable from normal children in their rates of noncompliance, interference, and demands upon the teachers attention. All of these areas were significantly higher for the ADHD children prior to medication. During unstructured play time, the ADHD children do not differ from normal children significantly and therefore medication does not have as much impact on improvement of behavior during this time. The noticeable improvements occur during structured play time where there are rules and complicated social interactions demanded (Whalen, Henker, Collins, McAuliffe & Vaux, 1979).

Pelham et al. (1990) designed a significant study comparing ADHD children's behavior during baseball drills and games. They found that the actual physical skills (hitting and catching) did not seem to change but there was a marked improvement in their ability to attend to and follow the game. Their teammates were more accepting and forgiving of their physical limitations but tended to be much more critical of any mistake made while not attending to the game. This study seems to indicate that important secondary gain can take place from medication involving social interactions.

The reduction of negative behavior after taking stimulant medication is well documented but there is little support in the literature for the acquisition of positive behavior. Whalen, Henker, Buhrmester, Hinshaw, Huber and Laski (1989) studied a group of ADHD and normal boys in a summer school program. The ADHD boys placed on medication were more likely to be named "best friend" and nominated as "fun to be with and cooperative" by the other

children. The improvement seemed to be dose related because the most improvement took place on the highest dose rate. Whalen and Henker (1991a) reviewed the study and concluded that, "An uncooperative classmate not only interferes with or disrupts a child's ongoing activities, but he also may get the other kids in trouble, perhaps by preventing task completion or eliciting negative group sanctions from the teacher." (p. 233) Whalen and Henker also concluded from the study that stopping the negative interactions of the ADHD children most definitely made for better peer relations but did not immediately give them the needed skills to build lasting relationships. They concluded, "Medication appears to reduce the abrasiveness of social intercourse- the disruptive or domineering demeanor of the child with ADHD. Medication cannot, however, be expected to spawn social competence, sensitivity, and support- qualities that allow children to interact amicably and cultivate chumships." (p. 234) Another study compared medicine versus placebo for ADHD children and adolescents. They found significant improvements for the children using MPH in their peer interactions; however, the adolescents did not improve their peer interactions when using MPH (Pelham, Vodde-Hamilton, Murphy, Greenstein & Vallano, 1991). The lack of improvement for adolescent peer relations may be due to changes in the way adolescents interact. In particular, adolescents don't view cooperation and compliance as positive attributes and peer pressure may override any positive effects which the medication could provide.

Whalen and Henker (1991) compared ADHD children on medicine with those on a placebo on a self-perceived anger scale. They found that the ADHD children taking the placebo experienced significantly higher scores in self-perceived anger compared to the children taking medication. The ones that

started out on the placebo and then were placed on medication had a significant decline in self-perceived anger. Hinshaw (1991) reviewed several research articles regarding the effects of MPH on aggression in children with attention problems. Aggression is complex and multidimensional construct; therefore, it is difficult to measure precisely and accurately. It is common for children to show their aggressive behavior in some settings or with some people but not with others. One study compared normal, ADHD/nonaggressive and ADHD/aggressive children for acts of aggression toward peers (Hinshaw, Henker, Whalen, Erhardt & Dunnington, 1989). The mixed ADHD/aggressive group started out with more than four times the rate of aggression, while the pure ADHD group was the same as the control group. There was a significant drop in aggression when a dosage rate of .3 mg/kg was used, but the rate of .6 mg/kg moved the ADHD/aggression group to normal levels of aggression. The results are consistent with previously cited studies, that higher dose rates are needed for maximum improvement in aggressive and disruptive behavior.

There has been lengthy debate over what effect MPH has on the affective state of ADHD children. Recent studies have revealed a more flat affect with children taking MPH compared to a placebo (Whalen, Henker, Hinshaw & Granger, 1989). There are still too many unanswered questions to draw any conclusions regarding how MPH alters the mood of children and there is no conclusive evidence as to how the potential dysphoria impacts the social interactions of ADHD children. It is also not known whether reduced interactions will necessarily impact social interactions negatively. A dysphoric mood could allow the ADHD children to reflect on social cues and observe prosocial activities of others; conversely, it may deny the ADHD children learning opportunities obtained from interacting with their peers

(Whalen & Henker, 1991a). Additional work needs to be done in this area to answer these questions. The use of stimulant medication is effective in between 65% and 75% of the ADHD children (Safer & Krager, 1988). Stimulants comprise about 90% of total medicine used for ADHD children, with MPH comprising about 93% of the total stimulant market (Wilens & Biederman, 1992).

There are still a substantial number of children who don't respond to stimulants or who have too many side-effects to continue their use. Antidepressants are typically the second choice for treating ADHD children. Barkley (1990) states that 70% of the children who do not respond to stimulants, will respond favorably to some type of antidepressant. Antidepressants are slower-acting but have been shown to produce similar behavioral benefits for ADHD children. The use of stimulants is usually focused on the learning schedule and involves medication only during the time when the children are at school. This can lead to problems at home because when the child goes back to baseline levels of behavior, and in some cases may experience rebound, then he/she will frequently behave badly at home. Antidepressants may be the preferred medication when there is a significantly higher incidence of behavior problems at home, than at school because antidepressants typically last 24 hours per dose (Barrickman, Noyes, Kuperman, Schumacher & Verda, 1991). Another factor which increases the efficacy of using antidepressants for ADHD children is the comorbidity of depression. As previously discussed, ADHD children have a higher than normal incidence of depression and their relatives also have a higher than expected rate of depression. Stimulant medication can exacerbate the depression in an ADHD child because of its sedating effects. The use of

antidepressants for children began with the treatment of ADHD children and only recently have they been used for the treatment of depressed children, (Pliszka, 1991). In fact, it is only in the most recent history, that childhood depression has even been recognized and treated. The rate of effectiveness of antidepressants for the treatment of depression is between 30% and 95%, based on a review of the literature by Pliszka. The effectiveness improves significantly when plasma levels are monitored in order to obtain the maximum therapeutic range. A note of warning should be voiced regarding a higher risk of heart problems with children who use antidepressants. There have been three incidences reported in the literature recently of children who died from heart problems, and who were taking antidepressants, (Pliszka, 1991). A careful screening should be conducted on children who have a history of heart problems or any child with a high family prevalence of heart problems.

Antidepressants

The use of antidepressants have consistently been found to be less effective in the treatment of ADHD than stimulants; however, they have also been found to be consistently more effective in the treatment of ADHD when compared to a placebo (Pliszka, 1991). The two most common antidepressants used for the treatment of ADHD in children are Desipramine and Imipramine. They both seem to work effectively and have the fewest side-effect (Pliszka, 1991). Recent studies have found Desipramine to be more efficacious than Imipramine for the treatment of ADHD, and seems to have fewer side effects (Barkley, 1990). Both medications have been found to be effective in the improvement of inattention, impulsivity, hyperactivity and aggression, but neither has shown improvement in cognitive functioning such as on a

Continuous Performance Test. Barkley wrote that for children with severe aggression problems, Imipramine may make their behavior worse, if exposed to long-term treatment. A newer antidepressant which looks promising as an alternative for ADHD treatment, especially for those children with high levels of depression is Fluoxetine (Prozac). Fluoxetine has been very effective in the treatment of depression, especially in adults, but Barrickman, Noyes, Kuperman, Schumacher and Verda (1991) were the first to investigate the use of Fluoxetine for ADHD children. They did not control for depression among their subjects but their was a 42% rate of affective disorders among first-degree relatives of the subjects in their study. They found that 60% of their sample of children and adolescents with ADHD were judged to be moderately improved in their behavioral symptoms. There was no effect on appetite or weight gain, which is a common side-effect for tricyclic antidepressants.

Riddle, Hardin, Soo, Woolston & Leckman (1988) found Desipramine to be an effective alternative for ADHD children who experience tic disorders or have a family history of tics disorders. They found that 71% of the subjects improved their global behavior ratings and there was not an increase in the incidence of tic symptoms.

In summary, the most compelling reason for using tricyclic antidepressants for the treatment of ADHD are the following: (a) children who don't respond to stimulants, (b) children who exhibit marked signs of depressions or anxiety, (c) children who develop tic disorders when they begin taking stimulants (Riddle et al., 1988), (d) children or adolescents who have a history of substance abuse (Barkley, 1990), (e) children who suffer from insomnia or nocturnal enuresis because this can be exacerbated by

stimulants (Hilton et al., 1991) and (f) children with no prior history of heart problems (Pliszka, 1991).

Miscellaneous Medications

There are a few other medications which do not fit into a single category but include antihypertensives, specifically Clonidine (Barkley, 1992), neuroleptics, such as thiordazine (Klein, 1991) and anorectics, such as fenflurafin (Aman, Kern, McGhee & Arnold, 1993) The use of Clonidine for ADHD is very recent even though it has been used for many years quite safely to treat high blood pressure. Clonidine is "thought to be an alpha-noradrenergic agonist acting on the presynaptic neurons to inhibit endogenous release of norepinephrine in the brain" (Weiss & Hechtman, 1992, p. 364). Clonidine has been shown to be effective in lowering the hyperactivity and impulsiveness, as well as decreasing aggressive behavior. It has not been found to be effective in helping children with their attention problems or improve their productivity in school, but it does provide a valuable alternative for some children. Hunt, Capper and O'Connell (1990) found Clonidine to be especially effective with children who have CD or ODD because it seems to especially effective with aggressive children and adolescents. Hunt et al. advocated the use of Clonidine and MPH together for children with conduct disorder or who have tic disorders because the MPH can be reduced by 40% when used in combination with Clonidine. It is possible that as additional research provides more accurate guidelines for the most effective dosage rates, Clonidine will prove to be even more useful.

The use of neuroleptics to treat hyperactive children has been reported by several investigators (Klein, 1993); however, it is controversial because of the concern for its possible deleterious effect on the cognitive functioning of

children. Klein (1993) used thioridazine to treat a group of ADHD children and measured its effect on their cognitive functioning. She found that the children stayed the same on thioridazine compared to placebo for all cognitive functioning except sequential processing, which went down significantly when the children were given thioridazine.

Fenfluramine typically is used to treat obesity but has a depressive effect on the central nervous system compared to stimulants, which are also used for weight control but have an increase on the level of activity of the central nervous system. Fenfluramine has previously been used to treat autism in children and seems to have serotonin reducing effect on the blood levels of children. It was theorized by Aman, Kern, McGhee and Arnold (1993) that Fenfluramin might be more effective in treating core symptoms of ADHD children who are also mentally retarded. Aman et al. used mentally retarded subjects in their study and found significant improvement in conduct problems, inattention and hyperactivity when compared to the placebo. Overall, the behavior ratings given by the teachers were improved to a greater extent than the parent behavior ratings.

Meta-Analysis

The first person to use the term "meta-analysis" was Gene Glass in 1976, at his presidential address to the annual meeting of the American Education Research Association (Hedges, 1987). Gene Glass defined meta-analysis as "the statistical analysis of a large collection of analyses results from individual studies for the purpose of integrating the findings" (Glass, 1976, p. 3). Since 1976, there have been literally hundreds of meta-analyses conducted and reported in the scientific journals. Disagreements about meta-analysis

revolve around many of the same issues which have been expressed for years between the relative value of quantitative versus qualitative research in general (Hedges, 1987). Hedges posits that this type debate obscures the real contributions which meta-analysis has made. He explains that the most significant contribution of meta-analysis to the field of research is an increased focus on the issue of methodological rigor in research reviewing. It has led to serious examination of methodological standards in research reviewing and impressed upon scientists the need to improve the standards.

Rigorous methodological standards work to insure the validity of research. Standards exist because it is commonly known that biases exists in which procedures will render the results either invalid or uninterpretable. Some of the areas which are potentially influenced by bias include: problem formulation, data collection, data evaluation, data analysis, and reporting of data (Hedges, 1987). Efforts to standardize these procedures are conducted in order to control biases and improve the validity and reliability of original research. The general increase in concern for the use of rigorous methodology is viewed as progress, even by those who are critics of meta-analysis. Some specific contributions which meta-analysis has made are listed by Hedges. First, meta-analysis has increased the concern about data collection in research reviews and has emphasized the need for rigorous control of the sampling activity of which studies to include in a review, and an appreciation for how the sampling process makes a significant difference in the outcome. Second, meta-analysis has greatly contributed to an increased emphasis upon effect size and away from statistical significance. Effect size contributes new and in some cases, more meaningful information about relationships between variables. Third, meta-analysis has led to better

analytic methods for reviewing articles and synthesizing a large body of work in a given area. It has given to science, a more effective method of expressing results and for understanding the variability of research results.

Schmidt (1992) posits that many scientists are frustrated with the progress which psychology has made in this century and that one of the reasons for the lack of progress is due to an over emphasis on statistical significance. He states, "traditional data analysis and interpretation procedures based on statistical significance tests mitigate against the discovery of the underlying regularities and relationships that are the foundation for scientific progress" (p. 1173). If a statistic is significant, then a relationship or effect is assumed and if the statistic is not significant, then the relationship does not exist. The basis for performing tests of significance is to control Type I errors, but there is little attention paid to control Type II errors. Type I errors are committed when it is assumed that a relationship exists, when in fact it does not. A Type II error exists when there is a true differences but it is missed, because it is assumed that no relationship exists. The current statistical procedures have quite effectively controlled Type I errors but Type II errors have by default been allowed to climb to high levels, often to the 50%-80% range (Cohen, 1990). Schmidt hypothesizes that as time goes by, in any particular research area, the knowledge and understanding get more and more precise. As a more clear understanding is gained in a particular area, the null hypothesis becomes less and less likely to be true. This indicates that researchers should increasingly pay more attention to statistical power. A review of an APA journal yielded a reduction in power from 46% to 37% during a 22 year span (Schmidt, 1992). A primary reason for the decline in power is the increased use of alpha-adjusted procedures such as the Newman-Keuls,

Duncan and Scheffe', which has yielded an additional increase in Type II errors of 17% (Schmidt, 1992). Schmidt's premise is that meta-analysis can effectively address many of the short-comings of statistical significance testing.

Meta-analysis provides empirical building blocks for theory development. A good theory is simply an effective explanation of the processes that actually take place in a phenomena. In order to construct an effective theory, one must know some of the basic facts such as the empirical relationships between the variables. When the relationships are quite varied across settings and populations, then complex interactive or moderator-based theories are necessary. Meta-analysis can greatly aide in understanding the complexities of relationships between variables and guide the theorist in developing comprehensive explanations. One of the primary reasons for science and theories is to establish causal explanations (Schmidt, 1992). Path analysis is used to test causal theories and meta-analysis is a useful building block to design accurate path analyses. Some people have said that meta-analysis is just a new, more quantitative way to review the literature (Guzzo, Jackson & Katzell, 1986). Schmidt (1992) is quoted in the following,

> meta-analysis is much more than a new method for conducting reviews. The realities revealed about data and research findings by the principles of meta-analysis require major changes in our views of the individual empirical study, the nature of cumulative research knowledge, and the reward structure in the research enterprise. Meta-analysis has explicated the critical role of sampling error, measurement error, and other artifacts in determining the observed findings and statistical power of individual studies. (p. 1179)

The treatment of ADHD children and adolescents is a complex and confusing maze of research which many times does not clarify the variables but rather places greater confusion upon them. Because of the extreme variability of results in treating ADHD children, meta-analysis seems particularly well suited for this investigative adventure. Smith and Glass (1977) investigated the effectiveness of psychotherapy by using meta-analysis and this presented a break-through study which has become the standard for all literature review procedures. Rather than ask the question, "Does psychotherapy work?", Smith and Glass taught us to ask what type of psychotherapy works best, with what clients, under what circumstances, with which disorders and with what type of therapist. This is the type of inquiry which needs to take place in the treatment of ADHD children and adolescents. A better understanding can be gained by a meta-analytic study of the various treatments for a ADHD, because successfully adapting individual treatment has already proven to be effective. It is obvious as one studies the literature involving ADHD children, that it is not a homogenous group but an incredibly diverse and complex group, which may in the future not even be considered a single diagnostic category. The future seems destined to provide a more accurate categorization of multiple sub-disorders of ADHD, which will then allow for inquiry of more homogenous subjects. Until that time, a clearer understanding can be gained by using meta-analysis to explain how the different variables both personal and experimental, interact to effect treatment.

CHAPTER THREE

Method

Chapter three describes the sample of studies, the review procedures for selection, the dependent measures used, and the type of analyses which will be performed. This study used meta-analytic procedures to investigate the effectiveness of pharmacological treatment for Attention-deficit Hyperactivity Disorder. Effectiveness is measured using many different types of outcome and this study sought to define whether medication is effective and if so, which type of medication resulted in the greatest improvement as measured by each of those outcome areas. The method of comparison will be to compute an effect size (Δ), which subtracts the mean of the medication from the placebo treatments and then divides that difference by the standard deviation of the placebo treatment. Effect size allows for a standardized measure so that direct comparisons can be made across many dependent measures and many studies.

Sample

This investigation surveyed the scientific periodicals to identify articles which reported the use of medication in the treatment of ADHD. *Medline* and *Psychlit* were utilized to locate the relevant articles. *Medline* is a computer data base which lists medical journals and *Psychlit* is a data base which lists psychological and educational journals. In an effort to obtain only those articles which utilized the DSM III R criteria to select subjects, the key words which were used in the search parameters included: ADHD and Attention-deficit Hyperactive Disorder. The treatment parameters were further narrowed by using the key phrase "drug therapy". The exact search command entered was "ADHD or Attention Deficit Hyperactivity Disorder and Drug

Therapy". In order to keep the number of studies to a manageable number, and to review only the most current psychopharmacological treatments, the articles were included only for the years between 1989 to 1994 inclusive. A printout of 144 abstracts was obtained from *Psychlit* and 301 abstracts from *Medline*. The total set of articles was screened for duplications and when located, duplications were deleted. The list of abstracts was further screened and articles were deleted which did not include the following criteria: (a) at least six subjects in the treatment group, (b) include the use of medication and a placebo treatment, (c) means and standard deviations of the medication and placebo treatments must be available for analysis (d) the dependent variables in the study must fit into one of the nine categories previously described, and (e) must use original research rather than reporting the results from a previous study. There were 23 studies which met inclusion criteria but did not report the means or standard deviations. The primary authors were contacted by mail and the information was requested. Only one author was able to supply the needed information and this was included in this study. The computer search yielded many articles which included theoretical discussions of ADHD diagnosis or treatment. For purposes of this study they were not useful and were not included. After the screening took place, there were 41 studies included for statistical analyses, which yielded 80 effects sizes. Some of the studies included more than one dosage rate of medication or more than one type of medication, therefore many of the studies included more than one effect size. The studies which used non medication methods of treatment, as well as medication were included but only the medication and placebo statistics were utilized.

Using more than one effect size for each study introduces nonindependent measures, which violates one of the assumptions of inferential statistics. The loss of important information by averaging different outcomes into one measure for each study was weighed against the violation of statistical purity and it was determined that the lesser of the two ills was to use all measures separately.

There were 41 studies in which analysis was performed and they yielded 80 distinct treatment conditions. The 80 treatment conditions were placed into nine sub-categories and averages were obtained for each of the nine sub-categories for each of 80 unique medication and dosage rates. The nine sub-category means were then averaged in order to obtain a global average for all treatment conditions. This yielded the possibility of 10 outcome measures for each medication or dosage rate. A breakdown for each year shows the following distribution: 10 studies in 1989, 6 in 1990, 9 in 1991, 8 in 1992, 5 in 1993 and 3 in 1994. The total number of subjects for all studies was 1,259; ninety three percent were male and seven percent were female. The mean age for all subjects used in the studies was 9.4 years old and the mean IQ was 98.5. Three of the studies were primarily interested in the effects of medication on mentally retarded subjects and those three studies had a mean IQ of 63.7.

Many of the studies reported the existence of comorbid disorders in the ADHD subjects. The following percentages were computed from the total subject population for each disorder: 11.4% qualified for conduct disorder, 6.5% qualified for learning disabilities, 4.3% qualified for mental retardation, 2.2% qualified for an anxiety disorder and 20.4% qualified for oppositional defiant disorder.

The mean time in which the subjects were exposed to the treatment was 2.09 weeks. The mean number of diagnostic procedures which the studies used to diagnose their subjects is 3.18. The mean number of subjects in the studies is 30.81, ranging from nine to one hundred sixty one.

Review Procedures

A copy of each article was obtained from library sources and information was recorded from each article. A recording instrument (Appendix A) was designed and utilized to obtain demographic information for each study, and to record each of the outcome measures. The information obtained from the studies included: year of publication of the study, sample size, the number of diagnostic levels used for inclusion, mean age of the subjects, the number of subjects with a comorbid disorder and type of disorder, weeks exposed to treatment, IQ of the subjects, how many of subjects in the treatment group were male or female and the type of medication and dosage rate.

The sample size is defined as the number of subjects in the treatment group. The number of diagnostic levels utilized in the diagnostic procedure involves a multi-layered approach to assessing subjects for inclusion. Typical criteria might include teacher behavior ratings, parent behavior ratings, clinical interview by a mental health professional, behavioral observations and standardized tasks. A child must have a clinically significant score for each diagnostic level in order to be included in the ADHD treatment group, and when several diagnostic inclusion levels are utilized, it should provide the most accurate selection of ADHD subjects.

The mean age of the treatment group and the gender of treatment group are self-explanatory. The existence of comorbid disorders is defined as the

existence of any disorders as defined by the DSM III-R which occur in addition to the existence of ADHD. Some typical comorbid disorders may include Oppositional Defiant Disorder, Conduct Disorder, Depression, Anxiety or Tourette's Syndrome. The IQ of the treatment group represents the measured mean intelligence of the treatment group based upon a standardized intelligence test. The weeks of treatment is defined as the number of weeks the subjects were exposed to the drug treatment and the category of medication is defined as the name of the drug which the treatment group was placed on during the treatment. There are two categories of medication: stimulants and antidepressants. The generic name of the drug will be reported in this study and drugs with the same chemical composition but simply different names will be combined into the same category.

Some medication is titrated by fixed dosage rates and others use a variable ratio based upon the weight of the subjects; both methods will be utilized and reported in this study. Many of the studies compared dosage levels of the same medication to each other and reported dependent measures for each level. Three categories were utilized so that dosage rate levels could be compared to each other. The three levels used in this study were low, medium, and high. Both dosage types were used in the analysis of dose level. For the fixed rated format, a dose of 5 mg. constituted a low dose level. A dose of 10 mg. constituted a medium dose and any dose above 10 mg. was placed in the high dose level. For the variable format, dose rates from .1 mg./kg. to .3 mg./ kg. were placed in the low dose level, dose rates from .4 mg./kg. to .6 mg./kg. were placed in the medium dose level and any dose level above .6 mg./ kg. was placed in the high dose level category.

The assignment of dosage levels for the fixed method followed the recommendations within the literature which typically define a dose of 5 mg. as a low dose, a dose of 10 mg. as a medium dose and a dose of 10 mg or greater as a high dose. The studies which used the variable method contained nine different dosage rates. The lowest three were assigned to the low level, the middle three were assigned the medium level and the highest three were assigned the high level. Using this method resulted in an unequal number of treatment conditions being placed into the three categories but it provided the best possible separation between the dosage levels. Additionally, some studies administered medication one time per day, most two times per day and others three times per day. The dosage per administration was used in the categorization regardless of how many times per day the subject received the dose. All of the studies made certain to test the subjects at the most optimum time related to the administration of the medication, so for testing purposes it did not matter what other doses they received that day. This is true for stimulant medication because the half life of the medication is so short. Within four hours, all medication is metabolized in the body.

Research designs include many different outcome measures to determine whether a child shows improvement from taking medicine. An attempt was made to cluster the various dependent measures into groups so that the results could be reduced to a few manageable categories. The outcome measures were sorted into nine general areas: parent behavior ratings, teacher behavior ratings, miscellaneous behavior ratings, academic achievement, standardized assessments, direct observation, social interaction, self-esteem and self rating. Average effect sizes were computed for each category, which were used in each of the treatment conditions, as well as a

global average effect size of all nine categories. It should be noted that although there were only 41 studies, there were 80 treatment conditions; therefore, some of the studies included more than one treatment condition.

The above categories were chosen because they have broad application across many different assessment instruments. The category descriptions and names of the categories were chosen to allow the largest number of studies to be used and to maximize the accuracy of placing the dependent measurements into their proper categories. The categories were chosen by performing pilot procedures on 5 studies and listing all of the dependent measures for the pilot studies. After these pilot studies were coded, the dependent measures were placed into categories and 5 additional pilot studies were coded to verify the goodness of fit for the categories and adjustments were made as needed.

In the early meta-analyses, combining very divergent heterogeneous outcome measures was commonly done, but this method tended to obscure meaningful differences in treatments and minimize the effectiveness of treatments (Crits-Christoph, 1992). This study will look at more precise breakdowns of outcome measures, as well as total effects, so that greater sensitivity may be obtained.

The effect size (Δ) was calculated by using the work of Glass (1981). Effect size (Δ) is obtained by calculating the difference between the mean of the placebo treatment and the mean of the medication treatment and then dividing the result by the standard deviation of the placebo treatment. Calculations were made so that a positive effect size would indicate that the medication treatment was superior to the placebo and a negative effect size indicates a superiority of the placebo group. This allows for standardized statistics and consequently different types of measurements can be compared

on a common scale. An effect size of one indicates that the mean of the medication treatment is one standard deviation higher than the mean of the placebo treatment. Effect sizes will be obtained for all of the dependent measures and used to investigate which type of medication is most effective and in which area is it most effective? Furthermore, dosage rates will be measured separately to investigate which dosage rates are most effective in each of the categories. Dosage rates will be placed into category levels so that comparisons can be made between the dosage levels. Statistical analysis will be performed to determine whether effect size is influenced by sample size, IQ of the subjects, weeks exposed to treatment, age of subjects, and rigor of diagnostic criteria. Cohen (1977) suggested the following guidelines for interpreting effect sizes for the behavioral sciences: a value of .2 is considered a small effect size, a value of .5 is considered a medium effect size and a value of .8 is considered a large effect size.

Current literature contains several different procedures to compute the effect size. Some studies yield just one effect size, while others yield multiple effect sizes (Baer & Nietzel, 1991). One way to calculate effect size is to include all of the outcome measures regardless of the sample size but this method results in obtaining non independent effect sizes, as well as a disproportionate weight for some studies. Another way to calculate effect size is to compute an average effect size for each study so that each study contributes only one independent effect size to the total. This method allows for each study to contribute equal weight to the meta-analysis but does not allow for careful examination of each dependent measure and significant specificity is lost. A third method of determining effect size is to weight the individual effect sizes based upon the sample size, allowing for measures which are not independent

but do not place disproportionate weight on small samples that contain many measures. After careful consideration of the advantages and disadvantages of each of these three methods, it was decided that all dependent measures will be used and they will not be weighted. It was determined that this method will yield the most useful information, despite the lack of independence of the results and violation of assumptions underlying parametric statistics.

Dependent Measures

The dependent measures used in this study were limited by the selection process of the authors of the studies used in this meta-analysis. It does not represent a sample of all possible dependent measures which could have been used and to this extent it is biased.

The dependent measures which were selected by the studies used in these analyses are all short-term in nature. The dependent measures in the field of ADHD research are consistently short-term and because of this are somewhat artificial. In real life, long-term benefits are more compelling and hold greater interest but are subject to so many influences that it is difficult to obtain specific measures. The more time which passes between treatment and measurement of any variable, the greater the external influences which act upon the variable.

Most of the dependent variables are based upon the judgments of other people, rather than the objective behavior of the child. This method of obtaining measurements from significant observers does exert influence on the outcome of the measures obtained and are only as reliable as the observers judgment. The judgment of significant observers of ADHD children are effected by many influences and should not be viewed as objective.

Analyses

To answer the research questions one through ten, an effect size will be computed and the work of Cohen (1977) will be used to measure the magnitude of the outcome effectiveness. The meaning of effect size is dependent upon the context in which it occurs, but Cohen suggested three categories be used in the behavioral sciences for interpretation of the results. As previously stated, Cohen suggested that a small effect size be defined as .2 standard deviations and anything smaller than .2 is not large enough to be meaningful. Cohen defined a medium effect size as .5 standard deviations and a large effect size is .8 standard deviations. Most treatment effects in the behavioral sciences are small because there is simply too much variation that is due to a wide range of variables and the measures which are used in educational and psychological research are too imprecise (Cohen, 1988).

Research question 11 will be evaluated by comparing the effect sizes obtained by averaging the nine outcome categories for stimulants and antidepressants and discussing the implications of the relative effect sizes of each. Because there is such a unequal number of studies between antidepressants and stimulants, an important assumption of parametric statistics is violated; therefore, inferential statistical analysis is not meaningful or prudent. Research question 12 will be answered by doing a one way ANOVA comparing the three dosage levels for each of the ten outcome categories and when significance is found, post hoc comparisons will be done to find the exact source of the significance.

Research questions 13 through 17 will be evaluated by performing Pearson correlations and computing statistical significance for each of the ten

outcome categories. Only those measures which include at least 15 subjects in a cell will be conducted because anything less than 15 subjects does not follow prudent data analysis and would not have sufficient power to identify true differences. Research question 18 will be answered by comparing the global effect sizes for each of the different types of stimulant medications: MPH, Dexedrine, pemoline and MPH- Sustained Release. Inferential statistical analysis cannot be conducted because there is such an extreme difference in the sample size of the four types of stimulant medications. MPH was used in sixty-eight treatment conditions, Dexedrine in two treatment conditions, Pemoline was used in one and MPH-SR was used in four.

Data collection was achieved by using a coding sheet (Appendix A) and obtaining pertinent information from each study. There was a limit set within each category in order to keep the number of measures to a manageable level. The category maximum was set high enough so that very few measures were not used individually. When the number of measures for any study exceeded the number of set categories, then averages were obtained so that they would fit the specified number. In this way, all outcome measures were used, but some were averaged. The maximum number of different outcome measures for each category was the following: 7 for parent behavior ratings, 7 for teacher behavior ratings, 7 for miscellaneous behavior ratings, 7 for academic achievement, 7 for standardized assessment, 7 for direct observation, 7 for social interaction, 6 for self rating, and 3 for self esteem rating. For example, if a treatment condition contained 8 dependent measures within the parent behavior ratings category, then two of the measures were averaged in order to fit within the maximum of 7 outcome measures. The dependent measures

which were averaged were randomly selected so that no experimenter bias would occur.

The individual outcomes within the category were entered into the computer and an average effect size was calculated for each of the nine categories on the 80 different treatment conditions. The global average outcome category was obtained from the average of all nine categories for each of the 80 different treatment condition. A treatment condition represents a unique type of medication or dosage rate from the 41 studies which were analyzed.

CHAPTER FOUR

Results

This section presents the results of statistical analyses, including the effect sizes of each of the ten outcome measures. In addition, each of the research questions are addressed. This chapter is divided into two sections, descriptive statistics and research questions.

Descriptive Statistics

Appendix B lists each of the studies with their effect sizes for the nine outcome sub-categories, along with the average of all outcome categories, which is referred to as global average. The primary author is listed and year of publication for each of the studies. Many of the studies have more than one treatment condition, consequently those studies list more than one set of effect sizes.

Descriptive statistics are summarized in Table 1 for the ten outcome categories. Included in the table are the mean, standard deviation, minimum and maximum scores and the number of treatment conditions observed for each category. The category means range from a low of .32 for self rating, to a high of 1.02 for teacher behavior ratings.

The five different types of medication were merged into one of two categories, stimulant and antidepressant. From the total of 80 treatment conditions, 75 (93.8%) utilized stimulants and 5 (6.2%) utilized antidepressants. Table 2 lists the effect size and number of occurrences for each of the ten outcome categories, subdivided by stimulant and antidepressant medication. It should be noted that studies of antidepressant treatments used only four.

Table 1

Descriptive statistics (mean of effect sizes, standard deviation, minimum score, maximum score, and number of effect sizes) for each of the ten categories

Category	Δ	SD	Minimum Score	Maximum Score	n
Academic achievement.	.49	.36	.07	1.32	41
Direct observation	.68	.30	.26	1.48	41
Misc. behavior ratings	.75	.62	.33	2.25	8
Parent behavior ratings	.63	.51	-.67	1.82	52
Self esteem rating	.40	.21	.07	.63	5
Self rating	.32	.12	.18	.47	8
Social interaction	.47	.31	.05	1.22	19
Standardized assessment	.65	.58	.07	2.57	31
Teacher behavior ratings	1.02	.85	-.12	4.51	44
Global average	.67	.52	.07	2.96	80

Table 2

Effect sizes and number of occurrences broken down by the type of medication.

Category Measures	Stimulant		Anti-depressant	
	Δ	n	Δ	n
Academic achievement.	.49	41		0
Direct observation	.68	41		0
Misc. Behavior Rat	.52	6	1.44	2
Parent behavior ratings	.60	26	1.08	2
Self esteem rating	.40	5		0
Self rating	.32	8		0
Social interaction	.47	19		0
Standardized assessment	.56	27	1.27	4
Teacher behavior ratings	.87	38	2.32	5
Global average	.60	75	1.91	5

Research Question 1

Does the use of medication significantly improve the overall performance as measured by the average of all measures, of ADHD children and adolescents when compared to the placebo treatment? As can be seen from Table 1, there were 80 treatment conditions obtained for the global average category. When comparing medication treatment to placebo treatment, results of analysis indicate an average effect size for global average

of .67, which according to Cohen is in the medium range. This means that a subject at the 50th percentile in the placebo treatment would be moved to the 75th percentile when placed on medication.

Research Question 2

Does the use of medication significantly improve parent behavior ratings of the ADHD children when compared to the placebo treatment? As can be seen from Table 1, there were 52 treatment conditions obtained for parent behavior ratings. When comparing medication treatment to placebo treatment, results of analysis indicate a treatment effect size for parent behavior rating scales of .63, which according to Cohen is in the medium range. This means that a subject at the 50th percentile in the placebo treatment would be moved to the 74th percentile when placed on medication.

Research Question 3

Does the use of medication significantly improve teacher behavior ratings of the ADHD children when compared to the placebo treatment? As can be seen from Table 1, there were 44 treatment conditions obtained for teacher behavior ratings. When comparing medication treatment to placebo treatment, results of analysis indicate a treatment effect size for teacher behavior ratings scales of 1.02, which according to Cohen is in the large range. This means that a subject at the 50th percentile in the placebo treatment would be moved to the 85th percentile when placed on medication.

Research Question 4

Does the use of medication significantly improve the academic achievement of ADHD children, when compared to the placebo treatment? As can be seen from Table 1, there were 41 treatment conditions obtained for academic achievement. When comparing medication treatment to placebo

treatment, results of analysis indicate a treatment effect size for academic achievement of .49, which according to Cohen is in the medium range. This means that a subject at the 50th percentile in the placebo treatment would be moved to the 69th percentile when placed on medication.

Research Question 5

Does the use of medication significantly improve performance of the ADHD children on standardized assessments, when compared to the placebo treatment? As can be seen from Table 1, there were 31 treatment conditions obtained for standardized assessment. When comparing medication treatment to placebo treatment, results of analysis indicate a treatment effect size for standardized assessments of .65, which according to Cohen is in the medium range. This means that a subject at the 50th percentile in the placebo treatment would be moved to the 75th percentile when placed on medication.

Research Question 6

Does the use of medication significantly improve the behavior of ADHD children when compared to the placebo treatment, as measured by direct observation of their behavior? As can be seen from Table 1, there were 41 treatment conditions obtained for direct observations. When comparing medication treatment to placebo treatment, results of analysis indicate a treatment effect size for direct observations of .68, which according to Cohen is in the medium range. This means that a subject at the 50th percentile in the placebo treatment would be moved to the 75th percentile when placed on medication.

Research Question 7

Does the use of medication significantly improve the social interactions of the ADHD children, when compared to the placebo treatment? As can be

seen from Table 1, there were 19 treatment conditions obtained for social interactions. When comparing medication treatment to placebo treatment, results of analysis indicate a treatment effect size for social interactions of .47, which according to Cohen is in the medium range. This means that a subject at the 50th percentile in the placebo treatment would be moved to the 68th percentile when placed on medication.

Research Question 8

Does the use of medication significantly improve the self-esteem ratings of ADHD children, when compared to the placebo treatment? As can be seen from Table 1, there were 5 treatment conditions obtained for Self-Esteem. When comparing medication treatment to placebo treatment, results of analysis indicate a treatment effect size for self-esteem ratings of .40, which according to Cohen is in the small range. This means that a subject at the 50th percentile in the placebo treatment would be moved to the 66th percentile when placed on medication.

Research Question 9

Does the use of medication significantly improve the self-ratings of ADHD children in various areas, when compared to the placebo treatment? As can be seen from Table 1, there were 8 treatment conditions obtained for self-ratings. When comparing medication treatment to placebo treatment, results of analysis indicate a treatment effect size for self-ratings of .32, which according to Cohen is in the small range. This means that a subject at the 50th percentile in the placebo treatment would be moved to the 63rd percentile when placed on medication.

Research Question 10

Does the use of medication improve the behavior ratings of people other than teachers and parents as compared to the placebo treatment (e.g. clinicians, nurses or camp counselors)? As can be seen from Table 1, there were 8 treatment conditions obtained for miscellaneous behavior ratings. When comparing medication treatment to placebo treatment, results of analysis indicate a treatment effect size for miscellaneous behavior ratings of .75, which according to Cohen is in the medium range. This means that a subject at the 50th percentile in the placebo treatment would be moved to the 77th percentile when placed on medication.

Research Question 11

Will there be differences in the overall effectiveness between stimulants and antidepressants? Due to the small number of studies using antidepressants, inferential statistical analysis could not be conducted. To answer this question, comparisons can be made between stimulant and antidepressant effect sizes. Table 2 summarizes the effect sizes for each category of medication. The global average effect size of the treatment conditions for antidepressants was 1.91, which means that a subject at the 50th percentile in the placebo treatment group is moved to the 97th percentile when placed on antidepressants. The global average effect size of the outcome measures using stimulants was .60, which means that a subject at the 50th percentile in the placebo treatment would be moved to the 75th percentile when placed on medication.

Research Question 12

Will there be differences between the low, medium, and high dosage levels for MPH medication, as measured by the ten outcome categories? This research question leads to the null hypothesis that there will be no significant differences between the effect sizes obtained from the different dosage levels of MPH medications, as measured by each of the ten categories.

There were 69 treatment conditions which reported the dosage level for MPH. There are two formats in which dosage rates are calculated, a fixed dose and a variable dose based upon milligrams of medication per kilogram of body weight. Of the 69 treatment conditions used in the dosage level analysis, 50 used the ratio method and 19 used the fixed method. Rates based upon both methods were used in the dose level analysis. For the fixed rate format, a dose of 5 mg, constituted a low dose level. A dose of 10 mg., constituted a medium dose and any dose above 10 mg. was placed in the high dose category. For the variable format, dose rates from .1 mg./kg. to .3 mg./ kg. were placed in the low dose level, dose rates from .4 mg./kg. to .6 mg./kg. were placed in the medium dose level and any dose level above .6 mg./ kg. was placed in the high dose category. There were four treatment conditions which used MPH-SR and these were placed in the medium dose because clinically the sustained release formulation is used to replace a 10 mg dose, given twice per day. A few studies administered medication one time per day, most studies administered medication two times per day and a few three times per day. The dose given for each administration was used to categorize the dosage levels, regardless of how many times per day the subject received the dose. All of the studies made certain to test the subjects at the most optimal time, related to the

administration of the medication, so for testing purposes it did not matter what other doses the children received during the day. This is true for stimulant medication because the half life of the medication is so short. Within four hours, all of the medication is metabolized in the body. Table 3 summarizes the effect sizes and number of occurrences for all ten categories subdivided by the three levels of medication.

Table 3

Effect size means and number of occurrences broken down by the dosage level for those studies which used stimulant medication

Category Measures	Low		Medium		High	
	Δ	n	Δ	n	Δ	n
Academic achievement.	.38	14	.50	15	.73	8
Direct observation	.54	16	.74	16	.94	7
Misc. Behavior Ratings	.49	3	.56	3		0
Parent behavior ratings	.62	9	.58	12	.40	4
Self esteem rating	.29	3	.56	2		0
Self rating	.29	4	.31	3	.47	1
Social interaction	.33	7	.45	8	.85	2
Standardized assessment	.33	10	.80	10	.56	3
Teacher beh. ratings	.78	13	.90	16	1.16	6
Global average	.48	30	.65	30	.82	9

A One-Way Analysis of Variance (ANOVA) was calculated for each of the ten outcome measures to determine whether significant differences existed between the three dosage levels. When significant differences were found, post hoc comparisons were computed using the Tukey method of correction to control the familywise error rate. There were two outcome measures which achieved significance for dosage levels, direct observation and global average. Significant differences were found between the three dosage levels for direct observation outcome measure. Post hoc comparison for group differences found the significant difference to be between the low and high dosage level. Table 4 shows the results of the One-Way ANOVA for direct observation.

Table 4

Summary of analysis of variance for dosage level on the standardized assessment outcome measure.

Source	D.F.	Sum of Squares	Mean Square	F	p
Between Groups	2	.8208	.4104	5.2569	.0099
Within Groups	36	2.8104	.0781		
Total	38	3.6312			

Significant differences were found between the three dosage levels for the global average of the nine sub-categories. Post hoc analysis indicated that the significant group differences were between the low and high dosage levels. Table 5 shows the results of the One-Way ANOVA for the global average outcome measure.

Table 5

Summary of analysis of variance for dosage level on the global average outcome measure.

Source	D.F.	Sum of Squares	Mean Square	F	p
Between Groups	2	.9209	.4604	3.3741	.0403
Within Groups	66	9.0063	.1365		
Total	68	9.9272			

Post hoc analysis was conducted to get a better understanding of the relationship between the exact dose level and the magnitude of the effect sizes for the outcome measures. To understand the strength of association between the level of dose and effect size the variable and fixed method of computing the dosage levels were separated. Because it could be argued that the two methods of titrating doses are incompatible for comparison purposes in their raw form, the treatment conditions which used fixed and variable methods were split into separate files and analyzed independently. Pearson correlations were run for each of the ten outcome measures for the fixed and variable methods. Table 6 summarizes the correlation coefficients, number of occurrences and actual probabilities for the fixed and variable methods. There were 21 treatment conditions which used the fixed method and 56 which used the variable method.

Correlational analysis found that none of the outcome measures had significant correlation coefficients for the fixed method of titrating doses. Analysis of the variable method of titrating doses yielded two significant outcome measures, direct observation and standardized assessments. The outcome measure of direct observation achieved a correlation of $r = .3908$, $p = .048$, which means that the higher the dose, the greater the effect size. Fifteen percent of the variance in the effect sizes for the outcome category of direct observation is attributable to the dose of MPH. The outcome measure of standardized assessment achieved a correlation of $r = .8136$, $p = .000$, which means that the higher the dose, the greater the effect size. Sixty-six percent of the variance in the effect sizes for the outcome category of standardized assessments is attributable to the dose of MPH.

Research Question 13

What is the relationship between the IQ of the subjects and their response to medication as measured by the ten outcome categories? This research question leads to the null hypothesis that there will be no linear relationship between the average IQ of the subjects and their response to medication. To test this hypothesis a Pearson Product Correlation was computed for IQ and the ten outcome measures. Table 7 reports the correlation coefficients, probabilities and number of observations for each of the ten measures. There was one outcome measure which obtained significant correlations, academic achievement. Academic achievement had a negative correlation of $r = -.6399$, $p = .001$, which means that the higher the IQ of the subjects, the lower the effect size they obtained.

Table 6

Correlation coefficients, number of occurrences and probabilities for dosage and outcome measures, split for the fixed and variable methods.

Outcome Measure	Fixed			Variable		
	r	p	n	r	p	n
Academic achievement.	-.1010	.681	19	.0674	.778	20
Direct observation	-.0199	.944	15	.3908	.048*	26
Parent behavior ratings				-.0804	.736	20
Social interaction				-.0126	.964	15
Standardized assessment				.8136	.000*	19
Teacher behavior ratings	-.0029	.991	17	-.0618	.764	26
Global average	.0717	.757	21	.0338	.804	56

Note: Empty cells indicate less than 15 occurrences. Asterisk indicates significant coefficients at the .05 level (2-tailed).

Research Question 14

What is the relationship between the age of the subjects and their response to medication as measured by the ten outcome categories? This research question leads to the null hypothesis that there will be no linear relationship between the age of the subjects and their response to medication. To test this hypothesis a Pearson correlation was computed for age and the ten

Table 7

Correlation Coefficients between IQ of the subjects and the ten outcome measures, as well as the probabilities and the number of observations.

Outcome Measure	r	p	n
Academic achievement.	-.6399	.001*	24
Direct observation	-.3804	.098	20
Standardized assessment	.4169	.096	17
Teacher behavior ratings	-.2278	.308	44
Global average	.0764	.610	47

Note: Asterisk denotes statistical significance at the .05 level (2-tailed).

outcome measures. Table 8 reports the correlation coefficients, probabilities and number of observations for each of the ten measures for age. Two significant outcome correlations were obtained for the variable of the mean age of the subjects, academic achievement and global average. Academic achievement obtained a correlation of r= -.3399, p= .034, which means that the younger the child, the better he/she responded to medication, as measured by academic achievement. global average obtained a correlation of r= -.2851, p=.015, which means that the younger the child, the better he/she responded to medication, as measured by the average of all measures.

Table 8

Correlation Coefficients between age of the subjects and the ten outcome measures, as well as the probabilities and the number of observations.

Outcome Measure	r	p	n
Academic achievement.	-.3399	.034*	39
Direct observation	-.2681	.109	37
Parent behavior ratings	-.226	.285	25
Social interaction	-.3107	.225	17
Standardized assessment	-.2208	.289	25
Teacher behavior ratings	-.3042	.076	35
Global average	-.2851	.015*	72

Note: Asterisk denotes statistical significance at the .05 level (2-tailed).

Research Question 15

What is the relationship between the level of rigor which the studies used to select subjects and the ten outcome categories? This research question leads to the null hypothesis that there will be no relationship between the number of levels of diagnostic inclusion and the effectiveness of medication. To test this hypothesis, Pearson correlations were computed for the number of levels of inclusion (diagnostic rigor) and each of the ten outcome measures. There were four correlation coefficients which reached significance, with three being negatively correlated and one positively correlated. The results for all ten measures are summarized in Table 9. Parent behavior ratings obtained a correlation of $r=-.4698$, $p= .010$, which means that those studies

which used more rigor in their diagnostic procedures reported smaller effect sizes. Standardized achievement obtained a correlation of r= -.4166, p= .022, which means that those studies which used more rigor in their diagnostic procedures reported smaller effect sizes on the outcome measure of standardized assessments. Teacher behavior ratings obtained a correlation of r= -.3508, p= .020, which means that those studies which used more rigor in their diagnostic procedures reported smaller effect sizes on the outcome measure of teacher behavior ratings. Social interaction obtained a correlation of r= .5592, p= .013, which means that those studies which used more rigor in their diagnostic procedures reported greater effect sizes on the outcome measure of social interaction.

Research Question 16

What is the relationship between the number of subjects in the studies and the ten outcome categories for all medications? This research question leads to the null hypothesis that there will be no relationship between the number of subjects and the effectiveness of medication. To test this hypothesis, Pearson correlations were computed for the ten outcome measures and the number of subjects in the studies. The results of the correlations are summarized in Table 10. The only significant correlation coefficient obtained for sample size was on the outcome measure of direct observation. Direct observation obtained a correlation of r= -.3317, p= .034, which means that the smaller the sample size of a study, the larger the effect size which was obtained.

Table 9

Correlation Coefficients between level of rigor in selecting subjects and the ten outcome measures, as well as the probabilities and the number of observations.

Outcome Measure	r	p	n
Academic achievement.	.1347	.414	39
Direct observation	-.0452	.785	39
Parent behavior ratings	-.4698	.010*	29
Social interaction	.5592	.013*	19
Standardized assessment	-.4166	.022*	30
Teacher behavior ratings	-.3508	.020*	44
Global average	-.2131	.063	77

Note: Asterisk denotes statistical significance at the .05 level (2-tailed).

Research Question 17

What is the relationship between the number of weeks exposed to treatment and the global improvements?. This research question leads to the null hypothesis that there will be no relationship between the number of weeks of exposure to treatment and the effectiveness of medication. This hypothesis was tested by performing Pearson correlations for each of the ten outcome measures and the number of weeks the subjects were exposed to treatment. Results of the correlational analyses are presented in Table 11. Parent behavior ratings and teacher behavior ratings were the only two

Table 10

Correlation Coefficients between the number of subjects and the ten outcome measures, as well as the probabilities and the number of observations.

Outcome Measure	r	p	n
Academic achievement.	-.1711	.285	41
Direct observation	-.3317	.034*	41
Parent behavior ratings	-.1509	.435	29
Social interaction	-.3161	.187	19
Standardized assessment	-.2956	.106	31
Teacher behavior ratings	-.2274	.138	41
Global average	-.1940	.083	80

Note: Asterisk denotes statistical significance at the .05 level (2-tailed).

which achieved significance and both were negatively correlated. Parent behavior ratings obtained a correlation of r= -.3749, p=.049, and teacher behavior ratings obtained a correlation of r= -.3409, p= .031. This means that for both behavior ratings the longer the subjects were exposed to treatment, the smaller the effect sizes were likely to be.

Research Question 18

Are there any differences between the different types of stimulant medication, as measured by the average of the nine outcome categories? This research question leads to the null hypothesis that there will be no differences between the four types of stimulant medication in their effectiveness. Due to the severe inequality in the number of studies using the

four types of medication, inferential statistical analysis could not be conducted. Table 12 summarizes the effect sizes of each of the four types of stimulant medication. The global average effect size for the studies using MPH is .58 which according to Cohen is in the medium category. This means that a subject at the 50th percentile in the placebo treatment group was moved to the 72nd percentile when given MPH. The global average effect size for the studies using Dexedrine is .44 which according to Cohen is in the small category. This means that a subject in the placebo group at the 50th percentile was moved to the 67th percentile when placed on Dexedrine. The global average effect size for the studies using MPH-SR is .97 which according to Cohen is in the large category. This means that a subject in the placebo group at the 50th percentile was moved to the 83rd percentile when placed on MPH-SR. The global effect size for the studies using Pemoline is .52 which according to Cohen is in the medium range. This means that a subject in the placebo group at the 50th percentile was moved to the 70th percentile when placed on Pemoline.

Table 11

Correlation Coefficients between the number of weeks the subjects were exposed to treatment and the ten outcome measures, as well as the probabilities and the number of observations.

Outcome Measure	r	p	n
Academic achievement.	-.1475	.384	37
Direct observation	-.2409	.134	40
Parent behavior ratings	-.3749	.049	28
Social interaction	-.1412	.600	16
Standardized assessment	.2645	.201	25
Teacher behavior ratings	-.3409	.031	40
Global average	-.0796	.525	66

Note: Asterisk denotes statistical significance at the .05 level (2-tailed).

Table 12

Mean effect sizes and number of observations broken down by the type of stimulant medication used in the study for each outcome category.

Category Measures	MPH		Dexedrine		MPH-SR		Pemoline	
	Δ	n	Δ	n	Δ	n	Δ	n
Academic achievement.	.51	36	.39	2	.34	2	.32	1
Direct observation	.70	38	.54	1	.41	1	.46	1
Misc. Behavior Rat	.52	6		0		0		0
Parent behavior ratings	.52	24		0	1.65	2		0
Self esteem rating	.40	5		0		0		0
Self rating	.32	8		0		0		0
Social interaction	.43	16	54	1	.68	1	.89	1
Standardized assessment	.48	24	.39	1	1.70	2		0
Teacher behavior ratings	.89	33	.41	1	.95	3	.39	1
Global average	.58	68	.44	2	.97	4	.52	1

CHAPTER FIVE

Discussion

Treatment Issues

Dependent Measures

It has been previously discussed in this study that ADHD children lack insight into their own behavior and don't seem to be good judges about how their behavior is impacting those around them. The two category outcomes which involve internal processes and self-awareness include the self-rating and self-esteem sub-categories. The average effect size for these two categories is .36. These measures are the two lowest effect sizes obtained in this analysis, which seems to support the idea that the children have a deficit of self-awareness and may be under estimating the improvement they experience after taking medication.

There are three outcome measures which involve behavior ratings by observers of the child's behavior, parent behavior ratings, teacher behavior ratings and miscellaneous behavior ratings. These three behavior ratings include people who interact closely and consistently with the child and usually have an in-depth understanding of the child's behavior. The average effect size for the three behavior ratings is .80. Contrast this effect size with the self-awareness effect size previously discussed, and there is substantial difference between the two ratings. Teacher's rated the children more improved after medication than any other outcome sub-category. Typically the medication is taken during the school hours; therefore, it is not surprising that teachers would see the greatest improvement. Furthermore, the demands place upon the ADHD child by school are the type which place the greatest strain on their attention, motivation and behavioral inhibition. Since

the unmedicated child is likely to have the greatest difficulty at school, it is predictable that upon being placed on medication, the child would show the greatest improvement at school. Intuitively, it also seems that teachers are more objective than parents in rating the child's behavior because they usually have more emotional distance and are less likely to get into a conflict loop with the ADHD child. Teachers also have the benefit of comparing the ADHD child with many other children of the same age in order to make more accurate behavioral judgments.

The parent behavior ratings may be affected by many factors including those discussed in the previous paragraph. An important aspect of the typical medication strategy is to give the child medicine only during the time when he/she is at school and consequently many times the medication has worn off when the child is at home. The parents do not rate the benefits of medication as positively as teachers because the medication has worn off and in fact the child may be suffering from the rebound effects of not being under the influence of the medication. Another important factor in the smaller parent behavior rating effect sizes is due to the complex psychosocial relationships in the family. The conflict between parent and child is not only influenced by the child's disorder but also by the family stressors, parental psychopathology and there is frequently secondary gain which will work to prevent the child from changing his/her behavior at home. The fact that the medication improves the parent ratings in spite of all of these negative factors is remarkable.

The 80 treatment conditions which are reported in this study are composed of 75 stimulants and five antidepressants. This inequality is indicative of the inequality of both the ADHD research and clinical use. The 75

stimulant treatment outcomes were also not equally distributed among the four types of medication, with 68 out of the 75 using MPH. The extreme difference in the number of studies for both of these categories precluded the inferential statistical analysis; therefore, it is more useful to discuss the meaning of the different effect sizes in a qualitative way. The global effect size for stimulants was .60 and for antidepressants it was 1.91. Even though antidepressants were utilized in only four sub-categories out of nine, the global average effect size obtained was more than three times that obtained for stimulants. In spite of the small sample size, this finding is significant and an attempt should be made to understand these striking results. Another way to look at the difference between the treatment of stimulants and antidepressants is that a subject at the 50th percentile in the stimulant group would be moved to the 90th percentile when placed on antidepressant medication. Since there are only a few studies which used antidepressants, caution should be used in forming any firm conclusions. This finding should serve to increase the future research in the area of antidepressants in order to verify whether these results can be replicated.

A partial explanation for the difference in the effectiveness between stimulants and antidepressants can be understood in the divergent ways the two medications work. Stimulants are activated in the body within minutes of consumption and are metabolized from the body within four hours. There is no need to gradually build up dosage levels and in fact, there is no buildup in the body at all. Stimulants are effective only within four hours of their administration, while most antidepressants conversely take approximately 30 days to stabilize their therapeutic levels, and once obtained they are active in the body 24 hours per day. When a child takes antidepressants, he/she is

receiving benefit in all types of settings, rather than only at school, as is the case with stimulants.

An additional factor which may contribute to the increased effectiveness of antidepressants is that many of the ADHD children are experiencing depression (Breen & Barkley, 1983; Barkley, 1992b; Gottschalk, Swanson, Hoigaard-Martin, Gilbert & Fiore, 1984; Barkley, DuPaul & Murray, 1990). The antidepressant medication may be treating the symptoms of depression, as well as the symptoms for ADHD, and when the depression is lifted, the child's behavior improves in two ways. Part of the symptoms for depression overlap with ADHD such as restlessness, concentration problems, emotional lability, sleep disturbance and psycho-motor agitation. An area which needs more study to tease out the medication effects and the individual affective problems is to control for the effects of antidepressants versus stimulants for those children who suffer from depression or dysthymia.

The different way that stimulants and antidepressants work in the body accounts in part for the disparity in the published research for each of the medications. Stimulants are much more time efficient because of the immediate action; studies using stimulants can be completed in about one-fourth the time it takes for antidepressants. Because antidepressants take 30 days to stabilize, it will take several months to complete a study with more than one dosage level. Many of the studies using stimulants are completed with a single dosage level in one day, which makes research using stimulants far more cost effective in time and money. Additionally, when studies need more time to titrate the dosage until the most effective dosage is determined, this can prolong the studies using antidepressants even further. With increased pressure on scientists to maximize their results in order to justify their

research money, the likelihood is for continued emphasis on stimulant medications.

When One-Way ANOVA's were run for dosage level, there were two outcome measures which were significantly different. Standardized assessment $F(2,25) = 3.76$, $p = .0375$ and global average $F(2,71) = 5.5379$, $p = .0058$ were the two outcome measures which had significant differences between the dosage levels. Post hoc comparisons found for both sub-categories that group differences were between the low and high dosage level. Standardized assessment was barely significant but as previously discussed all of the effect sizes are conservative; therefore, it was deemed unnecessary to alter the alpha values to correct for the ten One-Way ANOVAs. The global average due in part to the higher number of observations, showed robust differences. The analysis comparing group differences provides strong support that higher doses lead to greater improvement globally.

In order to get more sensitivity in measuring the relationship between effect sizes and actual dosages, Pearson correlations were computed for the medication dose and the ten outcome measures. It was necessary to separate the two methods of dose titration because of the lack of conformity in the two systems. Three of the outcome measures (parent behavior ratings, social interactions standardized assessment) for fixed method had meaningful correlations but because of the small number of occurrences, they lacked sufficient power to reach statistical significance. The variable method of dose titration resulted in two significant outcome measures, direct observation $r = .3908$, $p = .048$ and standardized assessment $r = ..8136$, $p = .000$. The positive correlations indicate that the higher the dose, the greater the effect sizes in the two categories. The actual dose of MPH account for 66% of the variance in

the outcome measure of standardized assessment. It is amazingly high for a single variable to explain that much variation in another variable. The results are especially meaningful because the type of instruments which make up this category have excellent reliability and validity in measuring the symptoms of ADHD. An effort should be made to find the lowest dose which is effective but there is consistent evidence which supports more effective change at the higher doses.

There were several problems encountered in trying to place the data for dose level into a meaningful organization. Some of the doses were administered one time per day, most commonly two times per day and some even three times per day. It was difficult to decide whether to categorize the dosage levels based upon total per day rates or per each administration. Additionally, when dosage rates were computed by the variable method of mg/kg, most of the studies had ceilings for maximum dosage rates so that the ratio did not hold true for the larger subjects. Some of the studies used different rates for each subject and other studies gradually altered the rate of dosage based upon effectiveness or gradually increased the dosage levels until a certain level was reached. All of these factors made it hard to place the individual dosage levels across studies into any type of meaningful categories that follow a consistent strategy.

There is a common belief that ADHD children with low IQs do not benefit in school from taking medication; however, there has been little research to actually confirm or deny this belief. A compelling finding in this study is the negative correlation $r = -.6399$, $p = .001$ for the sub-categories of academic achievement with IQ. The negative correlation indicates that the lower the IQ of the subjects, the more improvement academically they are likely to

experience. This is just the opposite of what would be expected based upon the literature. It may be the result of a ceiling effect for the subjects with higher IQs, in that they don't have as much room for improvement because they are at a higher level already. In effect, it may be "regression to the mean" working on the scores which pulls the high IQ subjects down and the low IQ subjects up. There is a question as to whether an accurate IQ score can be obtained from a child with ADHD because not only does ADHD impair past learning, but it also impairs the test performance to some extent. There are some subtests on all IQ tests which measure past learning and other subtests which are sensitive to attention and concentration. The deficits which ADHD children commonly experience will place them at a disadvantage on those tasks which sample previous learning or attention and make IQ scores for ADHD children subject to much greater variability.

Another factor which might partially explain the negative correlation between IQ and academic achievement is to analyze the three studies that yielded six treatment conditions which specifically tested mentally retarded ADHD children (Aman, Kern, McGhee & Arnold, 1993; Handen, Breaux, Gosling, Ploof & Feldman, 1990; Handen, Breaux, Gosling, Ploof & Feldman, 1992). The mean IQ for the subjects in the three studies were 65, 65 and 61, which are significantly below the other studies included in this analysis. Sixty four percent of the treatment conditions involved subjects with an IQ between 95 and 105. If the three studies which measured mentally retarded children were deleted, then the mean IQ of the subjects moves from 98 to 104. The three studies which used mentally retarded children found significant effects for medication and especially for academic achievement outcomes. It is interesting to note that 42% of the treatment conditions did not report IQ

scores which would seem to be an important variable to control in any research involving ADHD children.

Contrasting the negative correlation for academic achievement, the parent behavior ratings had an equally strong correlation but it was positive r = .6635, p = .01. The ADHD children with higher IQs were more likely to be rated with greater improvement from taking medication by their parents. The studies which involved mentally retarded children had only one treatment condition which involved parent behavior ratings; therefore, the impact of those studies was minimal. It is possible that the children with higher IQs were able to make better use of the medication to conform their behavior at home in order to meet parental expectations. At any rate, 44% of the variance in parent behavior ratings is accounted for by IQ, which is considered a very meaningful association.

How the age of the ADHD subjects affects their response to medication is an interesting question. The literature and clinical experience predict that children would have a more favorable response to medication than adolescents. This study supports that belief because nine out of the ten outcome measures had negative correlations with age. Several of the outcome measures did not achieve significance because of insufficient power; however, two of the outcome measures did achieve statistical significance, academic achievement and global average. Twelve percent of the variance in academic achievement and eight percent in global average is explained by the age of the subjects. It is likely that younger children respond to medication in general, more favorably because as the child gets older and develops habitual but ineffective learning strategies, the academic problems become less caused by neurological deficits and more due to other factors. It seems critical to

identify ADHD children as soon as possible and give medication a chance, so that academic discouragement does not become a pattern which if untreated, is difficult to alter.

Analyzing the relationship between the number of weeks which the subjects were exposed to treatment and the effectiveness of medication was thought to be meaningful. It resulted in only one mildly significant correlation coefficient which was negative. Because stimulant medication is so fast acting and does not accumulate in the body, it probably is not important how long the treatment is administered. It is interesting that nine out of the ten outcome measures were negative, which indicates that the shorter treatments resulted in bigger effect sizes. Another phenomena is that antidepressants tend to involve longer treatment schedules and since antidepressants had higher effect sizes, it seems even more likely that treatment outcomes for stimulants are inversely related to the time the subjects are exposed to treatment. The most plausible explanation for the negative relationship between time and effect size is that the closer in time the placebo and medication treatments occur, the sharper the contrast, and therefore the higher the effect sizes. When the exposure to medication is longer then perhaps there is a tendency to forget how much improved the behavior really is, because in essence the raters may become desensitized.

As previously discussed, the use of stimulants has been heavily slanted toward MPH in the literature and it was born out by this meta-analysis. Because of the inequality in the number of studies which used dexedrine, pemoline and sustained release MPH, it is not possible to make meaningful statistical comparisons. However, comparing MPH and MPH-SR for the ten categories provides some interesting patterns which merit discussion. Caution

should be exercised since there were only 4 treatment conditions that used MPH-SR, as compared to 68 which used MPH. The sustained release formulation of MPH is suppose to maintain its effectiveness for eight hours, compared to four hours for the regular formulation.

The teacher behavior ratings for the two forms of MPH did not differ with MPH obtaining an effect size of .89 and MPH-SR obtaining an effect size of .95. However, there were several other outcome measures which resulted in meaningful differences, all of them in favor of MPH-SR. Parent behavior ratings effect size for MPH was .52 and for MPH-SR it was 1.65, which is more than three times greater. As was previously discussed, when children receive MPH at school, many times they don't receive any benefit when they go home because the medication is already out of their system. Apparently, the MPH-SR is providing significantly more symptom relief at home than is the MPH because the parents are seeing symptom improvement in a totally different way than the teachers do.

The global average for MPH was .58, compared to .97 for MPH-SR , which is nearly double the effect size. Standardized assessments yielded an even larger disparity between the two formulations with the sustained release obtaining slightly over three and one half times the effect size of the standard formulation of MPH. This is both impressive and puzzling because the standardized assessment instruments are time limited and is would seem that no benefit would be received by the sustained release form but there appears to be a significant benefit in the way the MPH-SR is released in the body.

Methodological Issues

The present meta-analytic study indicates that medication is more effective than placebo in the treatment of ADHD children and adolescents. In all nine of the outcome sub-categories there were positive effect sizes ranging from .32 to 1.02, with an average effect size for all nine sub-categories of .67. All of the studies used in this meta-analysis involved subjects serving as their own control by taking both the placebo and medication treatments. The procedure for determining effect sizes which is typically used in meta-analysis assumes that there is no correlation between the dependent measures or between the placebo and medication treatments. Since the studies used in this meta-analysis were repeated measures, there is a significant amount of unmeasured correlation. With the use of placebo and medication treatments by the same subjects, it can be assumed that all variance between the two measures is due to treatment effects. The use of highly correlated scores results in underestimating the effects of treatment but there is not sufficient information to determine the exact degree of the underestimation. In order to make the correct adjustments to the effect sizes obtained in this study it would be necessary to know the correlations between the subjects placebo and medication scores for each of the studies. Any conclusions which are drawn from this study should be influenced by the fact that the effect sizes are highly conservative and in all likelihood are actually higher than those stated.

There are many excellent measures which are sensitive to the positive effects of medication and have very good reliability and validity. A trend was noticed in compiling the studies used in this meta-analysis that many of the

studies used newly designed or not widely distributed instruments for dependent measures. Typically, the standard instruments were used in the diagnosis of ADHD subjects but a different set of instruments was used to measure the effectiveness of medication. It is likely that at least some of the instruments used to determine the effect sizes in this study lack sufficient validity to measure the symptoms associated with ADHD. Part of the reason for the use of unique instruments is that many of the studies were interested in very specific aspects of ADHD symptoms and no standardized instruments are available to measure the specialized behavior. The use of newer and less validated instruments probably altered the obtained effect sizes for all medication treatments.

One major advantage of conducting meta-analysis is to look critically at the methodological issues and in particular methodological weaknesses within a body of research. As one tries to collect data from the various studies it becomes clear when there are weaknesses in the design or data reporting and it allows future scientists to remedy the weaknesses. What information is reported, how it is collected and coded are all issues in which the experimenter becomes much more sensitized by doing meta-analysis. Flaws in the literature become abundantly clear as one collects data from multiple studies and tries to make some sense of it.

The care and accuracy in which subjects are chosen to participate in an experiment is a critically important factor and if not properly done, can be a source of experimental bias. It is fundamental when conducting research on a sample of subjects with a specified disorder, that the subjects are accurately diagnosed for inclusion. The number of inclusion levels is a way to quantify the rigor in which each study controlled the purity of its subject sample.

Theoretically the more rigorous the selection procedures, the more accurate the selection process and the higher the effect sizes obtained. Of the four significant correlation coefficients obtained, three were negative and one was positive. Parent and teacher behavior ratings obtained correlation coefficients of -.47 and -.35 respectively, while standardized assessment obtained a correlation coefficient of -.42. Even though they are significant, they are not large coefficients and the rigor of subject selection explains approximately 17% of the variance in each of the three outcome measures. The significant results could be due to chance but if it is due to experimenter bias it is likely to be influenced by chance within each study. When subject selection is influenced by chance occurrences, then experimental results are likely to fluctuate and achieve spurious and inconsistent results.

When the search for relevant articles was begun by computer, the abstracts listed during the years from 1989 to 1994 numbered 445. After screening and careful analysis of the articles, only 41 were left which met the criteria of this meta-analysis. Many of the articles involved theoretical issues, case studies or opinions about ADHD but not true empirical research. There were 27 studies which did not report means and standard deviations and 15 had no placebo treatment but rather did a pre and post medication measurement. Perhaps the reason why so few empirical studies are being published which tests the effectiveness of medication is that so much previous research has been conducted that the scientific community believes that there is no need to prove over and over again that medication is effective.

A compelling trend which was noticed but is outside the parameters of this study was the powerful effect that the placebo treatment had on all measures. It is likely that if the placebo effect had not been so strong, the

effect sizes for medication would have been even larger. Most of the behavior rating scales are scored such that a high score represents problem behavior so that when the placebo treatment lowered a particular factor score to half what it was prior to treatment, then it limited the amount of improvement which the medication could have. It limited the potential variability for the medication treatment and limited the effect size potential.

Another factor which influenced the results of this study was the extreme variability in the placebo treatment. There were times when the standard deviation was significantly higher than the mean for the placebo and so even when the difference between the means for placebo and medication treatments were very large, the effect size that resulted was quite low.

Limitations

An attempt was made in this study to find a way to categorize all of the outcome measures into a consistent and meaningful system which made intuitive sense and could be replicated by others. Realistically, the labeling of outcome measures into categories in this study represent the work of one individual and it is likely that if others attempted to perform the same work there would be some differences in the way that outcome measures would be labeled. It is a beginning but certainly not an end in the meta-analytic study of ADHD children.

The dependent measures which were studies in these analyses were restricted to the dependent measures selected by the authors of the articles used. This has inherent limitations and generalizability should be carefully approached regarding behaviors in ADHD children which were not used in this meta-analysis. Furthermore, it is important to note that all of the

dependent measures are short-term in nature. All of the authors used dependent measures which could be measured within weeks of beginning the treatment and so long-term measures are not represented in any of the studies. No conclusions can be drawn about the long-term efficacy of medication based upon this study.

The decision as to whether to place a child on medication for ADHD is a complex and individual matter. This study only investigated the positive effects of medication and does not pretend to present all sides equally in the question as to whether to place a child on medication. Any time a child is placed on medication it should be done cautiously and judiciously. Other treatments which are less invasive should be tried first or at least simultaneously with medication.

Another limitation of this study is that no adults were included in this analyses. All of the subjects used in this study were under the age of 18 and no conclusions can be drawn from this study regarding the effectiveness of any type of medication for adults with ADHD. There are few studies to date which investigate the efficacy of placing ADHD adults on medication and so it is unlikely that a meta-analysis of this type could even be conducted.

Future Research

Of the 41 studies utilized in this meta-analysis none reported depression and only seven reported dysthymia among the subjects under study. Some of the literature has found the incidence of either depression or dysthymia among ADHD children to be much higher than in the normal population (Barkley, 1990). The lack of reporting of depression in the studies seems to indicate that there was a significant variable which was not controlled and it is likely that it impacted the way in which children responded to medication.

Future research should do a more effective job of controlling comorbid disorders and in particular depression and dysthymia. Comparisons between stimulants and antidepressants for children who suffer from depression should be performed to get a better understanding of the relationship between depression and the different types of medication.

Summary

In doing a meta-analytic study of the effectiveness of medication with ADHD children, it was hoped that it would provide a baseline so that other types treatments could be compared to medication. Furthermore, it seems that combinations of treatments may hold the greatest hope so that different treatments can be matched with the desire to change the different outcome measures. Some children may experience differing levels of disturbance in each of the nine outcome measures which were used in this study. It was learned from this study that not all of the outcome measures were improved equally from medication. Perhaps other types of treatment would specifically be more effective in those areas where medication is not so effective. Even within the use of medication for treatment of ADHD, there is sparse literature on any medication except MPH. There were several findings which merit a closer investigation for the use of MPH-SR and antidepressants. Hopefully, this work can be continued by others so that the questions raised in this study can be answered.

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Note: Asterisk indicates the studies used in the meta-analysis

APPENDIX A

RECORDING FORM

PUBLICATION ID #_____ SAMPLE SIZE _____

PUBLICATION YEAR _____ WEEKS OF TREATMENT _____

OF DIAGNOSTIC PROCEDURES._____ IQ OF TREATMENT SUBJECTS _____

MEAN AGE OF TREATMENT SUBJECTS _____ GENDER OF SUBJECTS _____MALE

COMORBID DISORDERS _____ _____ _____ _____FEMALE

TYPE OF TREATMENT

MEDICATION TYPE _____ DOSAGE_____

DOMAIN OF DEPENDENT VARIABLE & EFFECT SIZE

CATEGORY OF MEASUREMENT	TYPE OF MEASURE	$\bar{x}$ OF PLAC	S.D. OF PLAC	$\bar{x}$ OF TREAT	EFFECT SIZE
PARENT	CONDUCT				
	INATTENTION				
	IMPULSIVE				
	HYPERACTIVITY				
	HYP. INDEX				
	SHORT CONNERS				
	BARKLEY HSQ # OF SETTINGS				
	BARKLEY HSQ X SEVERITY				
	ACTRS				

CATEGORY OF MEASUREMENT	TYPE OF MEASURE	$\bar{x}$ OF PLAC	S.D. OF PLAC	$\bar{x}$ OF TREAT	EFFECT SIZE
	ADHD RATING				
	OTHER				
TEACHER	CONDUCT				
	INATTENTION				
	IMPULSIVE				
	HYPERACTIVITY				
	INATT-OVERACT				
	AGGRESSION				
	SHORT CONNERS				
	BARKLEY SSQ # OF SETTINGS				
	BARKLEY SSQ MEAN SEVERITY				
	ACTRS				
	ADHD RATING				
	OTHER				
ACADEMIC					

CATEGORY OF MEASUREMENT	TYPE OF MEASURE	$\bar{x}$ OF PLAC	S.D. OF PLAC	$\bar{x}$ OF TREAT	EFFECT SIZE
STAND.	CPT OMMISIONS				
ASSESSMENT	CPT COMMISIONS				
	CPT # CORRECT				
	STROOP REAC TIME WORDS				
	STROOP REAC TIME COLORS				
	STROOP REAC TIME WORDS-COLORS				
	MFFT-20 TIME				
	MFFT-20 # OF ERRORS				
	WCST				
	OTHER				
DIRECT OBSER	ON/OFF TASK				
	IN/OUT SEAT				
	FIDGETING				

CATEGORY OF MEASUREMENT	TYPE OF MEASURE	$\bar{x}$ OF PLAC	S.D. OF PLAC	$\bar{x}$ OF TREAT	EFFECT SIZE
	VOCALIZING				
	TOTAL BEHAVIOR RATING				
	% OF DISRUPTIVE BEHAVIOR				
SOC. INTERACTION					
SELF RATING					
SELF ESTEEM					
MISC	BEHAVIOR RATINGS				

Appendix B

Average effect sizes for each study and treatment condition broken down for each outcome measure.

Study Name	Parent	Teacher	Misc Beh Obs	Acad Ass	Stand Ass	Direct Observ	Social Interact	Self Rating	Self Esteem	Total Ave
Tannock et al. (1989)				.29		.67				.48
"				.31		1.15				.73
DuPaul et al. (1994)	.36	.46		.23	.1	.41				.31
"	.77	.59		.47	.39	.59				.56
"	.72	.5		.39	.46	.81				.58
Klorman et al. (1994)	1.1	1.74								1.42
"	.91	1.12								1.01
(1993)		.65		.91		.75				.77
"		1.32		1.32		1.29				1.31
"		1.5		1.29		1.3				1.36
"		1.72		1.31		1.48				1.5
Malone et al. (1989)					.4					.4
Feldman et al. (1989)		.63			.27					.45
Gualtieri et al. (1991)		3.06			.81					1.93
"		4.51			1.42					2.96
"		2.64			2.57					2.61
Millich et al. (1991)					.22					.22
Hinshaw et al. (1989)					..4					.4
Whalen et al. (1989)							.14			.14
Tirosh et al. (1993)	.68	1.57			1.54					1.26
Casat et al. (1989)	.79	.84	.63		.29					.64
Kaplan et al. (1990)		.95	.77							.86
Gadow et al. (1990)	.87	.55				.55				.66
"	.41	.84				.74				.66
Rapport et al. (1989)		.63		.51		.39				.51
Rapport et al.		1.16		1.05		.84				1.02
Rapport et al.		1.34		1.00		.81				1.05
Rapport et al.		1.46		1.21		1.06				1.24
Balthazor et al. (1991)				.17	.07					.12

Hinshaw et al. (1989)			.33							.33
"			.5							.5
Brown et al. (1991)	.15			.3	.35					.27
"	.08			.16	.32					.19
"	.38			.15	.16					.23
Aman et al. (1993)	.29	.59								.44
"	.4	.4								.4
Pelham et al. (1990)		.34		.25		.47	.31			.34
"		.34		.29		.41	.68			.43
"		.39		.32		.46	.89			.52
"		.41		.30		.54	.54			.45
Whalen et al. (1990)						.3	.27			.28
Evans et al. (1991)		.32		.57		.46				.45
"		.33		.56		.78				.56
Buhrmester et al. (1992)							.36			.36
Handen et al. (1990)		1.65		.26	.53	.89	.4		.38	.68
"		2.09		1.05	.67	1.29	.6		.63	1.06
Fischer et al. (1991)	.33	.38		.15	.15	.26				.26
"	.42	.56		.22	.2	..34				.68
Pelham et al. (1992)								.34	.44	.39
"								.39	.49	.44
Pelham et al (1992)								.19	.07	.13
Milich et al. (1989)								.18		.18
Sverd et al. (1992)	.47					.7	.94			.7
"	.12					.72	.83			.56
"	.48					.85	1.22			.85
Pliszka et al. (1989)	.75									.75
"	.82									.82
Pelham et al. (1990)						.76				.76
"						.87				.87
Carlson et al. (1992)				.41		.58		.44		.48
"				.40		.81		.35		.52
Carlson et al. (1991)					.77					.77
Handen et al. (1992)		.99		.67	.38	.57	.22			.57
"		1.31		.78	.31	.64	.28			.66

Pelham et al. (1991)		.63	.63	.31		.52	.27			.48
"		.40	.48	.35		.46	.05			.35
Elia et al. (1993)				.41	.46					.44
"				.48	.39					.44
Forness et al. (1991)				.12						.12
"				.07						.07
"				.17						.17
Forness et al. (1992)				.4						.4
Hicks et al. (1989).	.64				.43	.39				.49
"	.76				.52	.32				.53
Fitzpatrick et al. (1992)	1.53	.68			1.04					1.08
"	1.48	.61			1.55					1.22
"	1.82	1.88			1.85					1.85
Ialongo et al. (1994)	-.67	-.12			.63		.24			.15
"	.03	.41			1.07		.47			.43
Biederman et al. (1989)	1.37	.55								1.39

VITA

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