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ABSTRACT

This paper presents an updated review of the empirical literature which examines multimodal forms of treatment for Attention Deficit Hyperactivity Disorder (ADHD). Multimodal treatment typically involves some combination of psychostimulant medication, behavior modification, and cognitive training. Results of studies were grouped into three categories: medication plus behavior modification, medication plus cognitive training, and other treatment combinations. Studies most often used clinical outpatient populations, and interventions were implemented by clinicians, parents, and/or teachers. Findings indicate that: (1) for many children, stimulant medication, along or in combination with behavior modification and/or cognitive training, appears to improve behavior at home and school and contribute to improvements in academic achievement; (2) behavior modification appears to be effective in improving children's behavior in the specific situations where it is utilized, but when combined with stimulant medication does not appear to add additional benefit beyond that offered by the medication; (3) cognitive training does not appear to significantly improve the behavior of ADHD children; and (4) for some children, combining a low does of stimulant medication with a behavior modification intervention appears to facilitate the same level of behavior improvement as a high does of stimulant medication alone. (Contains 38 references.) (CR)

MULTIMODAL TREATMENT OF ATTENTION-DEFICIT HYPERACTIVITY DISORDER: AN UPDATED REVIEW OF THE EMPIRICAL LITERATURE

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by

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ABSTRACT

MULTIMODAL TREATMENT OF ATTENTION-DEFICIT HYPERACTIVITY DISORDER: AN UPDATED REVIEW OF THE EMPIRICAL LITERATURE

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This paper presents an updated review of the empirical literature which examines multimodal forms of treatment for Attention-Deficit Hyperactivity Disorder (ADHD). Multimodal treatment of this disorder typically involves some combination of psychostimulant medication, behavior modification, and cognitive training. Data was commonly derived from such instruments as the Child Behavior Checklist, the Home Situations Questionnaire, and the Conners Parent and Teacher Rating Scales. Results of studies were grouped into three categories: medication plus behavior modification, medication plus cognitive training, and other treatment combinations. Studies most often used clinical outpatient populations, and interventions were implemented by clinicians, parents, and/or teachers. Although the research findings are mixed, there appears to be some support for combining these interventions in order to target specific behavioral and academic deficits of children with ADHD. However, the research also suggests that stimulant medication appears to be the most efficacious treatment component in multimodal interventions.

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Introduction

Attention-Deficit Hyperactivity disorder (ADHD) is one of the most common of the childhood mental disorders. Nationwide estimates of prevalence suggest that between 3% and 9% of children in the U.S. are afflicted (American Psychiatric Association, 1987, 1994). Fortunately, ADHD is also one of the most treatable childhood disorders (Barkley, 1990). Several decades of research and clinical practice have been devoted to investigating various psychopharmacological and psychosocial treatment strategies. These interventions have demonstrated varying levels of efficacy; each treatment modality appears to show short-term strengths as well as long-term limitations (Barkley, 1990).

In the past, treatments for ADHD usually have fit into one of three circumscribed categories: psychopharmacological interventions, behavior modification interventions, and cognitive training interventions (Richters, et al., 1995). Although specific treatment regimens demonstrated a great deal of variability, most could be classified under the broad rubric of one of these

three modalities. Recently however, clinical treatment and research has taken a new direction, that of multimodal forms of intervention. Various combinations and permutations of the three basic forms of treatment have been implemented, as creative researchers attempt to move beyond convention to discover the most efficacious methods of treatment.

Published reviews of the research investigating multimodal treatments for ADHD have focused on two specific treatment combinations. Pelham and Murphy (1986) examined studies which combined stimulant medication with behavioral interventions, whereas Abikoff (1985), in his review of cognitive interventions for ADHD, reported on studies which combined stimulant medication and cognitive therapy. However, no comprehensive review of the research into multimodal treatment appears to have been published during the past decade.

This paper will acquaint the reader with the diagnostic features of ADHD, briefly examine the methods used in the three most common treatment modalities, review the recent research on multimodal forms of intervention, and describe some of the methodological problems inherent in comparing and contrasting treatments. Finally, the ongoing multisite, multimodal treatment study of ADHD by the National Institute of Mental Health will be discussed.

Description of the Disorder

The Diagnostic and Statistical Manual of Mental Disorders (fourth ed.; American Psychiatric Association [APA], 1994; DSM-IV) defines Attention-Deficit Hyperactivity Disorder as "a persistent pattern of inattention and/or hyperactivity-impulsivity that is more frequent and severe than is typically observed in individuals at a comparable level of development" (APA, 1994, p. 78). The disorder is usually evident at school, at home, and with peers, but may vary in degree. "Inattention" refers to the fact that these individuals are easily distractible, do not appear to listen, and often fail to finish tasks. "Impulsivity" is manifested in such behaviors as acting before thinking, excessive shifting from one activity to another, and difficulty awaiting one's turn in a group situation. "Hyperactivity" may be observed in such behaviors as fidgetiness or squirming in one's seat, excessive running or climbing in inappropriate situations, appearing "on the go" or as if "driven by a motor," or by talking excessively (APA, 1994). The prevalence of ADHD is estimated at 3 to 5% of school-age children in the U.S., and the disorder occurs much more frequently in males than females, with ratios ranging from 4:1 to 9:1, depending on the setting (APA, 1994).

Although ADHD is considered a childhood disorder and is usually diagnosed in the early school years, a large number of children (up to 70%) continue to manifest symptoms in adolescence (Gittelman, Mannuzza, Shenker, & Bonagura, 1985; as cited in Richters et al. 1995). During their

teenage years, these individuals may exhibit poor academic performance and behavior problems at home and school such as temper tantrums, defiance, police contacts, and rejection by their peers (Barkley, 1990). As many as two thirds of hyperactive adolescents may have serious discipline problems at school, resulting in high rates of suspension and expulsion and low levels of self-esteem (Mendelson, Johnson, & Stewart, 1971; Weiss, Minde, Werry, Douglas, & Nemeth, 1971; as cited in Richters et al., 1995).

It is estimated that 50 to 65% of individuals who were diagnosed with ADHD as children continue to exhibit difficulties into their adult years (Barkley, 1990). When compared to matched normal controls, hyperactive adults manifest significantly higher levels of impulsiveness and restlessness, nonmedical drug use, court referrals, incarceration, and personality disorders (Hectman et al., 1979, 1984; Loney, Whaley-Klahn, Kosier, & Conboy, 1983; as cited in Richters et al., 1995).

According to Borland and Heckman (1976; as cited in Richters et. al, 1995), adults who had been seen for hyperactivity at a child guidance clinic 25 years earlier were three to four times more likely than their brothers to report psychological problems such as nervousness, restlessness, depression, lack of friends, and low frustration tolerance. In another follow-up study of a group of adults diagnosed with ADHD as children, Weiss, Hectman, Milron, & Perlman (1985; as cited in Collier, 1989) found that a significant percentage (23%) fit the diagnostic criteria for Antisocial Personality Disorder.

Common Interventions

Pharmacological Treatment

A variety of medications have been used to treat ADHD, including antidepressants, clonidine, and neuroleptics (Barkley, 1990). The most widely prescribed treatment, however, is psychostimulant medication, particularly dextroamphetamine, methylphenidate, and pemoline (Whalen & Henker, 1976; as cited in Abikoff, 1985). Psychostimulants are considered as "first line" psychopharmacology for ADHD, with antidepressants generally considered a second-choice category (Barkley, 1990). Researchers estimate that between 2 and 2 1/2% of all elementary school-age children in North America (about 600,000) receive medication for hyperactivity (Bosco & Robin, 1980; as cited in Richters et al., 1995).

When compared to placebo conditions, stimulant drugs have demonstrated a high level of short-term efficacy in reducing numerous core ADHD symptoms (Abikoff, 1985). These include task irrelevant activities (finger tapping, fidgetiness, fine motor movement, off-task during direct observation) and classroom disturbance (e.g., oversolicitation in class during direct observation). At the same time, stimulants have been shown to increase levels of compliance and sustained attention (Abikoff & Gittelman, 1985; Jacobvitz et al., 1990; Pelham, 1982; as cited in Richters et al., 1995) and to have positive effects on parent-child interactions, problem-solving

activities with peers, and a variety of controlled laboratory and academic tasks (Richters et al., 1995).

Stimulant medications also appear to decrease the aggressive behavior demonstrated by many children with ADHD. Although early research appeared to indicate that stimulants had little effect on aggression (Loney, Prinz, Mishalow, & Joad, 1978; Loney, Kramer, & Milich, 1979; as cited in Loney, 1980), recent studies have proved more promising. At higher dosages, stimulants have been shown to decrease verbal and physical aggression (Hinshaw, Henker, Whalen, Erhardt, & Dunnington, 1989), covert antisocial behaviors like stealing and lying (Hinshaw, 1994), and the level of physical retaliation shown by children in anger-provoking laboratory situations (Hinshaw, Buhrmeister, & Heller, 1989). In fact, during active medication periods, children with ADHD are often indistinguishable from normal children with respect to their level of noncompliant, disruptive, and aggressive behaviors (Hinshaw, 1994).

Unfortunately, the efficacy of stimulant medications in treating ADHD appears to be limited to the short-term. Several studies have failed to demonstrate the long-term effectiveness of stimulant treatment for any domain of child functioning (Abikoff, 1985). This may be partially explained by the fact that most 1-month prescriptions for stimulant medication are not renewed by the parents of children with ADHD (Sherman & Hertzig, 1991; as cited in Richters et al., 1995).

Behavior Modification Treatments

Other than medication, one of the most common treatments for ADHD is some form of behavior modification (Barkley, 1990). These interventions are usually implemented by parents, teachers, or clinicians. Typically, parents or teachers of ADHD children are instructed in the use of contingency management procedures via clinic-based parent training programs or school consultation visits. These treatments usually consist of a variety of behavioral interventions such as observing and charting behavior, using extinction and punishment procedures for inappropriate behaviors, contingency contracting, home-school note systems, and token economies (Barkley, 1990).

Parent training in child behavior modification has been shown to improve both the home and school behavior of hyperactive children (Barkley, 1990), and token economy systems may normalize aggressive and off-task behaviors in the classroom (Gittelman et al., 1980). Behavioral treatments also have been shown to improve academic performance, but only if this is specifically targeted (Keogh & Barkett, 1980; as cited in Dulcan, 1986).

Although behavior modification interventions have been generally successful in treating children with ADHD, this approach is not without its shortcomings. These treatments have shown little generalization across settings or adults (Mash & Dalby, 1979; as cited in Collier, 1989), and, as is the

case with stimulant medication, treatment gains are generally short-lived (Horn et al., 1990).

Cognitive Training Treatments

A variety of treatment procedures which can be described as cognitive training interventions have been used to treat children with ADHD. These include self-instructional training, cognitive modeling, attentional training, self-regulation, cognitive problem-solving, strategy training, social problem-solving and cognitive behavior modification (Abikoff, 1985). The general goal of each of these treatments is to improve the cognitive mediational skills of hyperactive children, who are thought to have significant deficits in this area (Abikoff, 1985).

Cognitive training interventions spring from the early work of Meichenbaum and Goodman (1971; as cited in Collier, 1989) who developed a self-instructional training program which utilized modeling, overt and covert rehearsal, prompts, feedback, and social reinforcement. These interventions have been used extensively in an attempt to improve the behavior, social skills, and academic achievement of children with ADHD (Abikoff, 1985).

Whereas early studies into the efficacy of cognitive training interventions appeared promising, more recent research seems to indicate the treatment has weak and variable effects, and does not appear to significantly improve the behavior or academic skills of hyperactive children

(Abikoff, 1987). During the past decade, many studies have examined whether stimulant medication might facilitate greater treatment gains with cognitive training interventions (e.g., Abikoff et al., 1988; Hall & Kataria, 1992).

Assessment Instruments

A variety of instruments have been used to assess the behavioral, social, and academic problems of children with ADHD. Certain instruments have even been specifically designed to measure ADHD symptoms or the amount of improvement in those symptoms following treatment. A brief description of the most commonly used instruments will be presented here.

The Child Behavior Checklist

The Child Behavior Checklist (or CBCL) was developed by Achenbach and Edelbrock in 1986 (Sattler, 1992). It contains a list of behavioral problems and competencies which are rated by parents or teachers. Separate norms are provided for boys and girls separately in age ranges 4-5, 6-11, and 12-16 years. Child Behavior Profiles are available from the parent form, which consist of factor analytically derived behavior problem scales. Each of the profiles includes factors which are relevant to ADHD. The Teacher Profile reliably distinguishes boys who have been diagnosed by a psychiatrist with ADHD from other clinically referred boys, with ADHD (Inattentive Type) boys scoring higher on the Inattentive scale. Boys diagnosed as ADHD

(Hyperactive type) score higher on the Nervous-Overactive Scale than those diagnosed without hyperactivity (Edelbrock, Costello, & Kessler, 1984; as cited in Dulcan, 1986). According to Barkley (1990) the Child Behavior Checklist is well standardized and has a test-retest reliability of .72 to .97.

Conners Parent Rating Scale

The Conners Parent Rating Scale or Parent Symptom Questionnaire (Conners, 1985) is a widely used rating scale that aids in identifying behavioral problems in children from 3 to 17 years of age. There are two versions available, a 93-item version and a 48-item brief version. The 93-item version yields eight factors (Conduct Disorder, Fearful-Anxious, Restless-Disorganized, Learning Problem-Immature, Psychosomatic, Obsessional, Antisocial, and Hyperactive-Immature) whereas the 48-item version yields five factors (Conduct Problem, Learning Problem, Psychosomatic, Impulsive-Hyperactive, and Anxiety). Studies indicate the Parent Rating scale has adequate reliability and validity (Sattler, 1992).

The 93-item Parent Symptom Questionnaire has been demonstrated to differentiate between normal and clinical populations and between hyperactive and other clinically referred children (Conners, Rothchild, Eisenberg, Stone, & Robinson, 1974; as cited in Dulcan, 1986). It includes a global Hyperactivity-Impulsivity score which is derived from ratings on 10 items and has been shown to be sensitive to treatment effects. According to Barkley (1990), the Parent Symptom Questionnaire does not correlate well

with activity or attention measured by behavioral observations, but does correlate with measures of child noncompliance, academic problems, and response to medication.

Conners Teacher Rating Scale

The Conners Teacher Rating Scale (Conners, 1985) is a widely used rating scale that can identify a variety of behavioral problems in children from 4 to 12 years old. It complements the Conners Parent Rating Scale. Several versions of the scale are available, including a 28- and 39-item version. The 39-item version contains six factors: Hyperactivity, Conduct Problem, Emotional Overindulgence, Anxious-Passive, Asocial, and Daydream-Attendance Problem.

Like the Conners Parent Rating Scale, the Teacher Rating Scale includes a Hyperactivity Index which is sensitive to treatment effects, particularly changes in stimulant medication. A score of 1.5 is considered two standard deviations greater than the mean for normals, and has commonly been used as a cutoff for studies of hyperactivity (Dulcan, 1986). Test-retest reliabilities reported in the literature are adequate, ranging from .70 to .90 (Conners, 1985).

Home Situations Questionnaire

The Home Situations Questionnaire (Barkley, 1981; as cited in Barkley, 1990) was developed specifically for hyperactive children. It is a 16-item scale which focuses on those settings in which behavior problems occur, instead of

focusing on specific problem behaviors. It consists of 16 different problem situations that are often mentioned by parents of children with ADHD. Parents indicate whether their children exhibit any behavior problems in each setting, then rate the severity of the problems on a 9-point scale.

According to Barkley (1981; as cited in Barkley, 1990) a child with problems in five or more settings will be two standard deviations above the mean for normal children. He also found that using a cutoff score of seven or more problem settings resulted in the correct identification of 100% of the children in a group of children previously diagnosed with ADHD. The scale has also been shown to be sensitive to stimulant medication and to the effects of behavioral parent training (Barkley, 1990).

Attention Deficit Disorders Evaluation Scale (ADDES)

The Attention Deficit Disorders Evaluation Scale or ADDES (McCarney, 1989; as cited in Eckert and DuPaul, in press) is a rating scale which addresses the three major symptom areas of ADHD: inattention, impulsivity, and hyperactivity. The ADDES is available in both a 60-item teacher version, and a 46-item parent version. The respondent answers questions using a 5-point Likert scale, ranging from 0 (does not engage in the behavior) to 4 (engages in the behavior one to several times per hour). Total and subscale scores can be derived by simply summing the responses.

According to Eckert and DuPaul (in press), test-retest reliability over a 30-day period for both versions of the ADDES is adequate, with coefficients

ranging from .90 to .92 for the home version and .89 to .97 for the school version. Both versions of the scale have also been found to be internally consistent, and a large normative data base is available. The scales are accompanied by intervention manuals that provide direction based on the assessment results.

Other Instruments

In addition to the assessment instruments mentioned above, a wide variety of other methods have been used to assess for the presence of ADHD and to measure treatment effects. These include measures of cognitive functioning and academic achievement (e.g., the Wechsler Intelligence Test for Children, the Wide Range Achievement Test, the Matching Familiar Figures Test), laboratory measures of sustained attention and impulsiveness (e.g., the Continuous Performance Test, the Test of Variables of Attention) self-report measures (e.g., the Piers-Harris Self-Concept scale, the Nowicki Strickland Locus of Control scale), and a variety of published behavioral observation methods.

Review of the Research

For the sake of organization, the following research results are presented in three separate categories of multimodal interventions. These are: (a) Medication Plus Behavior Modification, (b) Medication Plus Cognitive Training, and (c) Other Treatment Combinations. While not all of

the studies mentioned fall neatly into one of these categories, they are grouped in this manner for ease of comparison.

Medication Plus Behavior Modification

As mentioned above, both pharmacological and behavior modification interventions have been used successfully to treat children and adolescents with ADHD. If these treatments work well when used alone, it stands to reason that they might be even more effective when used in combination. Though this conclusion appears to make sense intuitively, is it borne out by the research? If so, are the effects additive, or does this combination lead to even greater treatment gains? Several studies have attempted to examine the efficacy of these interventions when used together.

Landmark studies by Gittelman-Klein et al. (1976) and Firestone, Kelly, Goodman, and Davey (1981) attempted to compare the relative efficacy of stimulant medication (methylphenidate) and behavior modification alone and in combination. These studies will be described here in detail, as they are representative of much of the research into this particular treatment combination, and are frequently cited by experimenters conducting similar research.

In Gittelman-Klein et al.'s 1976 study, their 75 subjects were elementary school children between the ages of 6 and 12, referred for hyperactivity and attentional problems in the classroom. Selection criteria included a Hyperactivity factor score of 1.8 (out of a possible 3) on the

Conners Teacher's rating scale, an absence of any signs of neurological disease or psychosis, and a Verbal or Performance scale I.Q. of at least 85 on the Wechsler Intelligence Scale for Children. In addition, the parents of these children had to report that their child was hyperactive or had behavior problems at school, and be willing to participate in the study after it was explained to them.

The researchers then determined that each of the subjects actually manifested observable behavior problems in the classroom, using an observation code designed by O'Leary and co-workers (unpublished; as cited in Gittleman-Klein et al., 1976). The index child and a same sex classmate were observed for three 16-minute periods during structured lessons. The children were rated on the following categories: (a) Interference: calling out, interruptions of others during work periods, (b) Off-Task: failure to attend to classroom assignments, (c) Gross Motor Movement: out-of-seat motor activity when it violates the class rules, (d) Minor Motor Movement: in seat rump activity, and (e) Solicitation: seeking the teacher's attention. Mean cutoff observation scores which maximized the identification of hyperactive children and minimized false positives were selected, and children with elevated mean scores on at least two of the categories were included in the study.

Children who met the study criteria were randomly assigned to one of three treatment conditions for an 8-week period: behavior therapy with

methylphenidate, methylphenidate alone, or behavior therapy with placebo. Behavior therapy was implemented at both home and school, with specific reinforcements and punishments identified for each child. A token economy was instituted in the classroom, with the teachers awarding "smile faces" which could be cashed in at home for backup reinforcers. Medication (methylphenidate or placebo) was administered within 2 days of the initiation of the behavioral treatment, with all children receiving 10 mg of medication per day for the first week, followed by gradual weekly increments. Teachers were called weekly, and the medication was regulated according to reports from the parents and teachers.

After 8 weeks of treatment, the researchers obtained another Teacher Rating Scale and conducted new classroom observations. Teachers, mothers, and psychiatrists also reported their impressions of the child's behavior on an 8-point scale: 1, Completely Well; 2, Much Improved; 3, Improved; 4, Slightly Improved; 5, Unchanged; 6, Slightly Worse; 7, Worse; 8, Much Worse. The classroom observers were blind to any of the treatment conditions, whereas the other evaluators were blind to the medication conditions but were aware when a particular child was not receiving behavior therapy.

The data from the Teacher Rating Scale and the observational code were analyzed to determine the effect of each treatment and whether treatments differed in relative efficacy. Within-treatment effects were

determined by contrasting the pre- and posttreatment means of each treatment group with t tests for correlated means. Between-treatment differences were tested by analyses of covariance, adjusting the posttreatment scores for the groups' initial, pretreatment values. If the covariance analyses yielded significant F ratios, the authors performed Tukey tests of Honestly Significant Differences to determine which group contrasts were significant. The global ratings of improvement made by the parents, teachers and psychiatrists were divided into categories of Improved and Unimproved for purposes of analysis.

Gittelman-Klein and her associates (1976) published initial results based on a final sample of 34 children, 32 boys, and 2 girls. Thirty-two of the children were White, 2 were Black; their mean age was 8 years, 2 months. Thirteen received behavior therapy with methylphenidate, 12 received methylphenidate alone, and 9 received behavior therapy with placebo. After 8 weeks of treatment, the dosage of methylphenidate given to the medicated children ranged from 10 mg to 60 mg per day, with an average daily dose of 35.6 mg. The authors reported results from the three different measures, the Teacher Rating Scale, classroom observations, and global improvement ratings.

Within-treatment analysis of the Teacher Rating Scale scores indicated that the children in all three treatment groups were rated as significantly less pathological on the factors of Conduct Disorder, Anxiety, and Hyperactivity

(ps from < .05 to < .0001). On the factors of Inattention and Sociability, the groups receiving behavior therapy with medication and medication alone were significantly improved. Significant between-treatment differences were found on four of the five factors of the rating scale. The groups receiving the medication alone and the medication with behavior therapy were significantly superior to the group receiving behavior therapy with placebo on the factors of Conduct Disorder, Inattention, Hyperactivity, and Sociability (ps from < .05 to < .01). No significant difference was found between the group receiving medication alone and the group receiving medication with behavior therapy.

When the Classroom Observation scores were analyzed for within-treatment effects, the authors found that all three groups showed a significant reduction in the amount of Minor Motor Activity (ps < .01). The groups receiving medication alone and medication plus behavior therapy had significantly lower scores on the measure of Disruptive Behavior (ps < .001), whereas the group receiving behavior therapy plus placebo did not. None of the treatment groups showed a significant change in the amount of Solicitation, the degree to which a child sought the teacher's attention. The comparisons between treatments indicated that groups receiving medication alone and medication plus behavior therapy showed significantly less Disruptive Behavior than the group receiving behavior therapy plus placebo (p < .01 and p < .05, respectively). No statistically

significant difference in Disruptive Behavior was found between the two groups receiving medication. The medication plus behavior therapy group had significantly lower Minor Motor Activity scores than the behavior therapy plus placebo group ($p < .01$), while the medication alone group was not significantly different from the other two groups. No between-groups differences were apparent on the Solicitation measure.

When the Global Improvement Ratings were compared, the teachers rated 100% of the children who received medication plus behavior therapy as improved, 75% of the medication alone children as improved, and 56% of the behavior therapy plus placebo children as improved. The medication plus behavior therapy group was significantly superior to behavior therapy plus placebo group, whereas no significant difference was found between the other groups. The mothers' global ratings of improvement did not favor any treatment group, with rates of perceived improvement between 67% and 85% across treatments. The psychiatrists rated 100% of the children who received medication plus behavior therapy as improved, 83% of the medication alone children as improved, and 44% of the behavior therapy plus placebo children as improved. As with the teachers' ratings, the medication plus behavior therapy group showed significantly more improvement than the behavior therapy plus placebo group, whereas no significant difference was found between the other groups.

Gittelman-Klein and her associates (1976) argued that their study provides strong evidence for the use of methylphenidate in treating ADHD children, whether the medication is used alone or in combination with behavior therapy. Although each of the three treatments produced significant clinical improvement, children treated with a combination of methylphenidate and behavior therapy showed the most gains, followed by those treated with the medication alone. Children treated with behavior therapy plus placebo showed significantly less improvement than the two groups which included medication. The authors also point out that in "no single instance was the combination of medical and behavioral treatment significantly superior to medication alone; the differences between the two were negligible" (p. 374). In other words, adding a behavioral intervention to medication treatment did not make any appreciable difference in treatment outcome.

Firestone et al. (1981) conducted a study similar to Gittelman-Klein and her associates (1976), comparing the differential effects of parent training and stimulant medication on hyperactive children. Unlike Gittelman-Klein et al.'s study however, Firestone and his colleagues were interested in determining the effects of these interventions on academic achievement as well as behavior.

The subjects were 43 children between 5 and 9 years of age, who fit the DSM-III (APA, 1980) criteria of attention/deficit disorder with hyperactivity.

The children were randomly assigned to one of four groups. In one group the parents received training in behavior modification and the children received a placebo. In the second group the parents received the same training and the children received methylphenidate. The third group included the parent training and methylphenidate, but the medication was switched to placebo at the 4th month of the study, immediately after the posttreatment measures were conducted. The fourth group was not told about the parent training and received only methylphenidate. Parents in each of the parent training groups had regular contact with their children's teachers, and home-school contracts were set up. Parents, teachers, therapists, and individuals assessing the children were blind to the medication conditions.

The children were assessed using the Conners Rating Scales for teachers and parents, an emotional adjustment scale designed by Weiss et al. (1975; as cited in Firestone et al., 1981), and a reaction time apparatus developed by Cohen et al. (1971; as cited in Firestone et al., 1981) which measured mean reaction time and provided a total number of "impulsive responses." In addition, two measures of academic achievement were obtained, The Gates-MacGintie Reading Tests and the Arithmetic Subject Test of the Metropolitan Achievement Tests.

The authors reported that while 91 families met criteria for inclusion, only 43 followed the treatment prescriptions and completed the posttests.

There were 12 children in the medication only group, 13 in the parent training plus placebo group, and 18 in the parent training plus medication group (because the authors reported posttest results only, they combined the group which was switched from medication to placebo after 4 months with the other medication group).

An analysis of within-treatment effects showed that all three groups showed improved academic achievement on the Metropolitan Achievement Test, whereas only the medication groups improved on the Gates-MacGintie Verbal scores. On the reaction-time test, the medication groups showed significant improvement on reaction time and impulse control, whereas the parent training plus placebo group did not. All three groups showed uniform improvement on the Conduct Disorder, Inattentive-Passive, and Hyperactivity Index factors of the Conners rating scales.

On the Gates MacGintie and reaction time tests, both medication groups showed significant improvement over the placebo group ($p < .01$), but the medication alone group did not differ from the medication plus parent training group. On the Hyperactivity Index of the Conners Teacher Rating Scale, the medication alone group showed significant improvement over both the parent training plus medication group ($p < .01$) and the parent training plus placebo group ($p < .001$). In addition, there was a trend favoring the superiority of parent training plus medication over parent training plus placebo ($p < .08$). No other significant differences were reported.

In a series of studies conducted during the 1980s, Pelham and his colleagues (Atkins, Pelham, & White, 1989; Pelham, Schnedler, Bologna, & Contreras, 1980; Pelham et al., 1985; Pelham, Milich, & Walker, 1986; Pelham et al., 1988; Schell et al., 1986; as cited in Carlson et al., 1992) investigated treatments which combined behavior therapy and stimulant medication. Those studies generally found that the combination of the two treatments was more effective than behavior therapy alone (Pelham et al., 1993). However, similar studies failed to show any benefit in combining these treatments. In a 1985 study, Pelham et al. found that the combined treatment was no more effective than the medication alone (Carlson et al., 1992). However, that study also failed to find main effects of the classroom behavior therapy component. In another combined behavioral and medication program, Gittelman et al. (1980) found no incremental benefit beyond medication alone. Other researchers have pointed out that that study used a relatively high dose of methylphenidate (0.75 mg/kg) whereas the behavior therapy was outpatient and relatively short-term (Carlson et al., 1992).

In 1986, Pelham and Murphy reviewed the studies which investigated combined behavioral and pharmacological treatments (Carlson et al., 1992). They found that 13 of the 19 studies showed the combination of the two treatments was superior to either treatment alone for at least one of the independent variables examined. The combination was more likely to be

found for classroom behavioral or social measures. Of the 10 studies which included academic measures, only one found the combined treatments to be more effective than the single treatments.

More recently, Carlson et al. (1992) conducted a study to evaluate the separate and combined effects of behavior modification and two different dosages of methylphenidate on both classroom behavior and academic performance. Their subjects were twenty-four 6- to 12-year-old boys attending an 8-week summer treatment program. Each of the boys met the DSM-III-R (APA, 1987) criteria for a diagnosis of ADHD. Seven boys had a co-diagnosis of oppositional/defiant disorder and another 15 had a co-diagnosis of conduct disorder. Eleven of the 24 had Woodcock-Johnson Achievement scores (reading, arithmetic, written language, or a combination) 15 points below their WISC-R full scale IQ and were classified as learning disabled.

Each day of the program, the boys attended a 1-hour class conducted by a developmental specialist and one or two teacher's aides. The class began with a 2-minute timed arithmetic task followed by a 10-minute reading task. The children were then assigned seatwork for approximately 30 minutes. At the end of the class time, each child received public feedback about his classroom behavior and academic performance.

The study used a counterbalanced within-subjects design, in which each of the boys was subjected to two different classroom conditions and three different medication conditions. The behavior management classroom

condition included social reinforcement, a token economy, rules, feedback, time-out, an honor roll system, and home-based daily report program. In the regular classroom condition, all of the behavior management elements were dropped, and the children were exposed to typical classroom conditions. During weeks 6 and 7 of the program, classes received 1 week of the behavior management condition and 1 week of the regular classroom condition. During those weeks, the boys received one of three daily medication conditions in a randomized order: placebo, 0.3 mg/kg methylphenidate, or 0.6 mg/kg methylphenidate.

The effects of treatment conditions on classroom behavior were assessed by direct observation, using an observational scheme developed by Atkins, Pelham, & Licht (1988, 1989; as cited in Carlson et al., 1992). Academic measures included a timed arithmetic task from The Mad Minute (Addison-Wesley, 1981; as cited in Carlson et al., 1992) and a timed reading task from the Barnell Loft Specific Skills Series (Bonig, 1978; as cited in Carlson et al., 1992). The children also completed a daily self-rating questionnaire to examine the effects of treatment conditions on their self-perceptions of their classroom behavior and academic performance.

For each dependent variable, 2 (behavior modification: behavior modification vs. regular classroom) x 3 (drug: placebo, 0.3 mg/kg, 0.6 mg/kg) analyses of variance (ANOVA) were conducted. When sphericity assumptions were met, results of univariate analyses were reported;

otherwise multivariate analyses were reported. The authors considered comparisons reaching an alpha level of .01 significant; those reaching an alpha level between .01 and .05 were considered trends.

Carlson and her associates reported a main effect of medication $F(2, 46) = 24.47$, $p < .001$, and a trend for a main effect of behavior modification condition, $F(1, 23) = 6.62$, $p < .02$, for on-task behavior. These effects were qualified by a significant behavior modification by medication interaction, $F(2, 46) = 5.26$, $p < .01$. Comparisons of rates of observed disruptive behavior revealed main effects for behavior modification condition, $F(1, 23) = 13.68$, $p < .001$, and medication, $F(2, 46) = 10.73$, $p < .001$, as well as a significant behavior modification by medication interaction, $F(2, 22) = 4.78$, $p < .01$.

Follow-up analyses were conducted to compare performance in each of the classroom settings for each dosage of medication. In the behavior modification classroom, the boys showed significantly lower rates of on-task behavior on placebo than on either dosage of medication. Rates of disruptive behavior were significantly higher on placebo than on 0.6 mg/kg medication and showed a trend toward being higher than on 0.3 mg/kg, $p < .06$. No differences in on-task or disruptive behavior were found between the two dosages of medication. In the regular classroom setting, when the boys received 0.6 mg/kg of medication, they had significantly higher rates of on-task behavior and lower rates of disruptive behavior than

when they received 0.3 mg/kg. When they received placebo, the boys showed significantly poorer performance on both measures than when they received either dosage of the medication.

The authors also compared the behavior of the boys in the behavior modification plus placebo condition to the boys in the regular classroom given 0.3 mg/kg or 0.6 mg/kg of medication. No significant differences were found between the group which received behavior modification plus placebo and the group which received regular classroom plus 0.3 mg/kg medication. By contrast, children receiving behavior modification plus placebo had significantly lower rates of on-task behavior and higher rates of disruptive behavior than those receiving regular classroom plus 0.6 mg/kg of medication.

On the academic measures, significant main effects of medication were found for the number of timed math problems attempted, $F(2, 21) = 8.03$, $p < .001$, timed reading percentage correct, $F(2, 20) = 6.02$, $p < .01$, and percentage of seatwork completed, $F(2, 21) = 11.97$, $p < .001$. Follow-up comparisons of medication effects showed that children on placebo performed more poorly than those on 0.3 mg/kg or 0.6 mg/kg, with no significant differences found between the two dosages. No significant interactions between medication and behavior modification were found for any of the academic measures.

Analyses of the self-rating questionnaires revealed that the children perceived their work as more accurate and the teachers as being more fair in the regular classroom than in the behavior modification classroom. The children also felt the medication helped them follow rules better, try harder, complete more work, and work more accurately. Children given 0.6 mg/kg perceived that their pill helped more and their teachers were fairer than did children on placebo. No significant differences between the two dosages of medication were found for any of the questionnaire items.

Carlson and her associates concluded that their findings demonstrated the efficacy of both stimulant medication and behavior modification in the treatment of ADHD. They pointed out that when used alone, a dosage of 0.3 mg/kg of methylphenidate and a behavior modification regimen produced roughly the same improvements in behavior. When the two treatments were combined, they produced results nearly identical to a dosage of 0.6 mg/kg of the medication. The authors believed their research provides a rationale for combining the treatments, thereby gaining the same results with a significantly lower dosage of medication. In addition, they argued that their findings demonstrate that stimulant medication can improve ADHD children's academic performance and self-perceptions, and that a lower dosage of the medication is sufficient to achieve positive results.

Carlson and her associates (Pelham et al., 1993) then conducted a second study using a similar population from the summer day treatment

program mentioned above. They duplicated many aspects of the earlier study, but included different dependent measures and added multiple data points per treatment condition. Their goals were to determine whether they would replicate results from their 1992 study and to examine each subject's individual responsiveness to the various treatments.

Their subjects were 31 boys attending the summer treatment program. They ranged in age from 5.42 to 9.92 years (M = 8.23 years), and each met the DSM-III-R criteria for a diagnosis of ADHD. Ten of the boys also met the criteria for a diagnosis of oppositional/defiant disorder, while another 15 met the criteria for conduct disorder. Seventeen of the 31 had a Woodcock-Johnson Achievement score (reading, arithmetic, written language, or a combination) 15 points below their WISC-R full scale IQ. Twelve of the boys were receiving services for learning or behavior problems.

The authors used the same independent variables, behavior modification classroom vs. regular classroom and placebo vs. two different dosages of methylphenidate. The dependent measures included behavioral observation, classroom points earned for following rules, accuracy and productivity of academic work, and teacher ratings from the IOWA-Conners Teacher Rating Scales. In addition, teachers rated each child daily on three questions to determine the social validity of the treatment. The teachers were asked to assess how much each child resembled a "normal child" in his

interactions with peers and adults, as well as how pleasant they found their interactions with that child.

Analyses of the behavioral intervention alone showed significant improvement in rule-following behavior, disruptive behavior, and the Conners Oppositional/Defiant rating. An effect approaching significance was found for on-task behavior and for the Conners Inattention/Overactivity rating, $p < .10$. No effects were found for the academic seatwork measures. On the social validity teacher ratings, there was a significant effect for the rating of normality of peer interactions, and there were trends for the other two measures, $p < .05$. Analyses of the methylphenidate intervention alone showed significant improvement for all measures except seatwork accuracy.

Two sets of comparisons were performed in order to determine any incremental effects of the combined treatments beyond behavior modification and medication alone. First, the simple effects of medication at the behavior modification level of treatment were computed to determine the incremental value of medication beyond the effects of behavior modification. Adding medication to behavior modification produced significant improvement for all of the measures. The second comparison examined the simple effects of behavioral treatment at the average of the low dose and high dose levels of medication. The effect of adding behavior modification to medication was not significant for any of the dependent measures.

The authors also examined individual differences in response to treatment by computing effect sizes (ESs) for each child for each dependent measure. Effect sizes were calculated for all treatment conditions, using a single index of response made up of weighted effect sizes for each of the measures. They found that the overall medication effect generally produced significantly greater effects than the behavioral intervention alone, $t(26) = 5.13$, $p < .0001$. The combined behavior modification/medication ES was superior to the behavior modification ES, $t(26) = -4.4$, $p < .0005$, but was no different from the overall medication ES, $t(26) = -1.26$. When either a low or high dose of medication was added to behavior modification, 21 boys showed incremental improvement in ES of .25 or more beyond the effect of behavior modification alone. When behavior modification was added to the low dose of medication, 11 boys showed an improvement in ES of .25 beyond the low dose alone, whereas adding behavior modification to the high dose of medication produced an incremental improvement of .25 ES over the high dose for only 4 of the boys.

Pelham and his associates (1993) contended that their results were consistent with previous findings demonstrating that both behavior modification and stimulant medication separately improve the classroom behavior of ADHD children, but that only the medication had an effect on academic performance. They also argued that their research demonstrated that, although the combination of the two treatments is more potent than

behavior modification alone, the effect beyond medication alone is limited. They admitted that their conclusions were based on the acute effects of the two treatments, and called for long-term research into the combined treatment. The authors also pointed out that the effects of their behavior modification intervention on academic performance should be interpreted with caution. Although response cost was used to modify classroom behavior, it was not used to penalize children when they failed to show academic improvement. The authors cite earlier research (Atkins et al., 1989; Rapport, Murphy, & Bailey, 1980, 1982) in which the use of negative consequences for off-task seatwork appeared to motivate children more than simply rewarding them for academic achievement.

The studies mentioned above appear to be the most comprehensive, well-designed investigations into the treatment combination of behavior modification and stimulant medication conducted since 1986. Other recent research on this specific treatment combination appears to be limited to single subject designs or studies involving a small number of subjects. For example, Speltz, Varley, Christopher, Peterson, and Beilke (1988), examined the effects of dextroamphetimine (10 mg and 5 mg/day) plus contingency management on the work behavior, play interaction, and aggressiveness of a 4-year-old ADHD boy who had not responded to the behavioral intervention alone in a day treatment setting. They found significant improvements in

the boy's work behavior and reductions in his aggressiveness after the stimulant medication was added to the behavioral intervention.

Abramowitz, Eckstrand, O'Leary, and Dulcan (1992) examined the effects of a behavioral intervention alone and in combination with stimulant medication on the off-task classroom behavior of 3 boys (aged 10-11 years) with ADHD. Two different doses of methylphenidate or placebo were combined with two different intensities of teacher reprimands (immediate vs. delayed). Abramowitz and her colleagues reported results which suggest that, for some children with ADHD, an intense behavioral intervention can achieve results comparable to those achieved with medication, whereas for some children stimulant medication may make intense behavioral intervention unnecessary. In a similar study, Hoza, Pelham, Sams, and Carlson (1992) examined the effects of two dosages of medication and two strengths of a behavioral intervention on 2 boys, ages 10 and 11. The authors reported that combining the most potent doses of each treatment appeared to be more effective than either treatment used alone, making very difficult-to-manage children with ADHD manageable.

Medication Plus Cognitive Training

Several studies have attempted to determine if interventions which combine cognitive training with stimulant medication are more effective than either of these treatments alone. In a 1985 review of early cognitive training interventions for hyperactive children, Howard Abikoff examined a

number of studies which examined the effects of this treatment combination on cognitive functioning, academic performance, and school and home behavior. Abikoff reported that these studies produced largely negative results, and provided little evidence that cognitive training is as effective as stimulant medication or provides additional benefit when added to stimulant medication. However, Abikoff and Gittelman (1985) pointed out that many of these early studies were hampered by their "methodological limitations, such as extremely brief treatment periods, lack of control groups, little or no training in social skills, and failure to assess maintenance effects" (p. 954).

Subsequent to Abikoff's review, the author and an associate (Abikoff & Gittelman, 1985) attempted to avoid many of these methodological problems in a comprehensive study of the cognitive training/stimulant medication treatment combination. The authors' stated goals were to determine if the combined treatment (a) enhanced academic performance beyond treatment with stimulants alone, (b) improved further the behavior of children who only responded partially to medication, (c) facilitated withdrawal of stimulant treatment, and (d) led to maintenance of academic gains after cessation of medication. Abikoff and Gittelman's study will be described here in detail, as it is representative of much of the research into this treatment combination and is particularly comprehensive in scope.

The study included 65 children between the ages of 6 and 12 who were identified as hyperactive by both their teachers and their parents and had a minimum hyperactivity factor score of 1.8 on the Conners Teacher Rating Scale. In order to identify children who needed continued stimulant medication, those receiving maintenance stimulant treatment were switched, single-blind, to a placebo for a maximum of 4 weeks. Those who received hyperactivity scores on the Conners of 1.5 or above were considered placebo failures and were included in the study, as long as their parents also reported obvious behavioral deterioration at home. The children were also assessed to determine whether they were full or partial stimulant responders. Children who continued to display residual academic or behavior problems after their stimulant dosages were titrated were considered partial responders.

All children in the study were given stimulant medication twice per day, with a few receiving a third dose in the afternoon. Medications included methylphenidate (up to 80 mg/day), dextroamphetimine (up to 50 mg/day), and pemoline (up to 150 mg/day). The children were then randomly assigned to a cognitive training condition, an attention control condition, or a medication alone condition for 16 weeks.

The first phase of the cognitive training condition consisted of 8 weeks of twice-weekly individual 1-hour training sessions. Self-instructional and cognitive modeling procedures were used to teach reflective problem-

solving skills and verbal control over impulsive responding. The researchers did not include academic material in the self-control training, as they "hoped the cognitive training would modify the children's problem-solving approaches and that these modified cognitions would in turn ameliorate other response domains, especially academic performance" (p. 954). During these sessions, trainers praised the children for using reflective problem-solving behaviors, and each child was awarded 25 points which could be traded in for toys and games. The points were considered noncontingent reinforcement, and were awarded to the children for "working hard and trying your best."

During the final 8 weeks of the program, the children met in groups of three for two weekly 1-hour sessions, where they were taught interpersonal problem-solving skills. The trainers used exercises taken from AWARE: Activities for Social Development (Elardo & Cooper, 1977; as cited in Abikoff & Gittelman, 1985), a program that couples role-playing and the recognition of feelings. The children were presented with difficult situations they might encounter at home or at school and were encouraged to problem-solve and work cooperatively. The children's parents met twice with staff members to learn about the social problem-solving approach, and were encouraged to apply it at home.

Children in the attention control group were provided with the same amount of attention and exposure to materials, but did not receive specific

instruction in the problem-solving techniques. They were simply instructed to work slowly and carefully and were praised for doing so. Like the children in the treatment group, they also received 25 points per session for participating. They were also exposed to the AWARE exercises, but did not receive training in interpersonal problem-solving and cooperation.

At the end of the 18 weeks, the children receiving medication alone and those in the attention control group were all switched to placebo without the parents' and teachers' knowledge. In the cognitive training group, half of the children were randomly assigned to remain on stimulant medication, and half were switched to placebo. The authors hoped to assess whether any treatment effects from cognitive training plus medication were maintained differently in children who continued receiving medication versus those withdrawn from medication. During follow-up, teachers were contacted weekly by telephone and Conners ratings were obtained on the Parent-Teacher questionnaire.

Outcome measures used in the study included parent and teacher reports, achievement tests, and tests of cognitive functioning. All pretreatment measures were taken while the children were receiving placebo. Teacher and parent ratings of behavior and academic performance were also obtained after the children were returned to medication, prior to being assigned to one of the treatment groups. All of the outcome measures were repeated at the end of the 16 weeks and at a 4-week follow-up point.

Teacher reports included the Conners Teacher Rating Scale, the Hillside Behavior Rating Scale (BRS), and the Hahnemann Elementary School Behavior Rating Scale. Parents rated their children on the BRS, the Home Hyperactivity Scale, and the Parent Attitude Test. Achievement test measures included the Gray Oral Reading Test; the Wide Range Achievement Test spelling, reading, and arithmetic tests; and the Stanford Achievement Test reading comprehension and math application and computation tests. Cognitive functioning measures included the WISC-R, the Paired Associates Test, the Continuous Performance Test, the Matching Familiar Figures Test (MFFT) and the Raven's Coloured Progressive Matrices, a measure of nonverbal reasoning.

At the end of treatment, teacher reports indicated no differential treatment effects on classroom behavior, except for ratings of distractibility and concentration on the BRS, $p < .03$. The children who had been treated with medication alone were rated significantly less distractible than those in the attentional control group, $p < .05$. Parent reports indicated no difference in treatment effects on home behavior. The academic measures showed no significant differences between treatments in oral reading, reading comprehension, word recognition, spelling, math computation or application. The cognitive performance measures indicated no differential treatment effects on verbal and full-scale WISC-R IQ scores, the Paired Associates Task, Continuous Performance Task, Raven's Progressive

Matrices, or numbers of errors on the MFFT. Significant differences were found on the WISC-R performance IQ, $F(2, 42) = 3.22$, $p < .05$, and on latency scores on the MFFT, $F(2, 42) = 4.58$, $p < .02$. The attentional controls received significantly higher performance IQ scores than the children who received the cognitive training, $p < .05$. On the MFFT, the cognitive training group had significantly longer latencies than the group treated with medication alone, $p < .05$.

With respect to the interaction effects between treatment and responsiveness to medication, no significant interactions were found. This appeared to indicate that the residual behavioral or academic problems that remained with medication treatment were not improved by effects of cognitive training compared to the other treatments.

As mentioned earlier, follow-up measures were taken after some of the children were randomly switched to placebo at the 16-week point. The authors hoped to assess whether any treatment effects from cognitive training plus medication were maintained differently in children who continued receiving medication versus those withdrawn from medication. The classroom behavior measures indicated one significant group difference during placebo treatment phase. The children who received placebo after medication alone were rated less disruptive with placebo than the children in the other two treatment groups, $p < .05$. Parents' ratings were similar, with the medication alone group rated as less impulsive on placebo than the

children who had received medication with cognitive training, $p < .05$. The authors found no evidence that academic performance or cognitive functioning was enhanced in the cognitive training group after withdrawal from the medication.

In order to determine whether the combination of stimulant medication plus cognitive training facilitated withdrawal of stimulant treatment, the authors compared the number of days the children in each group were able to be given placebo during the 4-week follow-up period and the percentage of children in each group who did not require re-medication during the placebo-substitution period. There was no significant difference in how long the children in the three treatment groups were given placebo, and no significant difference in the percentage of children in each group who deteriorated during the 4-week follow-up period.

The authors argued that their results indicated that children with ADHD who require maintenance stimulant treatment do not gain any additional benefit from cognitive training. Combining the two treatments did not significantly improve the behavior, academic achievement, or cognitive functioning of these children, and the cognitive training did not facilitate the withdrawal of stimulant medication. Abikoff and Gittelman (1985) contended that their study supports earlier research which found that training ADHD children in social and academic problem-solving skills does not improve their behavior or academic skills.

Abikoff and another group of researchers (Abikoff et al., 1988) then conducted a study in which they attempted to focus exclusively on the academic problems of children with ADHD. Their stated goal was to determine what effects cognitive training plus stimulant medication might have on the scholastic achievement of youngsters specifically identified as "academically deficient." Unlike the earlier study (Abikoff & Gittelman, 1985), the 1988 study included self-instructional training that focused on self-monitoring and self-reinforcement of problem-solving behaviors, and used only academic tasks and materials.

The study included 34 children who displayed cross-situational hyperactivity. At school, they each had received a minimum mean hyperactivity score of 1.5 on the Conners and severity rating of at least moderate on a 5-point global behavior rating scale. At home, their parents had to report long-standing behavior problems consistent with a diagnosis of ADHD. In addition, they had to meet the DSM-III criteria for ADHD according to the study psychiatrist. Academically, each child had to be at least 1 year below expected grade level in math or reading, according to a grade expectancy formula based on the math and reading subtests of the Stanford Achievement Test and the WISC-R.

Children who met the criteria were placed on medication, and academic functioning was reevaluated in those that responded. Children were accepted for the study if their teachers continued to report at least

moderate academic difficulty, and their achievement scores remained a year or more below expected grade level. Of the 34 children who met the study criteria, 11 were assigned to academic cognitive training plus medication, 10 to remedial tutoring plus medication, and 13 to medication alone. All of the children were maintained on stimulant medication (methylphenidate, up to 60 mg/day, or dextroamphetimine, up to 35 mg/day).

The cognitive training program incorporated self-instructional training, self-monitoring, self-reinforcement, and attack strategy training. Each child's training was individualized to focus on his or her academic deficits in math and/or reading. The academic training materials consisted of widely used education texts, workbooks, and tutoring programs. In order to increase the relevance of the training to their actual schoolwork, children worked on exercises taken from their own school workbooks and texts during every fourth session. The remedial tutoring program emphasized the amelioration of the children's skill deficits in math and/or reading. The same materials were used, but no cognitive training techniques were employed. Both groups earned points for correct answers, which could be traded in for prizes. Each group also received social reinforcement, in the form of praise and encouragement.

Dependent measures included achievement tests, cognitive tests, teacher reports, parent reports, and children's self-ratings. Data were collected before treatment, at the end of treatment, and at a 6-month follow-

up. Data were analyzed by analysis of covariance, with baseline scores serving as covariates. Two-tailed tests of significance were used. In order to assess changes within groups, correlated t tests were used to evaluate baseline-posttest and baseline-follow-up differences. Two-tailed probability levels were applied to all contrasts.

At the end of the 16-week treatment phase, the cognitive training group did not differ significantly from the tutoring group or the medication alone group on the tests of academic achievement or cognitive performance. Similarly, the cognitive training did not differentially improve classroom behavior, teacher ratings of academic competence, parent ratings of home behavior, or the children's self-ratings.

At the 6-month follow-up, an analyses of the 47 different measures showed only three significant treatment differences, two of which involved cognitive training. Those differences were: (a) The children who received medication alone had significantly higher scale scores than the children in the tutoring group on one of the academic achievement measures, the SAT math application subtest, $p < .05$; (b) the children who received cognitive training were judged as more competent by their teachers in math than the medication only children, $p < .05$; and (c) the cognitive training group had significantly lower scores than the medication only group on one of the self-measures, the Intellectual Achievement Responsibility scale, $p < .05$,

indicating the cognitively-trained children accepted less personal responsibility for academic failure experiences.

An analysis of within-group changes indicated significant posttreatment improvements in each of the groups. The children who received cognitive training showed gains in academic achievement, teacher ratings of academic competency, and parent ratings of homework problems. However, self-ratings indicated that the children in this group perceived themselves as less responsible for their academic failures after treatment. The children in the remedial tutoring group also showed significant academic improvement, as well as significant improvement in self-concept. The medication only group showed significant academic improvement, but at follow-up were rated as significantly more hyperactive by their teachers.

Interestingly, the authors pointed out that, in each of the groups, teacher ratings of academic competency often did not coincide with actual scores on achievement tests. In fact, 43% of the children initially referred for the study because their teachers had identified them as academically impaired were excluded, as academic testing failed to document significant deficits. The authors hypothesized that "in many cases, reported poor classroom performance may be related to behavioral ADHD signs and not to achievement deficits" (p. 429).

Brown, Borden, Wynne, Schleser, and Clingerman (1986) conducted a similar study to examine the differential effects of cognitive training,

stimulant medication, and their combination. Unlike the Abikoff et al. (1988) study just mentioned, Brown and his colleagues designed their study somewhat differently, conducting posttesting after all children had been completely withdrawn from medication. Their goal was to examine the efficacy of the various treatments across time, controlling for any medication effects which might be present at posttesting.

Their subjects were 28 boys and girls who met the DSM-III criteria for ADHD. Each of the children were of least average intellectual functioning and were 1 year or more behind in at least one subject area (arithmetic, reading, and/or spelling) as measured by the Wide Range Achievement Test. The children were divided into four groups: (a) cognitive training plus stimulant medication, (b) cognitive training plus placebo, (c) stimulant medication plus attention control, and (d) placebo plus attention control. Medication procedures were double-blind, with medicated children receiving 10 mg to 40 mg of methylphenidate daily, depending on their body weight.

Children in the cognitive training group attended twenty-two 1-hour treatment sessions twice weekly over a 3-month period. Training included strategies for improving attention, specific skills to improve academic performance, social problem-solving training including imagery and role-playing, and metacognitive skills training using a Socratic dialogue process. Children in the attention control groups also attended twenty-two 1-hour sessions which exposed them to the same training materials and a therapist

but did not include the problem-solving strategies taught in the cognitive training groups.

Dependent measures included 13 instruments which yielded 21 variables. These included measures of "attentional deployment and cognitive style" (Matching Familiar Figures Test, Children's Checking Task, the Embedded Figures Test, and the Attention-Concentration Factor of the WISC), academic measures (Wide Range Achievement Test, Durrel Analysis of Reading Difficulty, and the Detroit Tests of Learning Aptitude) and behavior and impulse control (Teachers' and Parents' Conners, the Teacher Rating Scale of Attention and the Teacher Rating Scale of Impulsivity, and the ADD-H Comprehensive Teachers' Rating Scale). All posttesting occurred approximately 24 to 72 hours after the children had been withdrawn from the stimulant medication.

The authors performed a 2 (Medication Condition) x 2 (Cognitive Training) x 2 (Time) repeated-measures multivariate analysis of variance on the three groups of measures. None of the main treatment effects or their interaction were significant for the three groups of measures. They also performed a separate 2 (Medication Condition) x 2 (Cognitive Training) x 2 (Time) repeated-measures analysis of variance for the Conners Parent Rating Scale. These were nonsignificant for medication, $\underline{F}(1, 31) = 2.52$, ns, training $\underline{F}(1, 31) = .02$, ns, and their interaction $\underline{F}(1, 31) = .76$, ns.

Commenting on the results of their study, Brown and his colleagues (1986) argued that when their results are considered along with previous research in the field, several conclusions may be drawn.

> First, stimulant medication appears to have a noticeable effect while children are receiving it. However, these effects dissipate rapidly upon discontinuation of the medication. Second, cognitive effects appear weak and much more research is needed to harness the power of such techniques. Third, the idea that the two treatments (methylphenidate and cognitive training) would interact to produce a more efficacious treatment is logical and enticing; however research simply has not verified this notion entirely. (p. 495)

Finally, a study by Hall and Kataria (1992) attempted to assess the relative efficacy of two treatments (cognitive training and behavior modification) on a computerized test of attention and impulse control, the Gordon Diagnostic System (GDS; Gordon, 1979; Gordon, McClure & Post, 1986; as cited in Hall & Kataria, 1992). Each treatment was administered under both on-medication and off-medication conditions (N=21).

As their study involved only one measure, their findings will be briefly summarized here. Hall and Kataria found partial support for using cognitive training plus medication in treating the impulsive behavior shown by many children with ADHD. Significant additive effects were seen when cognitive training was combined with medication on a computerized "delay" task, allowing some children to better control their impulsivity. However, the effect was not seen for a computerized "vigilance task," which

seems to confirm much of the research demonstrating a lack of efficacy for the treatment combination.

Other Treatment Combinations

In addition to the research into ADHD treatments which combine stimulant medication with behavior modification or cognitive training, recent studies have examined other combinations and permutations of these three primary interventions. Since Pelham et. al's (1986) review of the studies which combined behavioral interventions with stimulant medication and Abikoff's (1985) review of the research into cognitive interventions, a variety of innovative multimodal interventions have been attempted.

Horn, Ialongo, Popovich, and Peradotto (1987) attempted to compare the relative efficacy of behavioral parent training, cognitive training, and a combination of the two treatments. In contrast to the studies reviewed earlier, none of the children in their study were treated with stimulant medication. This study will be examined in some detail, as it is representative of other research combining these two interventions.

The subjects were 24 elementary school-age children and their parents referred for treatment of chronic inattention and impulsivity problems. Children were included in the study if they scored 15 or more (2 SDs above published means) on the Hyperactivity index of the Conners Parent Questionnaire, had no gross physical impairments or intellectual deficits,

and they (and their parents) had not been diagnosed with psychosis. Eight families were randomly assigned to each of three treatment conditions: (a) parent training plus child self-control training, (b) parent training alone, and (c) self-control training alone. Each intervention group met for eight weekly, 90-minute sessions.

The parent training group consisted of mothers of 8 of the children. If the father was currently living in the home he was strongly encouraged to attend as well. The parents were taught specific skills such as observing and charting behavior, using extinction and punishment procedures for inappropriate behaviors, and contingency contracting. Training sessions included didactic presentations, discussions, and role plays. All parents completed weekly homework assignments, including readings from Living With Children: New Methods for Parents and Teachers (Patterson, 1976; as cited in Horn et al., 1987) and working on individual behavior management projects with their children.

Children in the self-control training group were instructed in self-control strategies adapted from Camp and Bash (1981; as cited in Horn et al., 1987) and Meichenbaum (1977; as cited in Horn et al., 1987). Each child was taught a problem solving plan comprised of six self-instructional steps (e.g., "what is my problem?", "how good is each solution?"). Training included didactic presentations, role plays (including modeling by the group leaders and guided practice), and the use of games to stimulate the in vivo practice

or the self-control strategies. A token reinforcement system was used for behavioral management of the children during the group sessions, and a time-out procedure was used for instances of highly disruptive behavior.

Dependent measures were administered at pretest, posttest, and 1-month follow-up. These included child self-report and laboratory measures (such as the Piers Harris Self-Concept Scale, the Nowicki-Strickland Locus of Control Scale for Children, and the Matching Familiar Figures Test), parent-report measures of child behavioral problems (the Conners Parent Questionnaire), parent self-report measures (such as the Parent Attitude Research Inventory and the Community Interaction Scale), and classroom and academic measures (such as the Conners Teacher Questionnaire, a five-category behavioral observation coding system adapted from Abikoff, Gittelman, & Klein, 1980 [as cited in Horn et al., 1987], and the Wide Range Achievement Test).

In analyzing their results, Horn et al. (1987) conducted 3 (Treatment Group) x 3 (Time) multivariate analyses of variance on the dependent measures which comprised each of the conceptual categories. If the multivariate analysis of variance (MANOVA) was significant for a given category, 3 (Treatment Group) x 3 (Time) univariate ANOVAs were then computed for each dependent variable within that category.

On the child self-report measures, the MANOVA showed a significant main effect for time, $F(12, 5) = 29.86$, $p < .001$. Univariate analyses showed

significant increases over time in child perceived self-control, $F(1.18, 28.97) = 3.71$, $p < .05$, significant increases in reported self-concept $F(1.5, 23.93) = 5.16$, $p < .01$), a significant decrease in Matching Familiar Figures errors over time, $F(1.67, 26.72) = 4.29$, $p < .05$, and a significant increase over time in Slosson IQ scores, $F(1.99, 27.89) = 6.69$, $p < .01$. The significant effects found at posttest were still evident at 1-month follow-up. Differences between the three treatment groups were not significant for any of the child self-report measures.

On the parent-reports of child behavioral problems, the multivariate analysis of the Conners Parent Questionnaire Total Problems and subscales showed a significant main effect for time, $F(10, 7) = 20.70$, $p < .001$. Subsequent univariate analysis showed significant decreases over time in reported behavioral problems for Total Problems, Hyperactivity index, Conduct Problems, and Anxiety/Withdrawal. Significant decreases in these areas were also found from posttest to follow-up, indicating the children's behavior continued to improve after treatment ended. The only significant difference between treatment groups was found for the Hyperactivity Index, with the self-control training group demonstrating significantly lower scores at follow-up than the other two groups, $F(2, 16) = 17.54$, $p < .001$. Differences between groups at posttest were nonsignificant.

For the two remaining groups of variables, the parent self-report measures and the classroom and academic achievement measures, no

significant changes were found. None of the parents showed changes on measures of their attitudes toward discipline and child-rearing or measures of "maternal isolation," the number of social contacts the mothers had outside the home. None of the children showed significant changes on the Conners Teacher Questionnaire scores, the classroom behavioral observation scores, or the WRAT scores.

Horn et al. (1987) contended that the results of their study "do not support the hypothesis that combining behavioral parent training with cognitive self-control therapy produces treatment effects greater than either treatment alone" (p. 65). They pointed out that, although each of the treatment groups showed significant improvements in home behavior, differential improvement across treatments was only found in 1 of 32 comparisons. They believed this one difference may best be viewed as due to Type I error. The authors also believed their study provided evidence that behavioral improvements at home do not generalize to the classroom unless concomitant treatment methods are employed there as well. Since their study specifically excluded a classroom component, Horn and his associates (1987) suggested different results might be obtained if teachers were "instructed to prompt and reinforce the child's use of his or her problem-solving skills, or parents and teachers could jointly intervene with school behavior problems through the use of daily home report cards" (p. 65).

Horn and his associates (Horn, Ialongo, Greenberg, Packard, & Smith-Winberry, 1990; Horn et al., 1991; Ialongo et al., 1993) conducted a series of follow-up studies which modified or expanded the treatment components utilized in their initial 1987 study. This research will be described briefly here, as the subject characteristics and methodology used were quite similar to the study reviewed above.

In their 1990 study, Horn et al. attempted to extend the results of their first study by: (a) including a larger sample (42 children), (b) including a longer follow-up component (8 months rather than 1), and (c) including a school consultation component. In addition, treatment duration was lengthened from 8 weeks to 12 weeks. Dependent measures focused on home and school behavior and included the Child Behavior Checklist, the Conners Parent and Teacher Rating Scales, and the Teacher Self-Control Rating Scale. Attention and impulsivity were assessed by the Continuous Performance Test, academic achievement by the WRAT, and self-concept by the Piers-Harris Self-Concept Scale.

Treatment protocols were nearly identical to those used in the 1987 study, with the addition of the school consultation component. The classroom teacher of each the children in the study was contacted at three different points (after the 1st, 6th, and 10th therapy sessions) in order to inform them about the treatment being provided and to instruct them in ways to intervene in the classroom. If a child's parents were receiving parent

training, the teacher was instructed in the use of a daily home report card system. If a child was receiving cognitive self-control training, their teacher was instructed in ways to prompt and reinforce the "Problem-Solving Plan." Both types of instruction were provided to the teachers of children who were receiving the combined treatment.

As in the 1987 study, Horn et al. (1990) found little evidence that a treatment combination of parent training plus cognitive self-control training is superior to either of the treatments alone. Each of the treatment groups showed significant pretest to posttest and pretest to follow-up improvements in at-home behavior as measured by the Total Problems and Externalizing scales of the Child Behavior Checklist (CBCL). The parent training group and the combined treatment group also showed significant improvements on the Hyperactivity scale of the CBCL, whereas the cognitive self-control training group did not. None of the groups showed statistically significant changes for any of the other measures.

The authors also examined whether or not any of the treatments brought the ADHD subjects to within normal limits for behavior at posttest or follow-up. They conducted univariate t tests comparing the parent training, cognitive self-control training and combined treatment subjects to normal controls at posttest and follow-up. They found that the ADHD children remained significantly different from normal controls on every measure except one. The children who had received the combined

treatment had Piers-Harris Self-Concept Scale scores that were not significantly different from the control children, indicating treatment had facilitated an improvement in reported level of self-efficacy.

Horn and his associates conducted another multimodal treatment study (Horn et al., 1991) which examined the additive effects of parent training, cognitive self-control training, and stimulant medication. ADHD children in this study received a treatment combination identical to the one used in the 1990 study, as well as one of two different dosages of methylphenidate. The researchers hoped to establish whether the three-pronged treatment would (a) lead to a greater magnitude of improvement, and (b) result in a greater generalization of treatment effects across settings and "response classes" (i.e., academic, behavioral, and social problem-solving deficits).

The study included 117 subjects who met the same diagnostic criteria for ADHD as those in the 1987 and 1990 studies. They were randomly assigned to one of six different treatment groups: (a) medication placebo alone, (b) low dose (0.4 mg/kg) stimulant therapy alone, (c) high-dose (0.8 mg/kg) stimulant therapy alone, (d) medication placebo plus behavioral parent training and child self-control instruction, (e) low-dose stimulant therapy plus behavioral parent training and child self-control instruction, and (f) high-dose stimulant therapy plus behavioral parent training and self-control instruction. As in the 1990 study, parent training and self-control

instruction consisted of 12 weekly, 90-minute sessions, and a school consultation component was included.

Outcome measures included behavioral measures such as the Child Behavior Checklist (CBCL), the Conners Parent and Teacher Rating Scales, a computerized test of inattention and impulsivity (the Continuous Performance Test), an academic measure (WRAT-2), measures of self-concept and locus of control (the Piers-Harris Self-Concept scale and the Nowicki Strickland Locus of Control scale), and a clinic-based observational system (the Restricted Academic Setting, Roberts et al., 1984; as cited in Horn et al., 1991).

The authors found no evidence that the combination of stimulant medication, parent training, and self-control instruction was more effective than medication alone in treating the core symptoms of ADHD. On almost every measure, the groups receiving stimulant medication improved to a more significant degree than the groups who did not receive it. However, the authors did find some support that a low dose of stimulant medication combined with the other two interventions was as effective as the high dose of medication alone.

When analyzing the teacher ratings of the children's inattentive, impulsive, and hyperactive behaviors, the authors found that the parent training+self-control instruction+low dose of stimulant condition was more effective than the low dose alone, parent training+self-control instruction+

placebo, or placebo alone conditions and as effective as the high dose alone and parent training+self-control instruction+high dose of stimulant conditions. However, they caution that these results stemmed from a single posttest teacher rating, and may simply be no more than chance findings.

In regards to the parent report data, all of the groups (including placebo alone) improved significantly on the CBCL and the Conners Hyperkinesis Index, and no differential treatment effects were found. The authors suggested that this may have been due to "parental expectancies and reaction to the demand characteristics of the study"(p. 239). They noted that Gittelman-Klein and her colleagues (Gittelman-Klein, et al., 1980) reported a similar pattern of results in a study comparing combined treatment effects, with teacher ratings showing differential effects and parent reports showing equal improvement across all conditions, including placebo alone.

On the academic measure, neither the medication alone nor the combined interventions resulted in improvement on the WRAT-2 Arithmetic and Spelling subscales. The group which received the high dose of stimulant medication did improve on their WRAT-2 Reading scores, but the degree of improvement was modest.

Finally, analysis of the Piers-Harris Self-Concept scale scores indicated that the groups receiving a high dose of stimulant medication had significantly higher scores than the groups receiving a low dose or placebo. The authors pointed out that these findings appear to refute the hypothesis

that ADHD children who receive stimulant medication may attribute any success to the medication, thereby developing an external locus of control (Whalen & Henker, 1976; as cited in Horn et al. 1991).

Ialongo et al. (1993) conducted follow-up research using the subjects from the 1991 Horn et al. study. They wished to determine if the children who had received the combined interventions plus the stimulant medication would maintain their treatment gains better than the children who had received the medication alone. They hypothesized that the self-control strategies might have been better learned by the children who were medicated, and these strategies might be prompted and reinforced by the behavioral parent training and school consultation interventions, even after the medication was withdrawn.

Using the same measures as the 1991 Horn et al. study, Ialongo and his associates conducted follow-up assessments of 71 of the subjects from the original study (7 children dropped out between posttest and follow-up). Assessments were conducted 9 months after termination of the behavioral interventions and withdrawal of the stimulant medication. As in the original study, assessors were blind to the treatment status of the children at all times.

When the results from the 9-month follow-up were analyzed, the researchers found no support for their hypothesis regarding the maintenance of treatment gains. All of the children showed declines on the teacher

ratings of inattention, hyperactivity, and impulsivity, the direct observations of off-task behavior, performance on laboratory measures of attention and impulsivity, and on sight vocabulary. As with the original study, the only significant differences between the subjects who received medication only and those who received the parent training+self-control instruction+ medication intervention were found on the parent ratings of their children's behavior. Since all the other measures showed declines in treatment gains, Ialongo et al. (1993) attributed this difference to expectancy effects or the demand characteristics of the study.

Other published multimodal treatment studies conducted since 1986 have either failed to compare and contrast treatment combinations (Grizenko, Papineau, & Sayegh, 1993) or included a limited number of subjects (Henry, 1987; Sheridan, Dee, Morgan, McCormick, & Walker, 1996). These studies will be described briefly here.

Henry (1987) attempted to assess the effects of a videotaped symbolic modeling program and two phases of parent training on the behavior of ADHD children who had already been stabilized on stimulant medication ($N = 6$). He found no additive effects for the symbolic modeling component but significant additive effects for parent training which included a time-out procedure for noncompliance.

Sheridan et al. (1996) examined the effects of a 10-week social skills training program on the behavior of ADHD children who were already

receiving stimulant medication (N = 5). The program included a parental skills component, in which the children's parents were taught to assist their children with skills learned in a clinic setting. The researchers found child improvements in the children's self-reports of their social skills knowledge, but little actual improvement in their observed behavior.

Grizenko et al. (1993) assessed the effectiveness of a multimodal day treatment program for children with disruptive behavior problems, including some diagnosed with ADHD (N = 5). The program included stimulant medication, individual psychotherapy, social skills groups, and family therapy. Compared to a waiting list control group, the children showed limited improvements in both behavior and self-perception.

Discussion

Methodological Considerations

Most of the studies cited above appear to be well-designed and meet broadly accepted criteria for experimental rigor in psychological research (i.e., random sampling and subject assignment, unbiased data collection, standardized treatments and instruments). However, the reported results must be evaluated in light of a variety of research limitations. A few of these limitations have already been mentioned and in fact have been acknowledged by the researchers themselves. In addition, certain threats to internal and external validity are common to much of the research cited and

will be briefly mentioned here. These limitations might be subsumed under three general headings: subject variables, limitations of instruments, and treatment integrity. Rather than present an exhaustive list of possible experimental confounds, a few of the methodological problems inherent to ADHD treatment research will be presented.

Regarding subject variables, it is unfortunate that some of the studies mentioned (e.g., Firestone et al., 1981; Carlson et al., 1992) did not include a control group. A few of the researchers cited ethical reasons for the absence of controls. For example, Horn et al. (1987, 1990) defended the absence of control groups, citing "the serious and debilitating nature of ADHD" and opted instead to utilize the "best available treatment" control approach, wherein "newer treatments are compared to the best (known) available treatment" (Horn et al., 1990, p. 100). This certainly makes for a compelling ethical argument, but unfortunately at the expense of experimental rigor.

Another subject variable which is unavoidable in research of this type is the heterogeneity of children diagnosed with ADHD. Although most of the studies cited used established methods for diagnosing the disorder (i.e., cutoff scores on parent and teacher rating scales or formal diagnosis by a psychiatrist) the fact remains that ADHD is a complex disorder which involves a wide range of social, behavioral, and academic deficits. In their provocative essay on ADHD treatment research, Whalen and Henker (1991) argued that this heterogeneity in the subject population introduces major

methodological hurdles into comparative treatment studies. For example, they pointed out that if one simply considers the academic difficulties of children who meet the diagnostic criteria for ADHD, it is feasible that

> one child may be unable to inhibit prepotent impulses and focus his attention long enough to learn what he is to do and how he is to do it. A second one may have major difficulties organizing his thoughts and materials or mobilizing available skills well enough to attack the problem. A third child may have no difficulty getting started, but may be unable to maintain focus and protect his concentration for a sufficient length of time to complete his assignments. A fourth child may be more interested in exploring the contents of the boxes that have just been delivered to the classroom than in doing his seatwork, even though the academic assignment is well within his sphere of competence. And a fifth ADHD child may be achieving above grade level, despite his behavior problems. (p. 127)

In addition to the significant differences which can be found between individual subjects, one must also consider whether the subject sources may be vulnerable to possible selection bias. Research indicates that ADHD children referred by psychiatrists have more serious problems than do those referred by pediatricians (Costello, Edelbrock, & Costello, 1985; as cited in Whalen & Henker, 1991). Similarly, children referred by schools show more difficulties in concentration, whereas clinic referrals contain a higher percentage of disruptive behaviors (Whalen & Henker, 1991). Other subject variables which could affect results include individual responsiveness to stimulant medication, family psychopathology, and current environmental stressors. When one considers the wide variance among children classified

as ADHD, it seems difficult, if not impossible, to make definitive statements regarding assessment or treatment.

Another factor which can contribute to methodological problems in ADHD treatment research is the type of assessment instruments used. Although many of the studies cited utilized objective measures such as achievement tests or computerized measures of attention and impulsivity (e.g., Pelham et al., 1993; Horn et al., 1991), most also used a variety of questionnaires and rating scales.

Since these instruments rely on parents or teachers as informants, results are bound to be affected by respondent bias. For example, Horn et al. (1991, p. 239) suspected that "parental expectancies and reaction to the demand characteristics of the study" biased the post-test and follow-up results they reported on the Child Behavior Checklist and the Conners Parent Rating Scale. In another study cited, Abikoff et al. (1988) found little correlation between teacher ratings of academic competency and actual scores on achievement tests, leading the researchers to speculate that "in many cases, reported poor classroom performance may be related to behavioral ADHD signs and not to achievement deficits" (p. 429).

Since many of the social and behavioral problems of ADHD children may be situation or person specific, even the most reliable measures may present completely disparate "snapshots" of a given child. Achenbach, McConaughy, and Howell (1987; as cited in Whalen & Henker, 1991) found

only limited agreement among informants and instruments, with intercorrelations in the .20 to .40 range. Whalen and Henker (1991) pointed out that "parents, peers, professionals, and objective observers see hyperactive children doing different things at different times and under different conditions . . . in a sense each measure reflects a unique Child x Perceiver x Setting performance sample" (p. 128). They argued that this is a major implication for the study of treatment efficacy, since "a treatment may or may not appear successful, depending on the measurement targets and instruments used to document its effects" (p. 128).

A third methodological factor which must be considered in ADHD treatment research is treatment integrity. In this regard, treatment with stimulant medication appears to offer few procedural problems: A child is administered a particular dosage of a particular medication at a particular time, or he or she is given a placebo. Of course, unless the child is administered the medication by a physician or nurse, there will always be difficulties verifying compliance. A parent may or may not reliably dispense medication regularly and accurately, and the veracity of their reporting can only be confirmed by regular blood screenings.

Behavioral and cognitive treatments introduce a entire realm of methodological challenges. These forms of treatment are not easily quantified, and those who administer them (i.e., parents, teachers, graduate assistants) are themselves living, breathing, bundles of variables. Whalen

and Henker (1991) contended that comparisons between the three treatment modalities may be like comparing apples, oranges, and mangos:

> What types and amounts of behavior or cognitive treatment are comparable to a 20 mg., twice-daily dose of methylphenidate? What is a minimally effective or a standard dose of cognitive-behavioral training? What duration of behavioral intervention is comparable to 6 months of stimulant treatment? How can therapist contact be equated or its effects controlled across treatments when CBT [cognitive behavioral therapy] requires far more frequent and intense sessions than does either ST [stimulant therapy] or BT [behavior therapy] and when the target of change in BT may be the parent or teacher rather than the ADHD child? (p.129)

If one considers the difficulties involved in comparing these treatments (let alone the amount of variance possible within a given modality), it may be impossible to tease out whether poor treatment outcomes are due to ineffective interventions or the failure of a parent, teacher, or experimenter to follow or complete a therapeutic protocol.

The methodological problems mentioned here appear to be part and parcel of ADHD treatment research. It should be noted that most of the researchers cited in this review took great pains to ensure standardization in their subject selection, assessment instrumentation, and treatment regimens (e.g., high levels of interrater reliability, uniform parent training curriculum, direct or videotaped observation of trainers). At the same time, given the limitations discussed, it seems difficult if not impossible to make conclusive statements about treatment efficacy.

Results

When we consider the myriad methodological issues discussed above, it would seem naive to make definitive assertions regarding the research findings cited earlier. However, it is important to note certain trends which appear to crop up repeatedly. These will be discussed here briefly, followed by a description of an ongoing study which is perhaps the most comprehensive to date in the area of multimodal treatment of ADHD.

First, it seems clear that psychostimulant medication, whether used alone or in combination with the two other major treatments, has a powerful salutary effect for many children with the disorder. Studies reviewed here demonstrate that treatment with stimulants can improve behavior at home and school (e.g., Gittelman-Klein, et al., 1976; Firestone et al., 1981), academic achievement (e.g., Horn et al., 1987; Pelham et al., 1993), attention and impulse control on laboratory tasks (Hall & Kataria, 1992), and even reported levels of self-efficacy (Horn et al., 1990, 1991). At higher dosages, stimulants have been shown to decrease verbal and physical aggression (Hinshaw, Henker et al., 1989), covert antisocial behaviors like stealing and lying (Hinshaw, 1994), and the level of physical retaliation shown by children in anger-provoking laboratory situations (Hinshaw, Buhrmeister, & Heller, 1989).

When a behavior modification intervention is added to stimulant medication, the research findings are equivocal. Some studies appear to

demonstrate an additional benefit, while others do not. After examining the combined treatment effects on wide a variety of behavioral and academic measures, Gittelman-Klein et al. (1976) stated that in "no single instance was the combination of medication and behavioral treatment significantly superior to medication alone; the differences between the two were negligible" (p. 374). Studies by Pelham et al. (1986, 1993) and Firestone et al. (1981) appear to confirm these findings. However, other researchers found limited support for combining the two interventions. Pelham and Murphy (1986) in their early review of studies utilizing this treatment combination, reported that 13 of 19 studies showed the combined treatment was superior to either treatment alone for at least one of the variables examined.

Carlson et al. (1992) reported that combining behavior modification with a low dose of methylphenidate seemed to produce the same improvements in behavior as a high dose of the medication alone. However, these additional improvements did not extend to measures of academic achievement. Similarly, Abramowitz et al. (1992) reported results which suggest that for some children with ADHD, an intense behavioral intervention can achieve results comparable to those achieved with medication, whereas for some children stimulant medication may make intense behavioral intervention unnecessary. However, it should be noted the results of this study may not be generalizable, as it only included 3 subjects. In another study with limited subjects ($\underline{N} = 2$), Hoza et al. (1992)

reported that combining very "potent" doses of behavior modification and stimulant medication appeared to be more effective than either treatment used alone.

As mentioned earlier, few of the studies combining behavioral and stimulant medication treatments found any additive effects for measures of academic achievement. However, as Pelham et al. (1993) pointed out, although many in-school behavioral interventions use response cost to modify classroom behavior, few use this method to penalize children when they fail to show academic improvement. They cite earlier research (Atkins et al., 1989; Rapport, Murphy, & Bailey, 1980, 1982) in which the use of negative consequences for off-task seatwork appeared to motivate children more than simply rewarding them for academic achievement.

Turning to studies which combine stimulant medication and cognitive training, it must be said that the results do not look promising. Credit must be given to Howard Abikoff and his associates, who continued to carry out extremely well-designed and comprehensive investigations into this treatment, even after Abikoff's own exhaustive review (1985) which appeared to cast serious doubt on the efficacy of cognitive training in the treatment of ADHD.

None of Abikoff et al.'s subsequent research, nor any of the other studies reviewed here (e.g., Brown et al., 1986), found evidence that there is any incremental benefit when a cognitive training intervention is added to

stimulant medication. One study (Hall & Kataria, 1992) did appear to find additive effects for the treatment combination on a computerized measure of attention and impulse control. Although the combined treatment was no better than medication alone in improving ADHD children's attention, it did appear to show positive additive effects on a measure of impulsivity.

Turning to the studies which combined the behavior modification and cognitive training interventions, Horn et al. (1987) found no evidence that combining the two treatments produced greater effects than either treatment alone. In their comprehensive study which included multiple measures, they could only find differential improvement for 1 of 32 comparisons. Each of their treatment groups (parent training alone, cognitive training alone, and the combined treatment) demonstrated significant improvement in home behavior. Unfortunately, these improvements did not generalize to classroom behavior, a finding replicated in similar studies.

When stimulant medication is added to the mix, the evidence seems to parallel earlier research which found the cognitive and behavioral interventions do not provide added benefit beyond the gains achieved with medication alone. Horn et al. (1991) and Ialongo et al. (1993) found that groups receiving stimulant medication improved to a more significant degree than groups receiving the combined cognitive and behavioral intervention plus placebo. Whereas they found no support that the

combined psychosocial treatment produced incremental benefit when added to a high dose of stimulant medication, they did find some evidence that children who received the combined cognitive and behavioral intervention plus a low dose of medication improved to the same extent as children who received a high dose of medication alone.

Finally, other multimodal treatment studies have attempted to combine stimulant medication with interventions such as videotaped symbolic modeling (Henry, 1987) and social skills training which is reinforced and prompted by parents (Sheridan et al., 1996). Although these innovative interventions may hold promise, few assertions can be made about their efficacy due to the limited sample size of the studies.

Based on these findings (and bearing in mind the methodological limitations mentioned above), a few tentative conclusions can be drawn about multimodal treatment strategies for ADHD:

1. For many children, stimulant medication, alone or in combination with behavior modification and/or cognitive training, appears to improve behavior at home and school and contribute to improvements in academic achievement.

2. Behavior modification, whether implemented by parents, teachers, or clinicians, appears to be effective in improving children's behavior in the specific situations where it is utilized, but when combined with stimulant

medication does not appear to add additional benefit beyond that offered by the medication.

3. Cognitive training does not appear to significantly improve the behavior of ADHD children, and does not lead to incremental improvement when added to stimulant medication or behavior modification interventions. However, there appears to be limited support for using cognitive training (alone or in combination with stimulant medication) to ameliorate some academic deficits, particularly if the training materials used are part of a child's actual classroom curriculum.

4. For some children, combining a low dose of stimulant medication with a behavior modification intervention (or a behavior modification/ cognitive training intervention) appears to facilitate the same level of behavioral improvement as a high dose of stimulant medication alone.

Current Research

Given the studies cited above, there appears to be considerable room for additional research into the multimodal treatment of ADHD. Currently, the National Institute of Mental Health (NIMH) is conducting a 5-year, multisite, multimodal treatment study of the disorder. This is the first major clinical trial in the history of the NIMH which is focused on a childhood mental disorder (Richters et al., 1995).

The NIMH Collaborative Multisite Multimodal Treatment Study of Children with ADHD (MTA) is currently exploring "the long-term effects of

both pharmacological and psychosocial treatments, synergistic or additive effects of stimulant and psychosocial treatments, and interactions of treatment types with comorbidity pattern and socioeconomic status" (Richters et al., 1995, p. 987). In the first year of this collaborative effort, the researchers involved developed a common protocol, developed training and implementation procedures, and produced manuals to "ensure cross-site consistency in study execution and hiring and training assistants/therapists" (Richters et al., p. 997). During the past three years the protocol has been implemented at numerous sites around the country, including the University of California at Irvine (R. Lee, personal communication, April 22, 1998).

Although published results of this study will not be available until 1999, the NIMH plans to release preliminary findings in November of 1998 (J.M. Swanson, personal communication, April 29, 1998). The researchers involved in the project hope to offer definitive recommendations for the treatment of ADHD, as they believe this study will be the most comprehensive investigation of multimodal interventions to date.

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