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Interventions to Address the Academic Impairment of Children and Adolescents with ADHD

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There exists a strong link between ADHD and academic underachievement. Both the core behavioral symptoms of ADHD and associated executive functioning deficits likely contribute to academic impairment. Current evidence-based approaches to the treatment of ADHD (i.e., stimulant medication, clinical behavior therapy and classroom behavioral interventions) have demonstrated a robust impact on behavioral variables such as attention and disruptive behavior within classroom analogue settings; however, their efficacy in improving academic outcomes is much less clear. Although surprisingly few treatment outcome studies of ADHD have attempted to incorporate interventions that specifically target academic outcomes, the studies that are available suggest that these interventions may be beneficial. The state of the treatment literature for addressing academic impairment in children and adolescents with ADHD will be reviewed herein, as well as limitations of current research, and directions for future research.

KEY WORDS: academic; ADHD; adolescents; behavioral; children; interventions.

INTRODUCTION

The relationship between Attention-Deficit/Hyperactivity Disorder (ADHD) and academic impairment has long been documented (Hinshaw, 1992b, 1994; Mash and Barkley, 2003; Zentall, 1993). There exists a strong link between ADHD and academic underachievement (Barkley, 1998; Hinshaw, 1992b) and a high rate of co-occurring learning problems in this group (Silver, 1992). Compared with normal controls, children with ADHD are more likely to have a history of learning disabilities, repeated grades, placement in special education, and academic tutoring (Faraone *et al*., 1993). Furthermore, prospective follow-up studies of children with ADHD into adolescence and adulthood indicate significantly higher rates of grade retention, placement in special education classrooms, and school dropout and expulsion relative to their peers (Barkley *et al*., 1990). The academic difficulties of children and adolescents with ADHD are significant, and typically include failure to complete homework, poor comprehension of material, poor study skills, low test and quiz grades, poor preparation for class, disruptive behavior, peer conflict, and conflict with teachers (Evans *et al*., 2004; Hinshaw, 1992b; Robin, 1998; Zentall, 1993).

CORE SYMPTOMS OF ADHD AND ACADEMIC IMPAIRMENT

The core symptoms of ADHD according to the current version of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) (American Psychiatric Association, 2000), inattention, hyperactivity and impulsivity, appear to play a considerable role in the development of academic impairment in children and adolescents with the disorder. Independent of the level of executive functioning deficits, the

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severity of ADHD symptoms has been found to predict academic underachievement in reading, writing and mathematics (Barry *et al*., 2002). Symptoms of inattention typically result in off-task behavior in the classroom; failure to listen to classroom or task instructions; forgetting to complete and turn in, losing, or failing to finish assignments; and shifting activities often (Mash and Barkley, 2003). Observational measures of children with ADHD have demonstrated increased off-task behavior; decreased work productivity; more activity and more errors on tasks over time; frequent distractions from assigned tasks; slower and less likelihood of returning to an activity once interrupted; less attention to the rules governing a task; and decreased ability to shift attention across tasks flexibly; than control children (Hoza *et al*., 2001; Lorch *et al*., 2000; Shelton *et al*., 1998; Zentall, 1993).

Symptoms of hyperactivity or excessive verbal and motor activity in children with ADHD also have implications for academic functioning, including difficulty staying seated in the classroom; excessive fidgeting; greater touching of objects; and playing noisily (Mash and Barkley, 2003). All of these symptoms may lead to increased discipline and negative teacher attributions in the classroom and lower levels of task completion. Activity patterns may appear disorganized and students with ADHD may fail to repeat specific activity patterns long enough to establish routines (Zentall, 1993).

Finally, symptoms of impulsivity, the child's difficulty in withholding active responses, typically result in academic errors because the child fails to wait long enough to consider alternative information, consequences, or responses (Zentall, 1993). Failure to inhibit salient or immediate responses results in poor multiple choice test performance, which requires carefully considering multiple alternatives before responding; poor planning, studying for tests, and completion of long-term projects, which require holding back overt responses while making covert ones; and failure to read directions or ask for help, because this requires waiting (Mash and Barkley, 2003; Robin, 1998; Zentall, 1993).

EXECUTIVE FUNCTIONING DEFICITS AND ACADEMIC IMPAIRMENT IN ADHD

The academic impairment observed in children and adolescents with ADHD is also consistent with research suggesting a core deficit in behavioral inhibition, the ability to delay prepotent responses to an event, and to filter out competing stimuli (Barkley, 1997). According to Barkley's model, this primary deficit is hypothesized to affect numerous executive functioning processes including nonverbal working memory, delayed internalization of speech (i.e., verbal working memory), immature self-regulation of affect/motivation/arousal, impaired reconstitution, and reduced motor control/fluency/syntax (Barkley, 1997).

Specific deficits in each of these areas may have direct implications for the development of academic problems in children with ADHD. For example, deficits in nonverbal working memory have been documented in children with ADHD (Barkley *et al*., 1992) and appear to result in forgetfulness, an impaired ability to organize and execute actions relative to time (i.e., time management), and reduced hindsight and forethought, leading to a reduction in the anticipation of future events (Mash and Barkley, 2003). These problems may manifest in ADHD as difficulty remembering to complete and turn in homework assignments, difficulty planning ahead for completion of long-term projects, and difficulty prioritizing or organizing homework tasks. Immature self-regulation of affect, motivation and arousal in children and adolescents with ADHD may lead to greater emotional expression in reactions to events and a diminished ability to induce motivational states in the service of goal-directed behavior. Consistent with these hypotheses, studies have shown that children with ADHD demonstrate lower work productivity, lower self-expectations, less persistence and more discouragement at academic tasks, less enjoyment of learning, and a preference for easy over challenging work (Carlson *et al*., 2002; Hoza *et al*., 2001). In addition, immature self-regulation of affect and motivation may result in the emotional and behavioral problems observed within the classroom, student-teacher conflict, and suspensions and other punishments, all of which serve to reduce student productivity and opportunities for learning. Furthermore, children with ADHD have been found to display greater difficulties in the development of motor coordination, especially in the planning and execution of complex, lengthy, and novel chains of goal-directed behavior (Mash and Barkley, 2003). They also demonstrate slower motor-response and perceptual speed (Barkley *et al*., 1992; Plomin and Foch, 1981). These deficits may affect numerous abilities, including competence in sports-related or mechanically inclined activities and classes (e.g., music, carpentry, football, art, etc.), and result in

difficulties within the classroom which may include poor penmanship, typing errors, and sloppy work.

Therefore, both the core behavioral symptoms of ADHD and disrupted executive functioning processes have direct implications for the development of academic problems within this population. These problems extend beyond off-task and disruptive behavior in the classroom to include academic problems such as failure to complete homework, poor comprehension of material, poor study skills, sloppy work and poor penmanship, low test and quiz grades, failure to read directions carefully, rushing through assignments, decreased motivation and persistence, inability to plan ahead to complete long-term projects, grade retention, and placement in special education. Current empirically supported approaches for ADHD appear to offer some benefit in addressing these academic problems; however, they also have significant limitations, which will be described below. A more comprehensive approach incorporating other interventions that specifically target academic problems in children and adolescents with ADHD may be necessary to more effectively ameliorate the academic difficulties of this group.

CURRENT EVIDENCE-BASED APPROACHES IN THE TREATMENT OF CHILD AND ADOLESCENT ADHD

Current evidence-based treatments for child and adolescent ADHD consist of stimulant medication and behavioral interventions, which include both parent training and school-based interventions (Pelham *et al*., 1998). Stimulant medication has been found to produce large, robust effects on a number of outcome measures including symptoms of ADHD, on-task behavior, disruptive behavior, and compliance (see Swanson *et al*., 1995 for a review). There is also strong evidence to suggest that stimulants improve academic productivity (i.e., task completion) and academic accuracy in the short-term within classroom analogue settings (Evans *et al*., 2001; Pelham *et al*., 1999; Swanson *et al*., 1995).

In contrast, no evidence is currently available to suggest that stimulant medication has an effect on long-term academic achievement (Swanson *et al*., 1995). In addition, limited studies have examined the efficacy of stimulant medication for a broad range of academic outcome measures (e.g., achievement scores, grades, comprehension of material, task persistence, organization, correct use of directions). Those that have utilized these measures have generally found considerably smaller effect sizes than for behavioral variables (Kavale, 1982; Rapport *et al*., 1994). Further, it is unclear whether stimulant medication, when used regularly, translates into long-term improvements in academic performance within a naturalistic classroom setting, as opposed to an analogue classroom. In addition, a number of limitations exist to an exclusive pharmacological approach in the treatment of ADHD, all of which may apply to the treatment of academic impairment in this population. Despite large effects on many behavioral outcome measures, stimulant medication does not normalize behavior. Furthermore, a significant minority of children (about 20–30%) is considered non-responders, and may show decrements in behavioral and academic performance on medication relative to placebo conditions (Barkley, 1990; Pelham and Murphy, 1986; Rapport *et al*., 1994). Although these drugs offer considerable short-term benefits on attention and behavior, they fall short in their ability to teach long-term skills or habits, which may be particularly important for improving academic functioning (e.g., organizational and study skills), and they require compliance with daily dosing requirements (Spencer *et al*., 1995). Finally, many parents and children may be opposed to medication use (Smith *et al*., 2000; Swanson *et al*., 1995). Therefore, while stimulant medication offers meaningful improvements in ADHD symptoms, classroom behavior, and work productivity in the short term, significant limitations are present. These limitations highlight the need to develop efficacious psychosocial interventions which involve parents and the school system and which demonstrate long-term benefit on the academic functioning of children and adolescents with ADHD.

In addition to the evidence for the effectiveness of stimulant medication, a large and convincing evidence base exists for behavioral parent training and behavioral school interventions, which has resulted in their classification as ''empirically-validated treatments'' for ADHD, according to the American Psychological Association (APA) Division 53 criteria (Lonigan *et al*., 1998; Pelham *et al*., 1998). Behavioral parent training and behavioral school interventions focus on the manipulation of environmental variables including antecedents (i.e., location, setting, structure), positive consequences (i.e., parent and teacher attention or praise, tangible rewards, point systems, daily report cards, and token economies), and negative consequences (i.e., time out, loss of privileges, reprimands, and response-cost procedures) to

improve behavioral outcomes (Chronis *et al*. 2005; Pfiffner and Barkley, 1998). These behavioral techniques are a necessary component of effective treatment for the behavioral and academic impairment of children with ADHD. However, the large majorities of studies that have tested behavioral interventions focus on classroom *behavior* (i.e., on-task and disruptive behavior) and have not included academic outcome measures. Behavioral techniques may be more limited in their ability to address academic performance unless the academic behavior (e.g., accuracy of assigned work) is directly targeted (DuPaul *et al*., 1998). Further, studies conducted so far have generally employed the use of analogue classroom settings in which paraprofessionals directly implement the treatment program. Therefore, results may not generalize to real-world clinical behavior therapy, in which teachers and parents are the agents of change. These interventions typically require considerable time and effort to implement, and, as a result, have variable levels of acceptability and practicality for use by parents and teachers. Another significant caveat is the limited evidence to suggest that behavior management programs promote generalization and maintenance of behavioral gains beyond the duration for which the token economy or other system is implemented (Pelham *et al*., 1998). Therefore, while these programs offer considerable benefit for improving classroom behavior, their effectiveness when directly targeting academic performance within a naturalistic classroom setting is less clear. Classroom behavioral interventions, which specifically target academic impairment and measure academic outcomes in real-world settings, should be tested in order to more fully address the academic problems of children and adolescents with ADHD.

RATIONALE FOR DEVELOPING AND TESTING ACADEMIC-FOCUSED INTERVENTIONS

Due to some of the significant limitations of stimulant medication and behavior management approaches, as well as evidence for smaller effect sizes for academic outcomes than for behavioral outcomes when testing these approaches, researchers have sought to develop and test alternative behavioral strategies to address the academic problems of children with ADHD. While behaviorally based classroom interventions typically target on-task and disruptive behavior, academic interventions for ADHD focus primarily on manipulating antecedent conditions such as academic instruction or materials in order to improve both behavioral and academic outcomes (DuPaul and Eckert, 1998). Although surprisingly few treatment outcome studies have attempted to incorporate academically focused interventions (DuPaul and Eckert, 1998), the studies that are available suggest that these interventions have beneficial effects on academic performance (e.g., Ervin *et al*., 1998; Evans *et al*., 1995; Ford *et al*., 1993). A recent meta-analysis of school-based interventions for children with ADHD found that both behavior management and academic interventions had similar positive effects on ADHD-related behaviors. It was however, difficult to discern the effectiveness of these approaches on academic performance due to the relatively few studies employing academic outcome measures (DuPaul and Eckert, 1997).

Teachers may prefer academic interventions over strict behavior management approaches given their time efficiency and more direct targeting of academic deficits (DuPaul and Eckert, 1998). Further, they may offer increased generalizability and maintenance of gains, as they often teach skills or use techniques that may be applied to a wide variety of situations. Finally, direct targeting of academic impairment may reduce the risk for negative long-term outcomes associated with increased academic problems in older children and adolescents with ADHD.

Academic approaches that have been developed and show some preliminary support for use with children with ADHD include: peer and parent tutoring, task and instructional modifications, strategy training, self-monitoring, use of functional assessment, and homework management programs (DuPaul and Eckert, 1998). The duration of this paper will focus on a review of the research investigating the impact of academic interventions on the on-task behavior and academic performance of children and adolescents with ADHD. Interventions which were considered and included in this paper are those which manipulate academic antecedents rather than focus on traditional behavior management approaches, those which examine academic outcomes (e.g., attention to a task or on-task behavior, task completion, task accuracy, grades, and achievement scores), and those which test these approaches in a clinical group of children with either ADHD, hyperactivity, or disruptive behavior problems. We chose to include those studies which focused strictly on on-task behavior if these studies also met our other two criteria, since a child's attention to a task is

a critical component of academic productivity. Potential advantages and limitations of each approach, the current state of the research literature, limitations of current study designs, and future directions will be discussed for each particular intervention.

PEER TUTORING

Children with ADHD show significant amounts of off-task and disruptive behavior during instruction and independent seatwork in the classroom (Abikoff *et al*., 1977). Large class size, lack of individualized instruction and prompts, and passive attention requirements may be a few of the key factors that exacerbate existing difficulties of children with ADHD. As a result, they may be less likely to integrate and learn class material, and may demonstrate lower levels of work productivity (Pfiffner and Barkley, 1998). Peer tutoring is a method of instruction in which children with ADHD are paired with a peer tutor that aids them in learning academic material. This method allows for one-to-one instruction that is individually tailored to the child's academic ability and is delivered at the student's own pace (DuPaul and Stoner, 1994). It requires active responding on the part of the student, and frequent, immediate feedback in the form of prompts and praise is provided by the tutor. Peer tutoring has been found to be effective in a variety of academic areas for students with a wide range of cognitive and academic abilities (Greenwood *et al*., 1991).

Unfortunately, despite the convincing rationale for the potential benefits of peer tutoring on the classroom behavior and academic productivity of students with ADHD, only a few studies have examined the efficacy of this method for use with this population (DuPaul *et al*., 1998; DuPaul and Henningson, 1993; Robinson *et al*., 1981). In a preliminary study, 18 hyperactive boys in 3rd grade were exposed to a peer tutoring procedure in which one student coached another on reading and learning to use new vocabulary words in sentences (Robinson *et al*., 1981). This procedure also involved token reinforcement for successful completion of peer tutoring tasks. Using a single subject, BAB reversal design, the mean number of tasks completed during the intervention condition rose to over 9 times the number completed during the reversal conditions. In addition, both children and teachers were able to effectively implement the intervention independently from the investigators. Although these results are promising, the relative effects of peer tutoring versus contingency management approaches provided by the token system within this study are unclear due to the study design and small sample size.

Two additional studies examining peer tutoring in children with ADHD have been conducted. These studies have employed a specific model of peer tutoring, Classwide Peer Tutoring (CWPT), developed by Greenwood, Delquadri, and Carta (1988). In this model, students with ADHD and their classmates are trained in tutoring procedures, and then randomly paired with one another for an academic subject. The tutor is provided with a script of academic material (e.g., 30 math problems) related to the current content of instruction in the classroom (DuPaul and Henningson, 1993). Items are dictated orally to the tutee one at a time from the script. The tutee then responds orally to the problem, but may use paper to work out difficult problems. Points are awarded to the tutee for each correct response, and feedback from the tutor is given for each incorrect response. The item list is repeated multiple times, and then the students switch roles. During the tutoring sessions, the teacher monitors the behavior of tutoring pairs and provides assistance, if necessary. Typically, privileges and other reinforcers are not necessary with this procedure but may be used when additional incentives are needed (DuPaul and Henningson, 1993; Greenwood *et al*., 1988).

A preliminary study attempted to investigate the effects of CWPT on the academic behavior and performance of a 7-year-old boy with ADHD using an ABAB reversal design (DuPaul and Henningson, 1993). During baseline and reversal conditions, mathematics instruction was provided according to the typical classroom routine, which involved 10–20 min of didactic skills instruction to the entire class with periodic requests for certain students to complete problems on the board or at their own desk. In contrast, the peer tutoring condition was implemented according to the CWPT approach described above (Greenwood *et al*., 1988). Results demonstrated large increases in on-task behavior, decreases in fidgeting behavior, and increases in math problem accuracy during intervention conditions compared to baseline and reversal conditions. Unfortunately, these findings are limited due to the examination of a single case, and the lack of academic performance measures (DuPaul and Henningson, 1993).

The encouraging results from this preliminary study were followed with an investigation of CWPT in a group of 18 children with ADHD and 10 peer

comparison students in grades 1 through 5, again employing an ABAB reversal design (DuPaul *et al.*, 1998). Each experimental condition lasted 1 to 2 weeks and the specific subject area targeted was based on the child's weakest academic area according to his or her teacher. During baseline conditions, the teacher conducted class activities according to typical routine, which included independent seatwork and large and small group instruction. During intervention conditions, the CWPT approach was implemented. Mean active on-task behavior of students with ADHD was increased from a mean of 29% during baseline conditions to a mean of 80% during intervention. Similarly, off-task behavior dropped from a mean of 24–27% during baseline conditions to 6–8% during CWPT conditions. Similar improvements were observed for peer comparison students. Changes in academic performance were more variable for students with ADHD, relative to behavioral effects, as a result of the intervention. An average increase of 22% in weekly test scores was observed with the implementation of four 20-minute CWPT sessions, as opposed to an average gain of 13% in test scores during baseline. Seven of the 14 students with ADHD (50%) for which test data were available were classified as treatment successes, defined as showing an incremental improvement of at least 10% on post-test scores during intervention conditions compared to baseline conditions. In contrast, three of 10 peer comparison students without ADHD (30%) were considered treatment successes. Children who were presented with material that was more challenging were more likely to experience treatment success. Finally, a high level of consumer satisfaction was reported by both teachers and students (DuPaul *et al.*, 1998).

These two preliminary studies offer evidence that CWPT is an effective intervention for students with ADHD which can improve both classroom behavior and academic performance. Advantages of this approach include one-to-one individualized instruction, frequent and immediate feedback, active participation of students, and high levels of practicality and acceptability. Peer tutoring can be implemented by teachers in a general education setting with a high level of fidelity using a resource (i.e., peer tutors) that is readily available in the classroom (DuPaul and Henningson, 1993). Another advantage highlighted in the DuPaul *et al.* (1998) study is the potential benefits of CWPT for all students, regardless of diagnosis. This allows teachers to implement the intervention with the entire class, without having to single out students with ADHD which may create social stigma, especially among adolescents (DuPaul and Henningson, 1993). Peer tutoring may also provide opportunities for the development of prosocial behavior in children with ADHD, as they are encouraged to interact with peers who may not otherwise choose to interact with them socially. Furthermore, it appears from current data that CWPT increases both on-task behavior and academic accuracy, with a greater effect on the former. However, it is likely that the amount of improvement in academic performance may increase through a long-term intervention, since an increasing differential response over time to CWPT versus baseline was observed in the DuPaul et al. (1998) study.

One more study attempted to extend peer tutoring findings by examining their use in the home setting as implemented by parents. This study by Hook and DuPaul (1999) examined whether parent tutoring procedures are also effective for improving the academic performance of children with ADHD. Four children with a diagnosis of ADHD, in grades 2 and 3, participated in a multiple baseline design in which a parent tutoring procedure based on the work of Greenwood et al. (1988) was tested. This procedure involved 10-min tutoring sessions on oral reading tasks, held weekly twice for a period of 1–2 months. Similar to CWPT, the procedure involved one-to-one instruction, immediate feedback (i.e., error correction and praise), and required active responding. Words correct per minute (wcpm) increased for all participants from baseline to tutoring conditions for reading performance at home, and for three of four participants at school, although reading performance was not normalized compared to control children. In addition, these gains were partially maintained at one-month follow-up. Students' attitudes towards reading improved slightly from baseline to follow-up for three of four students, and parents and teachers reported high levels of consumer satisfaction with the intervention (Hook and DuPaul, 1999).

These results are encouraging and parallel results found for the CWPT intervention. Future studies of both parent and peer tutoring procedures are therefore recommended and would benefit from the use of larger sample sizes; employing between-groups subject designs; increasing the breadth of academic performance measures; varying the duration, frequency and length of tutoring sessions; examining the generalizability of improvements due to CWPT to other academic domains or classrooms; and determination

of the moderators in family, school and child characteristics that influence the effectiveness of this approach are warranted. Parent tutoring procedures may be useful in combination with peer tutoring in the classroom, and future studies may also examine the impact of these approaches together in the remediation of academic difficulties.

COMPUTER-ASSISTED INSTRUCTION

Computer-assisted instruction (CAI) entails the presentation of specific instructional objectives, highlighting of essential material, use of multiple sensory modalities, division of content into smaller chunks of information, use of repeated trials, and provision of immediate feedback about response accuracy (Ford *et al*., 1993; Kleiman *et al*., 1981; Mautone *et al*., 2005; Ota and DuPaul, 2002). This method has been suggested as a way to improve the sustained attention and work performance of children with ADHD. Aspects of CAI may help teachers plan individualized activities for students with shorter attention spans, allowing these students to be more actively involved in learning, and increasing confidence and motivation (Fitzgerald, 1994).

Although preliminary research has found that children may improve on-task behavior and increase work productivity during CAI, very few studies have explored the effects of CAI on children with ADHD specifically. An initial study by Ford *et al*. (1993) examined aspects of CAI on the attention of twenty-one, 3rd and 4th grade students with ADHD through comparison of various reading and math computer software packages. Using a within-participants design, participants were instructed with four software programs in a random order: math drill and practice; math instructional game; reading drill and practice; and reading tutorial, drill and practice. Each package compared two different formats: game versus non-game format, playing against the computer or against a partner, animated or non-animated graphics, and unlimited time to respond or limited time to respond. Results indicated that the attention of participants increased on software with a game format, without animation, and with unlimited time to respond. Straight tutorial animation did not appear to hold the attention of children with ADHD as well as games did. Further, more inattentive behaviors occurred on the reading versus math software packages. Unfortunately, numerous methodological problems limit the conclusions that can be drawn from this study. This study did not control for carryover effects or assess inter-observer agreement on behavioral observations, was implemented in a laboratory and not a naturalistic classroom setting, and the procedures used to diagnose ADHD were not consistent with recommended practice (Ford *et al*., 1993). Furthermore, due to the many differences in content, task and format, it is impossible to parse apart whether the differences were due to package format or other factors. Finally, while this study chose to focus on behavioral (rather than academic) improvement, it is quite likely that CAI may have effects on academic performance as well. It therefore would be beneficial for future studies to focus research attention on academic, in addition to behavioral outcomes.

More recent studies have attempted to extend previous findings through examining changes in academic performance in addition to on-task behavior, conducting studies in classroom settings as opposed to the laboratory, and using more carefully controlled study designs that assess inter-observer agreement and treatment integrity. For example, a recent study by Ota and DuPaul (2002) examined the effects of CAI on the mathematics performance and on-task behavior of three, 4th through 6th grade students with ADHD. This study was conducted in a private, special education setting. Using a multiple baseline design, modest improvements in mathematics performance (i.e., digits correct per minute) and significant improvements in on-task behavior were observed for all participants during treatment (i.e., 20 min of CAI 3 to 4 times per week) compared to baseline conditions (i.e., regular teacher instruction and independent seatwork). Treatment integrity was assessed by having teachers complete a checklist of the number of steps they followed during the CAI intervention. Inter-observer agreement was also assessed on 33% of the observations for each of the three participants. This study built upon previous literature by examining the effects of CAI specifically on mathematics performance, and by assessing for inter-observer agreement and treatment integrity. The modest increases in academic performance found in the CAI condition may be due to the short duration over which this intervention was implemented. In addition, all three students were also receiving stimulant medication; different results may have been found for children who are not using medication. Finally, this study has limited generalizability, as the intervention was conducted in a private school, special education setting (Ota and DuPaul, 2002).

Another study extended preliminary research to focus on younger students with ADHD within a general education classroom. Mautone *et al.* (2005) examined the effects of CAI on the mathematics performance and classroom behavior of three, 2nd through 4th grade students with ADHD. The CAI package involved difficulty levels tailored to individual academic needs, structured tasks presented in a game format, frequent and immediate feedback, and a short, video game reward for a certain number of points earned. A controlled case study was used in which the intervention was introduced sequentially among the three students. Baseline conditions involved typical instruction consisting of independent seatwork and group work. Results found increases in math digits correct per minute and on on-task behavior for all participants. Attention changes were immediate upon implementation of the intervention, whereas academic skills appeared to change more gradually. This is expected considering the severe skills deficits of these students which would likely take more time to change (Mautone *et al.*, 2005). Effect sizes for this intervention were all greater than 1.0, which is notably larger than the average effect size of 0.47 for CAI on academic achievement found in a meta-analysis examining 28 studies of CAI (Kulik *et al.*, 1985). This suggests that CAI may be especially beneficial for improving the academic performance of students with ADHD. This study also extends previous findings through matching students' academic needs to features of CAI, implementation within a general education classroom as opposed to a laboratory or private school, special education setting, use of students who were not medicated with stimulants, and assessment of treatment integrity and inter-observer agreement.

Not all research on CAI in an ADHD population has demonstrated positive effects greater than typical or traditional instruction. Fitzgerald *et al.* (1986) compared the efficacy of CAI with traditional paper-and-pencil instruction (TI) and with a no-practice condition, in the mastery of spelling words. Nine students were selected for the study based on scores in the clinical range on the Conner's Teacher Rating Scale. Students received five new spelling words for each condition each week, for a period of five weeks. In contrast to other studies of CAI, results from this study found that CAI and TI were equally effective and superior to the no practice condition. This study controlled for the amount of time the children spent on each practice condition, and each child participated in all three conditions (Fitzgerald et al., 1986). As the previous studies that have found positive benefits of CAI in children with ADHD examined mathematics performance, it may be the case that CAI confers no greater benefit on spelling task performance in children with ADHD than traditional methods. Future studies should attempt to replicate these results and continue to examine whether CAI is superior or equivalent to traditional approaches for other academic tasks, as well as whether certain aspects of CAI (i.e., format, animation, novelty, reinforcement schedule) can be identified that are beneficial for the learning of children with ADHD (Fitzgerald *et al.*, 1986).

Despite limitations of the current research, CAI offers a novel approach that may increase active responding and attention, motivation, and learning in children with attention problems. Advantages of CAI parallel those of peer and parent tutoring which also provide immediate feedback and require active responding on the part of the student. The CAI approach may be highly desirable for use in classrooms because it allows teachers more flexibility and time for individualized instruction, and provides a novel alternative to traditional instruction that may successfully capture the attention of children with ADHD. Unfortunately, too few studies have been conducted, those that have contain methodological flaws, and some findings have been contradictory. This prevents any definitive conclusions from being drawn regarding the efficacy of CAI for children with ADHD, although preliminary data appear promising.

TASK/INSTRUCTIONAL MODIFICATIONS

Task or instructional modifications involve implementing procedures such as reducing task length, dividing tasks into subunits and setting goals for the child to achieve in shorter time intervals, using increased stimulation of the task (e.g., color or texture), giving explicit instructions, and modifying the delivery or modality of instruction depending on the student's individual learning style (e.g., fast-paced versus slow-paced, visual versus auditory) (Dubey and O'Leary 1975; Dunlap *et al.*, 1994; Ervin *et al.*, 1998; Zentall and Leib, 1985). These methods focus on increasing the structure and organization of the child's environment, making goals and tasks appear more manageable to reduce frustration and increase persistence, and increasing relevant stimulation to help sustain attention. Unfortunately, although often included in Individualized Education

Plans (IEPs) and widely used in classrooms for improving the performance of students with emotional and behavioral problems, developmental disabilities and ADHD, instructional and task modifications remain largely untested for their effectiveness in improving the performance of children with ADHD. The majority of studies that have been conducted used single case experimental designs and have other methodological limitations which make it difficult to generalize their effectiveness to populations of students with ADHD.

Visual versus Auditory Presentation of Material

A couple of single case design studies have compared instruction in auditory versus visual modalities on the learning rate and acquisition of reading skills in children with ADHD. As children with ADHD have been theorized to have difficulties in the internalization of speech (i.e., working memory deficits), having them respond orally may allow for a greater integration and retention of material than when they must learn information silently. Dubey and O'Leary (1975) examined the effects of oral versus silent reading on the comprehension of two hyperactive children. Each child read four stories per session, two silently and two orally. Each reading was timed and followed by five comprehension questions which the children answered orally. Results found that oral reading consistently produced more effective comprehension than did silent reading, reducing by nearly one-half the number of comprehension errors produced by silent reading. Although oral reading resulted in slower reading speed, which may have led to more efficient processing of information, speed appeared to account for a minimal proportion of the variability in comprehension across conditions (Dubey and O'Leary, 1975). Oral reading may allow increased processing through presentation in both visual and auditory modalities, more efficient processing of information, or may facilitate appropriate attentional behavior. However, these results are limited to two children taking part in one individual tutoring session. Clearly, replication of this study and other studies involving the comparison of material presented visually versus in auditory formats are needed. Furthermore, the potential long-term impact of oral reading, and the generalizability of its benefits for children with ADHD, should be examined.

Another study investigated the effects of task modifications on the reading performance of three children, two with ADHD and developmental delays, and one with ADHD alone (Skinner and Johnson, 1995). This study employed an alternating treatment design which involved the use of taped words presented at two different speeds, fast-taped words (FTW) and slow-taped words (STW). During FTW, students were instructed to read aloud with an audiotape that delivered 15 words at the speed of one word per second and follow along on a worksheet. During STW, 15 words were delivered in 75 s (one word every 5 s). During assessment-only conditions, students had to read word lists aloud from worksheets. It was hypothesized that this audiotape modeling would increase oral reading accuracy. Consistent with this hypothesis, the accuracy and rates of accurate reading increased relative to baseline for the child with ADHD using both FTW and STW. In contrast, for the two children with ADHD and developmental problems, greater improvements were obtained using the FTW procedure. This study suggests that the opportunity to model accurate responding may improve reading performance, whether presented at a slow or fast speed. Contrary to expectations, slower pacing did not increase students' reading accuracy. This study has several limitations including being conducted in a laboratory setting, having a very small sample size, lack of teacher acceptability data, and the lack of generalized learning across untreated words (Skinner and Johnson, 1995). In addition, there may be a differential treatment response in children with and without co-occurring developmental disorders, which should be examined further in future studies.

Adding Structure to a Task

In addition to the modality of presentation, it has been hypothesized that adding structure to a task may increase the saliency of appropriate responses in children with ADHD, thereby lessening the need for self-produced stimulation (Zentall, 1975). Consistent with this, Pfiffner and Barkley (1998) recommend increased structure and predictability in classroom activities (i.e., posting a daily schedule and classroom rules, conveying explicit instructions, giving one instruction at a time) as beneficial for children with ADHD. In a study by Zentall and Leib (1985), 15 hyperactive and 16 non-hyperactive children participated in a repeated measures crossover design contrasting two conditions: a high-structure task in which participants had to replicate two designs from two models of black and white paper square designs; and a low-structure task which involved creating

original designs from the same number of black and white squares. Results found reduced activity levels for both hyperactive and control children in the high-structure task. Unfortunately, no accuracy of performance comparisons from high to low task structure were conducted because no correct position or number of squares was indicated in the low structure task (Zentall and Leib, 1985). Therefore, while this study suggests that added task structure may promote sustained attention and reduced activity levels, it is unclear whether this translates into improved academic performance. Furthermore, this study should be considered of a preliminary nature because a number of limitations were present including a lack of control for participants' ability level, and a lack of inclusion of measures of inter-observer agreement, treatment integrity and fidelity, and consumer acceptability and satisfaction.

Choice Making

An important task modification that has been explored and found effective for students with developmental disabilities is that of choice making (Newton *et al.*, 1993). Choice making allows the child a certain level of individual decision-making and personal control over the nature of the task. This consists of allowing the child to select academic tasks or materials from a number of pertinent and structured alternatives. This technique may be beneficial not only in increasing task performance and productivity, but also in improving social relatedness (Koegel *et al.*, 1987).

Although not specifically tested with children with ADHD, two single case design studies have examined and found some preliminary support for the efficacy of choice making in a naturalistic setting for students with emotional and behavioral disorders (Dunlap *et al.*, 1994). Two participants in 5th grade, one with ADHD and one with severe emotional disturbance (SED), participated in the first study. An ABAB reversal design was used to examine differences between a choice condition and a no-choice condition. The no-choice condition consisted of English and Spelling assignments being routinely presented on the blackboard and completed by students independently. These assignments were selected by teachers. In the choice condition, students were given an individualized menu of academic activities containing 6–10 relevant options. Choice making resulted in significantly higher levels of task engagement and less disruptive behavior than no choice conditions.

In the second study, an ABAB reversal design was used with a 5-year-old boy with SED (Dunlap *et al.* 1994). Choice conditions involved the child selecting a book to be read during the session. In the two no choice conditions, the teacher selected a book to be read. This study also attempted to determine if the effects of choice were due to obtaining one's preferred activity, or to the act of having a choice. Therefore, in the second no choice condition, the child was given a book that he preferred; this was based on his previous choices. This study replicated the positive effects of the choice condition. In addition, the no choice, preference condition was not associated with increased rates of task engagement or reductions in disruptive behavior. Therefore, it appears that the perception of having a choice improves behavior, whereas being given preferred material does not. These results are promising, and have the potential for easy application in classroom settings. However, the sample size of three limits any generalizations that could be made from this data. Also, these studies chose to specifically focus on behavioral outcomes, and therefore, it is unclear how improvements in on-task behavior translate into changes in academic performance using this technique.

Only one study has examined the use of choice making specifically in children with ADHD. Powell and Nelson (1997) tested the efficacy of choice making with a 7-year-old boy with ADHD. Baseline consisted of a no-choice phase in which the child was directed to work on the same assignment as the rest of the class. During the choice phases, the teacher presented three different assignments taken from the class curriculum, and the child chose one to complete. Disruptive and off-task behavior was found to decrease during the choice compared to the no-choice conditions. This study suggests that choice procedures may be helpful for managing the behaviors of children with ADHD in the general classroom. As with the other studies of choice making, academic achievement and work productivity were not measured in this study. More research in this area would benefit from including academic outcome measures and examining moderators, which influence the effectiveness of this intervention under various environmental conditions for children with ADHD.

Within-task Stimulation

A significant body of research has been devoted to examining the effects of high stimulation contexts on improving the performance of hyperactive

children on various tasks. This research is based on optimal stimulation theory, which suggests that all individuals have a biological need to optimize the level of incoming stimulation. Within this theory, hyperactive children have been hypothesized to have a greater need for stimulation and to be less tolerant of situations involving minimal stimulation, which results in increased errors, and excessive motor and verbal activity (Zentall, 1975). Therefore, according to this theory, high-levels of intra-task stimulation may serve to decrease activity levels and improve the performance of these children.

One of the main lines of research inquiry into within-task stimulation has examined the effects of adding color to various tasks on the performance and activity level of children and adolescents with ADHD. Sustained attention has been found to improve and activity level reduced in children with ADHD when color is added to simple vigilance or copying tasks (Zentall *et al.*, 1985; Zentall and Kruczek, 1988). For example, in a study of 16 boys with attention and behavior problems and 16 controls, ages 14–18, those boys with attention and behavior problems performed better on a repetitive copying task when presented with high-stimulation colored letters than with low-stimulation black and white letters, whereas the opposite was true of controls (Zentall *et al.*, 1985). These benefits of color stimulation resulted in fewer errors for hyperactive children during the early and middle stages of the task. This suggests that over time, adaptation may occur, and that the novelty of color wears off and no longer serves to increase stimulation. Extending these results to a search-attention task involving visual scanning, a study by Zentall (1985) found equivalent results to those found for sustained attention tasks. That is, the performance of hyperactive children was normalized during color conditions, especially during the first two-thirds of task performance.

In addition to improving performance on simple search and sustained attention tasks, the effect of color stimulation on more complex tasks has been examined, as well as the temporal placement of color stimulation as a moderating influence. Zentall (1986) analyzed the effects of color stimulation placed early versus late on two types of tasks, a repetitive vigilance task (the continuous performance task or CPT), and a complex learning task that required children to identify a relevant dimension (e.g., a number) from irrelevant dimensions (e.g., shape and position). Consistent with previous studies, between-groups analyses for the CPT sustained attention task found that stimulation added early or late normalized the performance and reduced the activity of hyperactive children compared to controls. However, in the complex learning task, color stimulation added late reduced the activity (e.g., talking, motor movements) of hyperactive children greater than color stimulation added early to the task. No treatment effects of performance were found. This may be due to a floor effect, since the hyperactive children infrequently solved the complex task (Zentall, 1986).

Similarly, when color was added initially to relevant cues in a spelling task requiring visual memory, slower task responses were observed in hyperactive children compared to controls; however, when the task was initially practiced without color, hyperactive children actually outperformed normal comparisons when color was later added to relevant cues (Zentall, 1989). Therefore, from these studies, it appears that color may help children with ADHD to sustain attention when added late to learning tasks; however, when added early it appears to disrupt learning and performance on complex tasks in which the child has not yet identified relevant cues from among the multiple task stimuli (Zentall, 1986).

Additionally, color added late may be more beneficial to children with ADHD when performing lengthier tasks that require extended responding. Belfiore et al. (1996) examined this hypothesis by examining nonspecific color added late to both a sight learning task and a reading comprehension task. Consistent with hypotheses, all three students with ADHD learned sight words equally well in the no color and color added late conditions for the sight word-learning task. However, for the longer reading comprehension task, all three students increased accuracy under the color added late condition, compared to the no color condition. After adapting to relevant cues of the reading task, color added later may help students read more thoroughly and sustain attention to lengthy tasks (Belfiore *et al.*, 1996). While these findings are promising, they should be replicated with a larger sample size and should compare differences between an ADHD and control group of children to determine whether these effects are specific to children with ADHD. Furthermore, in addition to the temporal placement of color, other moderators of the effects of intra-task stimulation should be investigated. For example, some evidence suggests that color used to highlight important letters or parts of a sentence will aid in remembering the spelling or comprehending the sentence and lead to greater performance than color added to irrelevant

parts of letters or sentences (Zentall and Kruczek, 1988).

Finally, a study by Zentall and Meyer (1987) expanded upon previous evidence of the positive effects of intra-task stimulation for children with ADHD by examining whether adding active motor responses into rote tasks (i.e., a word decoding and auditory vigilance task) would modulate the sensation-seeking activity and impulsive errors of children with ADHD. The active motor response involved giving children the option of repeatedly pressing a button in order to view various color slides of people, nature scenes, and inanimate objects. This optional instrumental motor response was given during the completion of a rote task. Consistent with optimal stimulation theory, it was found that under active response conditions, the impulsive errors, talking, noise making, and hyperactivity of children with ADHD was normalized for repetitive tasks. Therefore, it appears from this study that increasing stimulation through the requirement of instrumental motor responses may effectively preempt more disruptive types of stimulation-seeking activity and impulsive error performance for children with ADHD (Zentall and Meyer, 1987).

Overall, these studies offer considerable evidence that intra-task stimulation involving color significantly improves the performance and reduces the hyperactivity of children with ADHD. More specifically, current data suggest that for simple tasks (e.g., vigilance, copying, visual search, continuous performance) color added early or midway through the task normalizes the behavior and performance of children with ADHD in comparison to control children. Color may provide needed stimulation and promote closer attention to detail for these children. For more complex tasks involving learning acquisition (e.g., spelling requiring visual memory, concept formation tasks, and reading comprehension), color added early appears to inhibit the performance of children with ADHD relative to controls. This may be a result of the disrupted ability to focus on relevant cues among multiple stimuli initially and grasp the task at hand. However, when color is added later in the task, it again confers benefits to children with ADHD and appears to help sustain attention over a longer time period, enhancing performance on complex tasks.

Therefore, with a population of children with ADHD it appears that color stimulation is an effective tool for reducing hyperactivity and improving sustained attention. This approach may be easily implemented by teachers in the classroom, however, requires cognizance of the conditions and temporal placement under which color is likely to be beneficial versus harmful. Future research should focus on a more thorough examination of potential moderators to the relationship between color stimulation and improved performance in these children (i.e., relevance of stimuli, presence of other competing stimuli, etc.). Finally, other forms of stimulation (e.g., incorporating motor responses into the task) may also offer benefit to students with ADHD and should be examined more carefully in future studies.

Although promising, much work remains to be done in the examination of task or instructional modifications likely to be of benefit for children with ADHD. Pfiffner and Barkley (1998) have recommended a number of additional instructional modifications that appear beneficial and should be tested. For example, they suggest that academic assignments be brief to accommodate the child's attention span and presented one at a time rather than all at once in a packet or group, and that shorter time limits be implemented with use of a timer. Delivering a lesson in an enthusiastic, yet task-focused style and allowing frequent and active child participation may also be helpful. Furthermore, they recommend varying presentation formats to maintain interest and motivation. These intervention approaches remain to be tested for children with ADHD. In practice, integrating these intervention approaches and individualizing task and instructional modifications through the use of a functional analysis, described in detail later in this paper, is more likely to result in robust effects than any individual modification alone, and is consistent with the recommendation to provide multimodal treatment approaches for children with ADHD (Pelham *et al*., 1998).

SELF-MONITORING

Self-monitoring and self-reinforcement procedures are widely used and are emerging as effective tools in improving social and academic behavior in the classroom setting in general (Dunlap and Dunlap, 1989; Hertz and McLaughlin, 1987; Mace and Kratochwill, 1988). There also exists a small literature that suggests these gains may apply to children with ADHD as well. These techniques typically involve children setting goals for on-task behavior or classwork completion and accuracy, self-monitoring those goals, and self-administering rewards upon successful completion. Self-management procedures appear to have a number of potential advantages

over other approaches (Kern *et al*., 1994), including increased maintenance of behavior change when combined with other behavior management systems (Drabman *et al*., 1973); improved generalization relative to parent or teacher-implemented interventions (Rhode *et al*., 1983); less teacher and parent time required; and the opportunity to teach students independence, responsibility, and adaptive social behavior (Kern *et al*., 1994).

For example, in a study of six boys, ages 11 to 13-years-old, with a variety of diagnoses including severe emotional disturbance (SED), learning disabilities (LD), developmental delays, depression, and ADHD, Kern et al. (1994) found evidence for the efficacy of self-management procedures in improving on-task behavior and reducing disruptive behavior. In this study, participants were taught to self-monitor their on-task behavior and one individualized target behavior on a five-minute variable interval schedule, and to record this behavior at the sound of a bell on a tape recorder. Training and feedback were provided until student-observer agreement reached 80%. Points were awarded according to the accuracy of the student's self-monitoring record of his behavior during the session. These points could be cashed in for a tangible reward. A multiple baseline design was utilized, and all students showed significant increases in the percentage of intervals engaged in on-task behavior following implementation of the self-management procedures. This study therefore offers preliminary support for the utility of self-management procedures in improving on-task behavior in the classroom (Kern *et al*., 1994). However, significant limitations were present. The study was broad in its inclusion of a variety of diagnoses and not specific to ADHD and the procedures were largely implemented by paraprofessionals and not by classroom teachers, limiting generalizability to real world settings. That is, it is possible that parents or teachers may have more difficulty implementing this approach on a consistent basis. Finally, while this particular study chose to specifically focus on improving behavioral outcomes, it would be beneficial for future studies of this technique to examine the effects of this technique on academic outcomes as well.

A similar study examining self-reinforcement was conducted by Drabman et al. (1973) in which eight disruptive boys (ages 9–10) in a remedial reading class made self-ratings of their behavior and were rewarded for matching within one point of their teacher's ratings of their behavior. During this matching phase, items correct averaged 138 per hour, compared to 83 items correct per hour during baseline. Disruptive behavior was also significantly reduced. Performance during the matching phase was comparable to performance during token reinforcement by the teacher for good behavior (average of 130 items correct per hour) which did not involve matching ratings. In a subsequent self-evaluation phase, children received reinforcement based on their self-ratings which was not contingent upon matching with teacher ratings of their behavior. Number of items correct per hour averaged 158, disruptive behavior showed an 88% decrease from baseline, and there was a 0.70 correlation between student and teacher ratings during this condition. Therefore, students were relatively honest and accurate in their self-ratings, even after removal of the matching procedure. The authors suggest that this maintenance of appropriate behavior and honest self-ratings may have been a result of a number of factors, including social reinforcement by teachers and peers for appropriate behaviors and honesty, observations of academic progress, and bonus points awarded for matching during the earlier phases. This study demonstrated robust effects on academic accuracy and productivity using a shaping procedure which resulted in accurate self-monitoring in the absence of teacher checking. However, similar to the previous study by Kern et al. (1994), subjects were students with academic and emotional problems rather than a diagnosis of ADHD. It is therefore critically important to determine if these encouraging results will be maintained with a group of students with a diagnosis of ADHD.

A series of single subject studies was utilized to compare the effects of methylphenidate (MPH), self-reinforcement, and their combination on the academic performance of six male students with ADHD, ages 9–12 (Chase and Clement, 1985). Following 2 weeks of a baseline condition, each subject participated in seven treatment phases consisting of: MPH (plus non-contingent reinforcers), self-reinforcement (plus a drug placebo), and MPH plus self-reinforcement. Self-reinforcement involved each subject setting a goal for the number of reading questions he would answer by the end of the day, self-recording his completion and performance, meeting with the consultant to determine if he reached his goal, and recording points earned to be exchanged for reinforcers. Results suggest that the MPH-alone condition did not improve academic performance, most likely due to the fact that the children were also receiving non-contingent reinforcers in this condition.

These reinforcers may have counteracted the positive effect of MPH on short-term task productivity which has been well documented in other studies of the effects of this drug (Pelham, 1993; Swanson *et al*., 1995). In contrast, self-reinforcement alone generated large and highly reliable positive effects for five out of six children on the amount of reading questions completed. The accuracy of each child's performance on the reading questions was not targeted with contingent reinforcers; however, this accuracy also showed substantial improvement, and therefore suggests that this procedure may generalize to other academic behaviors as well as task completion. For all six children, the combination of MPH and self-reinforcement was found to be the most effective for improving the academic performance, both in terms of the amount and accuracy of work completed. External validity of this study may have been somewhat compromised given the use of a small sample size and an "experimental classroom". In addition, the medication dosage was not experimentally controlled, rather optimal dosage was determined on an individual basis by the child's prescribing physician prior to the start of the study (Chase and Clement, 1985). Nevertheless, these results suggest that utilizing a multimodal approach combining medication and an academic intervention such as self-management may be most effective in improving academic performance.

Abijola and Clement (1995) replicated this study with some improvements upon the study design by comparing: drug placebo; noncontingent reinforcers; 0.3 mg/kg MPH; 0.7 mg/kg MPH; and self-reinforcement in various combinations. Participants were 6 boys with ADHD participating in a daily morning reading tutorial. Results found that MPH demonstrated differential effects on various academic measures, that self-reinforcement consistently improved academic performance with a mean effect size of 2.66, and as in the previous study, the MPH and self-reinforcement combination conferred the greatest benefit.

Overall, preliminary research on the use of self-reinforcement strategies suggests that these procedures are beneficial for improving the attention and academic performance of children and adolescents with ADHD, especially when combined with other evidence-based approaches (i.e., stimulant treatment, reward systems). Furthermore, the success of this approach may vary depending upon the cognitive-developmental level of the child or adolescent, and may be particularly helpful for increasing independence and responsibility in older children, although this remains to be tested. Future studies would benefit from the use of larger sample sizes, the employment of academic outcome measures in addition to behavioral targets, evaluation within real-world classroom settings as opposed to analogue classrooms, and the implementation of these interventions over a longer time frame in order to fully establish the self-reinforcement skills and habits within the child or adolescent with ADHD.

STRATEGY TRAINING

Strategy training involves teaching and transferring a specific skill to children that they can implement in an academic situation to improve their performance (Evans *et al*., 1995). Similar to self-reinforcement, strategy training takes some of the burden off parents and teachers, giving added responsibility and ownership to the student. Similarly, there may also be increased opportunities for generalization if the strategy taught is applicable to a variety of academic situations.

Douglas et al. (1976) employed a cognitive training program to teach 18 hyperactive children in more effective and less impulsive strategies for approaching cognitive tasks, academic problems, and social situations. The intervention involved a combination of modeling, self-verbalization and problem solving strategy training techniques. The trainer would work on a task with the child while verbalizing aloud a clear statement about the nature of the problem and the strategies he was using to solve the problem. The child was then instructed to do the same. Emphasis was also placed on planning ahead and thinking sequentially and on learning strategies for organizing ideas and work materials. Over the course of the 3-month treatment and at 3-month follow-up, the treatment group showed significant improvement on several criterion cognitive measures compared to a no-treatment control group. Although an attempt was made to use different materials in the assessment battery and training sessions, the authors acknowledged that these materials likely resembled each other in essential ways (Douglas *et al*., 1976). This makes it less clear the extent to which the treatment group improved as a result of the interventions or rather familiarity with the testing materials. Furthermore, some measures, such as math achievement, memory testing, and the Connors Teacher Rating Scale, showed no significant time by group interactions. Therefore, it remains uncertain

whether self-verbalization and problem solving training effectively improve the cognitive performance of hyperactive children. Nevertheless, this is an important initial study into the use of self-verbalization and problem solving training across a wide range of academic and social tasks. It seems plausible that techniques designed to encourage the child with ADHD to stop and examine different alternatives would be effective in reducing the impulsive decision making which results in numerous academic errors and omissions (Douglas *et al*., 1976). However, this hypothesis awaits further research.

Another particular strategy has been tested for adolescents with ADHD. In recognition of the demands placed upon middle and high school students to understand and synthesize material from lecture format classes, Evans et al. (1995) attempted to test a directed note-taking activity (DNA) over an 8-week period in a lecture format classroom embedded within an intensive summer treatment program, in order to decrease off-task behavior and improve study habits of adolescents with ADHD. In this DNA, originally designed as a model of explicit instruction by Spires and Stone (1989), students were taught to divide notes into main ideas and supporting details through the use of lectures and models of notes to compare with their own. Gradually, less instruction is given in the note-taking process until students are able to produce accurate notes independent of any prompting. Results found significant increases in on-task behavior and improvement in scores on daily assignments as a result of taking notes. In addition, high quality notes were associated with better comprehension and higher on-task behavior and assignment scores. Although offering significant improvements in academic performance, this study was conducted in an experimental classroom setting, and therefore, it is unclear whether this intervention would be as successfully implemented by a teacher with a larger class size and more demanding classroom setting. Furthermore, quiz scores were unaffected by the intervention and suggest that long-term comprehension requires not only taking notes but also utilizing them to study (Evans *et al*., 1995). Therefore, this note-taking intervention may be most effective when combined with a larger set of educational interventions to address the behavior and academic achievement of adolescents with ADHD.

Utilizing the positive effects of the note-taking intervention combined with knowledge of the potential efficacy of a multimodal approach to the treatment of adolescents with ADHD, a multi-component academic intervention was implemented within the context of an after-school treatment program for seven adolescents with ADHD, at a public middle school (Evans *et al*., 2004). The challenging horizons program (CHP) combined psychosocial and educational interventions that included note-taking instruction using the DNA approach, and individualized study skills and organizational skills training. Organizational skills training involved bi-weekly review of the adolescent's assignment notebook to record whether assignments were written down clearly and accurately, review of the binder to record whether classwork was filed in folders according to each subject area, and review of the assignment notebook and book bag to record whether loose papers were present. Points were earned for meeting criteria which could be exchanged for individualized rewards. Study skills training involved training students in the use of memorization techniques to study for upcoming tests and exams. Dependent measures used to assess improvement included students' grades and symptom and impairment rating scales. Preliminary findings from the first year of the program reported large effect sizes on measures of inattention and school functioning and small to moderate effect sizes for grades (Evans *et al*., 2004). Results from the second year of the program found moderate to large effect sizes on academic functioning and classroom disturbance as rated by parents and teachers, whereas the community care group showed either no change or a decline on these measures (Evans *et al*., 2005). Furthermore, examination of grade point average (GPA) across semester found that while no differences were present between groups during the first semester, the CHP group had a significantly higher GPA than the community care group during the second semester.

These findings suggest that the multi-component CHP may be an effective intervention for addressing academic impairment in adolescents with ADHD. While the data reported in these two studies are encouraging, they should be interpreted with caution since a quasi-experimental design was utilized, and sample sizes were small. Additionally, the CHP intervention was a comprehensive program which included parent training and social skills interventions in addition to educational interventions, and therefore, which intervention or combination of interventions resulted in the improvement observed on academic measures cannot be determined. Therefore, future studies should employ study designs that isolate study skills, organization, and note-taking

approaches to determine their relative effectiveness for improving task performance and classroom behavior in children and adolescents with ADHD.

Overall, the limited research on strategy training, prevents any conclusions from being drawn at this time. However, the rationale for why some of these techniques may be useful based on the specific deficits of children with ADHD (e.g., problem solving and self-verbalization strategies to address impulsive decision making), appears noteworthy and warrants further research. Strategy training may teach older children and adolescents important habits and skills to improve academic performance, while taking responsibility and burden off parents and teachers. Alternatively, instruction by clinicians, parents and teachers in the use and practice of these strategies may itself be time consuming and require active involvement over the long term. It remains unclear the length of time it takes before adult involvement can be tapered and the child or adolescent becomes an expert in the self-application of these strategies. It also remains unclear whether these strategies, once learned, may generalize to other settings or classrooms beyond that in which they were taught. Finally, as each strategy may target a different aspect of the problem, it becomes important to assess the needs of each individual child, and may be beneficial to incorporate a number of strategies into the treatment of a child or adolescent with ADHD with significant academic problems.

HOMEWORK-FOCUSED INTERVENTIONS

A particularly important academic target for the treatment of children and adolescents with ADHD is homework completion and accuracy. Large-sample educational research has shown that, aside from ability, time spent on homework is the best predictor of student grades and achievement (Cooper *et al.*, 1998; Keith, 1982). Also, parental involvement in supporting homework activities results in academic gains (Epstein, 1986). Unfortunately, research has been inconsistent and methodologically weak in documenting the effectiveness and best procedures for homework interventions (Rhoades and Kratochwill, 1998). Furthermore, very few of these studies are specific to children with ADHD, and no study in this area has been conducted on adolescents or middle school students with ADHD, who present with unique developmental and environmental challenges.

Research on homework interventions for students with general academic problems have suggested that the use of goal setting and contingency contracting, parent training in structuring the home setting, and parent–teacher consultation are beneficial in the remediation of homework difficulties (Anesko and O'Leary, 1982; Bergan and Kratochwill, 1990; Kahle and Kelley, 1994; Miller and Kelley, 1994; Weiner *et al.*, 1998). In homework-specific parent training programs, parents are taught to identify and target specific behaviors and establish a consistent homework routine (i.e., determining a quiet setting with minimal distractions, starting the process early, providing aid when needed, breaking down assignments, and prioritizing tasks) (Anesko and O'Leary, 1982). Given the frequent difficulties children and adolescents with ADHD experience in the areas of planning ahead, prioritizing, filtering out distractions, and focusing on one task at a time, it makes sense that a homework intervention specifically targeting these areas would be particularly beneficial for this group.

Another parent-implemented intervention designed to target homework difficulties is the use of goal setting procedures. Goal setting consists of the comparison of performance goals against present performance level, and may be viewed as a form of self-monitoring in which children evaluate their own performance (Bandura, 1977). Goal setting is typically combined with contingency contracting, in which the addition of performance-contingent rewards are used to increase the efficacy of goal setting. These procedures are used to directly target the homework process and provide a framework around which children can complete homework (Miller and Kelley, 1994). As both self-monitoring of goal performance and contingency management in the classroom have proven successful for increasing the on-task behavior and task completion of children and adolescents with ADHD, these interventions are also likely to prove effective when implemented by parents and focused on improving homework performance.

Other studies have attempted to involve the school system in treatment for homework difficulties through parent–teacher consultation. Coordination across home and school is vitally important in identifying and resolving points of breakdown in the homework process, as each setting may influence the other. For example, a child may not be collecting his homework materials at school and bringing them home, making it difficult for parents at home to help the child complete homework. Conjoint behavioral consultation has proven effective for children with

academic problems as a method in which parents and teachers work together to address the academic, social and behavioral needs of an individual child (Weiner *et al*., 1998). This approach may be particularly salient for children and adolescents with ADHD, who due to forgetfulness, lack of organization, and impulsivity in conveying information, may often not bring homework materials home or write down homework assignments and may convey inaccurate information about projects and assignments to parents.

Teaching parents to structure the homework process, use goal setting, and consult with school staff are intervention approaches that have been tested and found effective for use with general populations of students with academic problems, but have been largely untested for efficacy in a population of children with ADHD. In recognition of the importance of homework in predicting academic success and the salient homework problems of children with ADHD, Habboushe et al. (2001) developed a comprehensive, family-school intervention program for children with ADHD that incorporated homework management procedures, goal setting, and parent–teacher consultation in a 10-week, 7 session group treatment for parents. Preliminary case studies illustrate positive outcomes on parent and teacher reports of homework problems, and increases in homework accuracy and completion rates. No group treatment outcome study based on this program has currently been reported.

Future studies should use multiple baseline and ABAB reversal designs to examine academic components such as goal setting, parent–teacher consultation, and parent structuring of the homework setting, as well as multiple baseline and between-groups designs that test the impact of comprehensive programs that integrate these approaches, such as the one developed by Habboushe et al. (2001) on improving the homework and academic performance of children with ADHD. Furthermore, these studies would benefit from expanding the range of outcome measures used to include measures of parent–child conflict, parenting stress, impairment and the inclusion of teacher ratings. Homework accuracy rates need to be isolated and examined as a separate dependent variable, because increasing homework completion rates without homework accuracy does not indicate learning. Finally, most of these studies were conducted with children, and developmental modifications to these interventions may be necessary when working with adolescents.

CLASSROOM-BASED FUNCTIONAL ASSESSMENT PROCEDURES

Considering the plethora of academic strategies readily available to teachers and other school personnel, it often becomes difficult to make an appropriate intervention choice for an individual child. Furthermore, as children with ADHD who do receive special education services spend the majority of their day in general education classrooms (Reid *et al*., 1994), the burden of meeting their educational needs falls on the shoulders of general education teachers (Reid and Maag, 1998), who often express difficulty managing the needs of these children (Reid *et al*., 1994). Teachers and other school personnel may collaboratively develop and implement academic accommodations based on policy guidelines (i.e., Individuals with Disabilities Education Act Amendments, 1997 (IDEA)), which may not match with our current knowledge base of what works (Nelson *et al*., 1999), and may or may not be appropriate for an individual child.

An important and increasingly utilized tool in the behavioral assessment and intervention planning for children is that of functional assessment (FA). This procedure allows the clinician, teacher or other professional to individualize academic interventions for the target child, based on the identification and manipulation of environmental variables that serve to initiate, maintain and/or increase the child's problematic behavior in a particular setting (DuPaul and Stoner, 1994; Ervin *et al*., 1998). These variables may include antecedent causes such as seat location in the classroom; activity grouping (i.e., independent versus group work); time of day; active or passive response requirements; task structure; sequence or organizational structure of the curriculum; lesson length, difficulty or format; instructional strategies used (e.g., mneumonics, peer tutoring); and presence of certain peers or friends (Reid and Maag, 1998). Specific consequences (e.g., lack of teacher response, peer attention, immediate or delayed feedback, avoidance of a particular subject) that influence the particular problematic behavior are also identified and systematically manipulated. The information derived from these analyses is used to collaboratively develop an effective and socially acceptable intervention for an individual child.

The majority of studies on functional assessment have been conducted in highly controlled settings with children and adolescents with severe developmental disabilities who exhibit high intensity behaviors such as aggression, disruption or self-injury (Carr

and Durand, 1985; Carr *et al*., 1980; Iwata *et al*., 1982) and with children with emotional and behavioral disorders who exhibit off-task and disruptive behaviors (Blair *et al*., 1999; Clarke *et al*., 1995; Kern *et al*., 1994). More recently, this approach has been examined for its efficacy in increasing on-task behavior and reducing disruptive behavior in children and adolescents diagnosed with ADHD (Broussar and Northup, 1995; Ervin *et al*., 1998; Hoff *et al*., 2005; Lewis and Sugai, 1996; Northup *et al*., 1995; Umbreit, 1995). Since the strategies utilized as a result of a functional analysis include changes to academic format, structure, and instructions, it is likely that the benefits of this approach extend beyond that of on-task behavior to other academic outcomes. However, no study to date has examined the effects of this approach on increasing academic productivity and accuracy in children or adolescents with ADHD. This is despite the mandated use of FA by IDEA in school settings to improve the classroom behavior and performance of children with a variety of special needs including ADHD (Hoff *et al*., 2005). Therefore, it is critical that more studies be conducted to examine the benefits of FA for use in general and special education settings as employed by school personnel to address the academic problems of children and adolescents with ADHD. This approach may prove the most effective means of intervention selection for an individual child with ADHD and may aid in the development of 504 plan and Individualized Education Plan (IEPs) goals and intervention plans which are more effective and appropriate for a given child.

There also may be some significant limitations to the school-based application of FA principles, including the considerable effort and time on the part of school personnel to generate and subsequently test hypotheses in order to design an appropriate intervention for an individual child. Some have suggested the use of interviews and brief functional assessment methods to address some of these practical concerns (Harding *et al*., 1994; Kern *et al*., 1994); more cost and time efficient methods of FA should be explored through future research. Furthermore, results of FA may not generalize to other classroom settings in which the child is currently involved without systematic intervention testing in those settings as well.

MULTIMODAL TREATMENT APPROACHES

While the focus of this literature review largely has been the examination of each individual academic technique, there have also been a number of multimodal treatment packages, which successfully incorporate many of these academic interventions. For example, the aforementioned CHP Program incorporates note-taking, organizational, and study skills training within the context of a comprehensive psychosocial treatment targeting multiple domains.

Another well-researched, multi-component program is the Children's Summer Treatment Program (STP), which combines an intensive summer treatment program with a school-year, outpatient follow-up program (Pelham *et al*., 2005). During the summer program, children spend 2 h daily in classrooms in which individualized seatwork, peer tutoring and computer-assisted instruction is provided. The rest of the day is spent in recreationally based group activities. Evidence-based contingency management techniques are utilized throughout the program and include the use of a point system, daily report card, time out, public recognition, and home-based rewards (Pelham *et al*., 2005).

Analyses of 258 boys with ADHD who attended the STP found large effect sizes on direct observations of on-task and disruptive behaviors (Pelham and Hoza, 1996). In addition, the classroom-based behavioral components of the STP (i.e., token economy, DRC and time out) have been specifically examined in two studies (Carlson *et al*., 1992; Pelham *et al*., 1993), which found improvements in on-task and disruptive classroom behavior but limited improvements in academic productivity as a result of these interventions. The academic interventions incorporated into the classroom component of the STP (e.g., peer tutoring, CAI) do not appear to have been isolated to examine their effect on academic productivity. A modified treatment design in which some students receive these academic interventions and others do not, as has been conducted with other component interventions within the STP (e.g., time out), may be necessary in order to tease apart the effect of the academic versus behavioral classroom interventions used within the STP. While aspects of the STP such as CAI and peer tutoring may likely hold benefit in improving academic performance, it is currently unclear the extent to which these individual academic components contribute to any improvements observed in academic productivity or on-task behavior in the STP classroom. Further, other academic measures such as achievement test scores and academic accuracy may be important outcomes to examine when isolating these STP components.

In another large, well-controlled study, Hechtman et al. (2004) compared the following three treatments in a sample of 103 children with ADHD: (1) stimulant medication alone; (2) stimulant medication plus psychosocial treatment that included academic remediation, organizational skills training, individual psychotherapy, parent training, and social skills training; and (3) stimulant medication plus attention control treatment. Results found no advantage on standardized achievement test scores or parent-report on the Homework Problems Checklist for the combined treatment compared to stimulant medication alone and stimulant medication plus attention control. Therefore, this particular study suggests that there may be little support for the incremental benefit of academic assistance in specifically enhancing the long-term achievement scores and reducing the parent-reported homework problems of stimulant-responsive children with ADHD (Hechtman *et al*., 2004).

Similarly, early findings from the largest and most well-controlled study in child mental health to date, the Multimodal Treatment Study of Children with ADHD (MTA; MTA Cooperative Group, 1999), found that the combined treatment (i.e., medication plus intensive parent training, biweekly teacher consultation, a paraprofessional aide working directly with the child in the classroom, and participation in the STP program) did not prove superior to medication management alone on multiple domains of functioning, including ADHD core symptoms and achievement test scores (MTA, 1999). However, numerous authors highlight limitations present within the MTA study design that may have favored a positive outcome for the pharmacological approach (see Cunningham, 1999; Pelham, 1999). Furthermore, in later analyses of a composite variable obtained by combining parent and teacher report, the combined treatment was found to be statistically and clinically superior (demonstrating 12% greater treatment success) than the medication management alone condition (Conners et al., 2001). In addition, significantly lower medication doses were required in the combined treatment versus the medication management alone condition (MTA Cooperative Group, 1999). Therefore, findings from the MTA study suggest that a comprehensive behavioral intervention may offer the greatest advantage and contribute significant additional benefit beyond the effects of medication alone on multiple domains of functioning.

Both the MTA study and Hechtman's multimodal approach compare medication to a comprehensive psychosocial treatment, and therefore cannot answer questions such as the extent to which specific academic interventions improve the achievement and academic behavior of children with ADHD, the effects of these interventions on non-stimulant responsive children, and their efficacy compared to other active behavioral approaches. Furthermore, while the MTA incorporated a wide variety of outcome measures, no measures of academic productivity or quality, test and quiz scores, or grades were utilized; only achievement scores were used to assess academic changes. Achievement scores may be less likely to detect small, daily changes in academic performance and therefore may not adequately highlight any differences that may exist in academic performance across conditions. Future studies of the separate and combined effects of these treatments would benefit from incorporating a wider range of academic outcome measures, some of which are more directly targeted by the interventions (e.g., daily classwork and test performance).

CONCLUSION

Children and adolescents with ADHD experience significant and debilitating impairments in academic performance and school-related behavior relative to their peers. This appears to be largely a consequence of the manifestation of executive functioning deficits in children with ADHD and resulting symptoms of inattention, hyperactivity and impulsivity. Academic problems of children and adolescents with ADHD commonly lead to significant negative outcomes including grade retention, special education placement, suspension or expulsion, and eventually, job failure. While stimulant medication and behavior modification typically target and have proven effective for improving the on-task and disruptive behavior of children with ADHD within the classroom, the effects of these evidence-based approaches on academic performance are much smaller and less often studied, and limitations to the utilization of these interventions in general do exist.

Academic interventions focus primarily on manipulating antecedent conditions such as academic instruction or materials in order to improve both behavioral and academic outcomes. Interventions which have received some research attention and have demonstrated at least some preliminary benefit in the treatment of children and adolescents with ADHD include: (1) classwide peer tutoring and parent tutoring which employ one-to-one instruction,

immediate and frequent feedback, and require active responding; (2) instructional and task modifications, which may include allowing students to choose assignments from among several pertinent alternatives, presenting material orally and requiring oral responses in addition to presenting material visually, adding structure or using explicit instructions, employing computer-assisted instruction, and using color or texture to increase stimulation within tasks; (3) classroom functional assessment procedures; (4) self-monitoring and reinforcement, particularly for older children and adolescents; (5) strategy training, including note-taking, study skills and organizational skills interventions; and (6) homework-focused interventions which incorporate goal setting, parent structuring of the homework process, and parent–teacher consultation approaches.

Of these interventions, there are a few approaches that currently appear most promising. In particular, peer tutoring has resulted in large effects on on-task behavior and smaller but still significant effects on academic productivity in two group-design studies. Self-monitoring techniques have resulted in large effects on on-task behavior, disruptive behavior, academic output and academic accuracy in a few studies (i.e., two between-group studies and one within-subjects design). These benefits were found to be larger than the effects of MPH on academics in one study; in another study, academic performance and the accuracy of self-ratings were maintained even after the matching process was withdrawn, in which students received points for matching ratings within one point of their teachers. Task modifications such as the addition of color stimulation to certain tasks resulted in fewer errors and greater productivity in a couple of studies employing a between-groups design. However, the benefits of color appeared to vary depending upon the complexity of the task, and the time in which stimulation was added to the task (i.e., early, middle or late). Finally, it also appears that some multimodal programs which incorporate organizational and note-taking skills training, and/or employ techniques such as peer tutoring and computer assisted instruction (e.g., the Challenging Horizons Program and the Summer Treatment Program) have experienced reliable success in improving the academic productivity and grades of children with ADHD. Therefore, it would be beneficial to isolate some of the component interventions used within these programs and test them in well-controlled group design studies.

Salient Characteristics of Academic-Focused Interventions

Although relatively little attention has been focused on the development of academic-focused interventions in the treatment of academic impairment in children and adolescents with ADHD, and the research that has been conducted is mainly of a preliminary nature, some tentative recommendations can also be derived from this review as to which aspects of academic-focused interventions may be most beneficial to the child or adolescent with ADHD.

First, it appears that academic interventions which require active engagement on the part of the student with ADHD typically result in better performance than those with passive attentional requirements (e.g., oral versus silent reading; peer tutoring versus traditional instruction, note-taking versus passive listening to lecture format classes). Active engagement may improve the length of attention span and allow for a deeper level of information processing. Active processing of information may be particularly important for increasing task accuracy. For example, in the Evans et al. (1995) study, the process of note-taking improved daily assignment scores and attention, but did not improve weekly quiz scores, which may require active studying of the notes taken in addition to the process of writing notes.

Another important goal of academic-focused interventions may be to decrease distractions and/or reduce the amount of competing, non-relevant stimuli, while providing an optimal level of relevant stimulation to hold attention on the current task. CAI research found some evidence that computer animation may be more of a detriment than a benefit to the task performance of children with ADHD, possibly due to providing too great a level of task stimulation, whereas providing computer activities in a game format was found to be beneficial to attention and performance. Similarly, adding color to a written or computer task appears to confer benefits for the child with ADHD in increased attention on simpler tasks, but for more complex operations, adding color may function as a distraction that actually inhibits learning. In addition, providing a choice of task from among several structured alternatives may serve to increase interest level, relevant stimulation, and thus the attention of the child with ADHD. Therefore, a consistent theme throughout the research on many academic-focused interventions is an attempt to increase relevant stimulation while removing potential

sources of distracting stimuli. This is consistent with optimal stimulation theory, which hypothesizes that children with ADHD have a greater need for stimulation and are less tolerant of situations involving minimal stimulation, which result in increased errors and excessive motor and verbal activity in this group during repetitive or mundane tasks or activities (Zentall, 1975).

Consistent with behavioral management practices which stress the effectiveness of positive reinforcement in the treatment of children with ADHD, the academic-focused interventions reviewed herein typically provided immediate feedback in the form of teacher and parent praise, computer rewards, tangible rewards or privileges. The use of positive feedback may be an important component to the implementation of these academic interventions, as they serve to reinforce targeted behaviors and increase motivation and persistence at tasks.

Consistent with academic accommodations for students with ADHD that are typically included on IEP plans, the academic-focused approaches tested in these studies often attempt to divide academic material into smaller chunks of information, or divide homework into smaller subunits through the use of goal setting. By making the workload appear more manageable, and focusing a child's attention on only one aspect of a task, increases in productivity have been observed. This may be a particularly important skill for children with ADHD to learn given their difficulties with organization and the completion of multi-step tasks. These techniques are a main component included in CAI, peer and parent tutoring, note-taking, self-monitoring and goal setting interventions.

Another characteristic of some of these interventions is the transferring of decision making and responsibility to the older child, which may be preferred by teachers and parents over the use of behavioral control, because of their time and cost efficiency. For example, having children set their own goals for productivity and monitor their task completion and accuracy frees up teacher time for more individualized instruction. Methods which place added responsibility on the child may also increase the maintenance of behavior change and generalization across settings, as children develop habits and skills that are further reinforced over time. The ability of these approaches to be effective is most likely highly dependent on the cognitive and developmental level of the child. As children with ADHD transition into adolescence, developmental changes such as increases in independence seeking, and cognitive changes such as increases in abstract thinking and problem solving capabilities (Smith *et al*., 2000), may make it more likely for the older child or adolescent with ADHD to become actively engaged in and responsible for aspects of his or her own intervention.

Another common theme observed was the focus on providing one-to-one instruction or tailoring the intervention to the specific needs of the child. For example, CAI instruction was designed to be self-paced, and to provide a choice among various levels of difficulty. Peer and parent tutoring also focuses on one-to-one instruction, allowing the child to progress at his or her own pace, and to receive individualized feedback. These approaches may be particularly salient for the child with ADHD, who may need a more intensive level of instruction at his or her own ability level in order to be successful. Finally, functional assessment procedures result in the development of an intervention which effectively modifies the antecedents and consequences maintaining the problematic behavior in the given environment for a specific child. Use of FA procedures may be the most effective method for practically choosing among a variety of efficacious alternatives.

The recurring themes presented here suggest that there are likely certain aspects of academic-focused interventions for children and adolescents with ADHD that are commonly incorporated into a variety of approaches due to their acceptability, efficacy, and practicality. It is recommended that future research attempt to uncover potential mediators and moderators of intervention success through a careful examination of components or aspects common to many academic-focused interventions. For example, active components of CAI may include aspects of the format, animation, novelty, reinforcement schedule, and duration of the intervention. Furthermore, dismantling studies which examine only one component of a given intervention are also of paramount importance in developing a more comprehensive understanding of what it is about these interventions that are beneficial for children and adolescents with ADHD.

Limitations of Current Research and Future Directions

Perhaps the most realistic conclusion that can be derived from this review is that while certain academic-focused interventions show considerable promise for children and adolescents with ADHD, surprisingly little research attention has been devoted

to testing their efficacy in the treatment of academic impairment in ADHD, and the majority of studies that have been conducted are severely limited by methodological flaws. As academic impairment is one of the major concerns for children and adolescents with ADHD, the field of clinical research and practice may benefit from increasing their focus on this functional domain. Future studies would benefit from employing larger sample sizes within randomized, controlled trials utilizing between-groups designs. This will serve to bolster preliminary evidence derived from single case and multiple baseline studies. In addition, the duration of most interventions was only one to two weeks, and more robust effects may require longer-term studies to be implemented with longer interventions and longer follow-up periods. Finally, many previous studies did not control for carryover effects, did not assess inter-observer agreement, and did not employ adequate measures of treatment fidelity and integrity. Therefore, it becomes difficult to make any real conclusions regarding these results given the myriad of confounding factors which may account for positive findings.

Furthermore, while many studies employed measures of on-task and disruptive behavior, many fewer employed academic outcome measures (e.g., task completion and accuracy, grades, quiz and assignment scores, achievement test scores, reading comprehension). This is critically important given the need to directly target and improve the academic behavior of these children. Some of the studies highlighted above observed large increases in on-task behavior and work productivity, with more variable changes in the accuracy of work. Accuracy rates may be more indicative of learning than on-task behavior or completion of work, and may be more difficult to change. Therefore, future studies may benefit from a more careful focus on objective measures of academic success such as improving task accuracy, test and quiz scores, and comprehension of material.

Another significant methodological caveat that arose repeatedly throughout these studies is the use of researchers to implement treatment in laboratory-based classroom settings, rather than implementation by teachers in an ecologically valid setting (i.e., regular or special education classrooms). Furthermore, as most studies failed to include measures of treatment acceptability, fidelity, and satisfaction, it remains unclear whether teachers, parents and other school professionals can effectively and consistently employ these interventions and will consider them practical, feasible and desirable for incorporation into their daily activities. Effectiveness studies in real-world settings are direly needed to explore these questions. Although some academic interventions are easy to apply (e.g., incorporating choice in tasks, adding color or other stimulation), other interventions require considerable time and effort on the part of teachers and parents in order to teach children a new habit or skill (e.g., note-taking training, study skills training, self-monitoring), implement a new technique (i.e., parent tutoring, homework program), or develop an individualized intervention (i.e., functional assessment). This may decrease the acceptability of the intervention by teachers and parents and the feasibility of implementation in home and school settings. Alternatively, it is possible that many short-term academic interventions may have more robust effects if administered over the long-term. O'Leary (1980) argued that changes in standardized achievement test scores have been demonstrated as a result of some short-term behavioral interventions, and therefore, replication and extensions of these treatments for at least 6–12 months are critically needed in order to determine if long range academic changes can be made. This is consistent with the concept of teaching "skills". Therefore, practicality and feasibility for implementation within the school setting must be balanced with the need for methods which offer the most long-term benefit to the academic skills of children with ADHD.

In developing more time- and cost-efficient methods, it would be essential to explore whether teachers and parents may be able to taper their involvement over time as older children and adolescents master academic habits and skills. Unfortunately, due in part to the short duration of most academic-focused treatment studies and the lack of follow-up assessments, this question remains largely unexplored, with the exception of some preliminary evidence that older children are capable of accurately self-monitoring their behavior and task performance. The ability to taper involvement over time will likely be partially dependent on the cognitive-developmental level of the child or adolescent. Therefore, studies need to be expanded beyond the examination of elementary school age children to include a wider range of ages and a greater number of adolescents, in order to understand critical developmental and individual differences which may influence treatment.

Another constraint of some of these studies involves the inconsistency with which a diagnosis of ADHD was established. Some studies required only that participants surpass a cut-off score on the

Conner's Behavior Rating Scale teacher version (e.g., Ajibola and Clement, 1995; Belfiore *et al*., 1996; Fitzgerald *et al*., 1986; Zentall, 1985) or another teacher report measure (e.g., Robinson *et al*., 1981; Zentall, 1986). This is not consistent with best practices for diagnosing ADHD, which include the integration of reports from multiple individuals in more than one setting (Barkley, 1998). In addition, some studies did not restrict their sample to individuals with ADHD, and therefore it cannot be determined from this data how much these findings apply to children with ADHD versus children with emotional and behavioral disorders in general.

For example, LDs are highly comorbid with ADHD and result in unique and typically more severe educational problems for the child with ADHD (Silver, 1992; Hinshaw, 1992a, 1992b). The exacerbation of academic difficulties found in children and adolescents with ADHD whom have a co-occurring learning disability suggests that the benefits of interventions may be dampened in this group (Hinshaw, 1992b), especially when administering short-term approaches that target only one domain. Most of the studies highlighted in this review did not examine the differential impact of treatment on those children with ADHD who also have an LD. Future studies should examine this variable as a moderator of treatment outcome.

There are other important areas of methodological concern. As mentioned previously, academic-focused interventions often utilize immediate feedback and consequences (i.e., praise and rewards) as part of the intervention. While this addition likely bolsters treatment effects, it also makes it difficult to disentangle the effects of contingency systems implemented concurrently with academic interventions from the effects of the academic interventions alone. Study designs need to be aware of this potential pitfall and correct for it through comparison of academic-focused treatment with and without contingencies, and/or through controlling for this variable in the study design or analyses.

Furthermore, studies of academic interventions implemented within the context of a multi-component treatment program (e.g., goal setting in homework programs, study skills in an after-school treatment program, CAI in the STP program) would benefit from dismantling studies designed to examine each individual component to determine the relative benefits of each. As individual components are found effective, a constructive treatment strategy may be used to develop a comprehensive treatment package to enhance outcome. Given the significant and wide-ranging academic deficits children and adolescents with ADHD manifest, it is likely that a multi-focused intervention will be most effective in the amelioration of these difficulties. As some academic-focused interventions prove effective, examination of the relative efficacy of these techniques or treatment packages through comparison to other active treatments (i.e., behavior modification programs and stimulant medication alone, and in combination) will become an important next step.

As research evidence accumulates, our knowledge base of effective academic-focused interventions should be used to inform parents, teachers and policy makers. Policy recommendations of "best practices" for educational accommodations should be consistent with research knowledge of "empirically supported" treatments in order to accurately direct the efforts of school professionals and practitioners. Increasing the communication between researchers, teachers and parents and the federal dollars allotted to education will most effectively result in current knowledge being put to use effectively. Furthermore, collaboration between home and school settings can result in more robust effects as teachers can communicate daily success and goal achievement to parents, and parents can support teacher-implemented interventions through reward systems at home, and vice versa. Through active efforts at disseminating research findings and through communication across disciplines and settings, strides can be made in the use of effective academic approaches for children and adolescents with ADHD in both home and school settings. These approaches may serve not only to improve grades and academic productivity in the short term, but also to disrupt negative long-term trajectories involving grade retention, school dropout, suspensions and expulsions, and substance abuse.

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