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ENHANCING ACADEMIC ACHIEVEMENT FOR CHILDREN WITH ATTENTION-DEFICIT HYPERACTIVITY DISORDER: EVIDENCE FROM SCHOOL-BASED INTERVENTION RESEARCH

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Although children with Attention-Deficit Hyperactivity Disorder (ADHD) exhibit significant academic difficulties in school settings, considerably less attention is devoted to remediating their academic problems when compared to behavioral and social difficulties. The purpose of this article is to review empirically supported academic interventions for children with ADHD. Specific evidence-based academic interventions are described under the categories of reading and mathematics, with examples that illustrate teacher-mediated interventions focusing on basic skills (e.g., phonological awareness in reading, mathematics computation) and higher-level cognitive skills (e.g., collaborative strategic reading, CSR; schema-based instruction, SBI). Finally, implications for educational practice and directions for future research on school-based academic interventions for students with ADHD are discussed. © 2008 Wiley-Liss, Inc. Dev Disabil Res Rev 2008;14:325–330.

Key Words: academic interventions; Attention-Deficit Hyperactivity Disorder; evidence-based practices

Children with Attention-Deficit Hyperactivity Disorder (ADHD) are characterized as those who exhibit developmentally inappropriate levels of inattention and/or hyperactivity-impulsivity [American Psychiatric Association, 2000; DuPaul and Stoner, 2003]. These children constitute about 3 to 7% of the school-age population in the United States, with the number of boys being 2 to 3 times more likely than the number of girls in school-based samples [American Psychiatric Association, 2000; Barkley, 2006]. In particular, children with ADHD are known to experience persistent behavioral and social problems as well as significant academic difficulties that adversely affect their school performance [e.g., Barkley et al., 1990a,b; Mannuzza et al., 1993; Montague et al., 2005; Frazier et al., 2007].

There is increasing evidence that ADHD symptoms (e.g., inattention, impulsivity, and hyperactivity) can impede learning and predict concurrent and later academic difficulties [e.g., report card grades, performance on achievement tests, teacher ratings of educational functioning; see Barkley et al., 1990a,b; DuPaul et al., 2004]. In fact, the standardized mean difference in achievement between students with and without ADHD is in the moderate to large range ($d = 0.71$) [Frazier et al., 2007]. It is not surprising then that children with ADHD are at higher than average risk for grade retention and school drop-out [Barberesi et al., 2007]. Further, the co-morbidity of ADHD with conduct disorder (CD), oppositional defiant disorder (ODD), mood disorders, anxiety disorders, learning disabilities (LD), and other disorders (e.g., mental retardation, Tourette's syndrome) can be debilitating and lead to life-long difficulties [Purdie et al., 2002]. Clearly, it is important for educators and other school personnel to be cognizant of effective interventions for this disorder and to promulgate their use to prevent later difficulties.

Although it is acknowledged that children with ADHD fall behind their peers academically [Barbaresi et al., 2007; Frazier et al., 2007], the majority of research has focused on treating the behavioral symptoms (i.e., inattention, impulsivity, and overactivity) of ADHD rather than the associated academic problems. The most common and widely studied treatments of ADHD include psychostimulant medication (e.g., methylphenidate) and contingency management strategies, both of which have shown to improve productivity on academic tasks possibly by improving these students' attention skills and speed of information processing [Barkley, 2006]. However, findings from the Multimodal Treatment of Children with ADHD (MTA) studies indicate that the impact of such treatments on educational achievement is negligible [MTA Cooperative Group, 1999, 2004]. Regardless of the benefits of medication (e.g., increased attention) and behavior modification strategies (e.g., reduction in disruptive behavior), interventions that directly focus on academic skill deficits in content areas such as reading and mathematics are important if

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we are to improve the academic achievement of students with ADHD.

The purpose of this article is to provide an overview of various empirically supported academic interventions for students with ADHD. First, academic intervention research with ADHD school-age samples conducted in school settings that include academic outcome measures is discussed. Specifically, we describe a recent randomized controlled trial study conducted with a large sample of elementary school children with ADHD. Second, specific academic interventions are described under the categories of reading and mathematics. Finally, implications for practice and directions for future research on school-based academic interventions for students with ADHD are discussed.

ACADEMIC INTERVENTIONS

Prior work in academic intervention research for students with ADHD has typically focused on instructional modifications such as altering tasks and materials presented to students. For example, Lee and Zentall [2002] showed that children with ADHD are likely to complete more problems and complete them accurately during a simple mathematics task when high rather than low levels of engaging stimuli are included within the task. Another example of this approach is the use of interspersal methods that present a series of high demand tasks interspersed by low demand tasks for acquiring mathematics skills [e.g., Robinson and Skinner, 2002]. Although the instructional modification approach has some value, the acceptability of this intervention in general education classrooms may be an issue. The majority of students with ADHD are placed in general education classrooms even though they may receive special education services [Barkley, 2006]. Teachers are often not likely to support such practices, in part because they may perceive these techniques to be disparate from their beliefs about how students learn, disconnected with their normal instructional methods, or not linked to the goals of "high-stakes" assessments [Boardman and Woodruff, 2004; Boardman et al., 2005].

Other widely used interventions for students with ADHD include peer-mediated interventions and computer-assisted instruction (CAI) [DuPaul and Stoner, 2003; Pfiffner et al., 2006]. Several models of peer tutoring have been investigated for use with this population. Most models include characteristics known to be effective for students with ADHD such as: (a) working one-to-one with another individual; (b) the learner determining instructional pace; (c) continuous prompting of academic responses; and (d) providing frequent, immediate feedback about quality of performance [Pfiffner et al., 2006]. A study by DuPaul et al. [1998], for example, evaluated the effects of class-wide peer tutoring (CWPT) for 18 students with ADHD who were placed in first through fifth grade general education classrooms. CWPT not only improved these students' academic performance, with moderate to large effects for math and spelling, but also led to reductions in their off-task behavior. Another example of peer-mediated interventions that is known to be effective is the use of peer-assisted learning strategies (PALS) for enhancing reading skills [see Locke and Fuchs, 1995].

Students with ADHD should first receive expert instruction in critical academic areas (e.g., reading and mathematics) to maximize the benefits of peer-mediated interventions and CAI.

CAI is a method that allows teachers to provide students with opportunities to review and practice the material independently. CAI is known to enhance presentation of instructional material and improve students' motivation and academic achievement [see Hall et al., 2000]. Research on CAI for small samples of children with ADHD has shown clinically significant gains in oral reading fluency [Clarfield and Stoner, 2005] and basic mathematics computation skills [Ota and DuPaul, 2002; Mautone et al., 2005].

In sum, peer-mediated interventions and CAI are promising in helping students with ADHD effectively learn academic content. Both these approaches maybe used for multiple purposes (e.g., tutoring and remediation, substitute for independent seatwork) and involve either the student or computer as teachers, with the majority of the interactions occurring between students or between students and the computer. For students with ADHD, however, it is important that they first receive instruction in critical academic areas (e.g., reading and mathematics) from experts or teachers in order to maximize the benefits of peer-mediated interventions and CAI. Yet, we found no teacher-mediated intervention studies focused specifically on students with ADHD that addressed these students' difficulties in reading and mathematics. Further, most of the research on academic interventions has involved small samples, the use of a single intervention or a "one size fits all" approach, wherein all participants receive the identical intervention regardless of individual differences, and evaluation of only short-term (e.g., several weeks or months) academic outcomes. Clearly, this research has not addressed the diversity of the ADHD population and the need for long-term evaluation of outcomes given the chronicity of this disorder. In the following section, we describe a recent large-scale, randomized controlled, longitudinal study that we conducted with elementary age students with ADHD using multiple treatments and measures to assess academic competence in reading and mathematics.

DuPaul et al. [2006] and Jitendra et al. [2007a] compared two different models of school-based consultation on the academic achievement of 167 elementary school children (grades 1 through 4) with ADHD. In addition to experiencing significant academic difficulties in reading and mathematics as reported by their classroom teachers, students in the study met DSM-IV-TR [American Psychiatric Association, 2000] criteria for one of the three subtypes of ADHD (68% combined type). The sample included 38% diagnosed with co-morbid ODD, and 15% with CD. About 29% of participants were receiving psychotropic medication.

Students were randomly assigned to one of two educational consultation groups: Intensive data-based academic intervention (IDAI) and traditional data-based academic intervention (TDAI) and received intervention in reading and/or mathematics from their classroom teachers. In both conditions, teachers received consultative, instructional support services for ~15 months from 11 trained consultants (school psychology and special education doctoral students), who were randomly assigned to one of the two consultation groups.

Some of the common elements of consultation across both conditions included: (a) consultants providing ADHD informational sessions to teachers, (b) planning consultant-teacher collaboration meetings to design academic interventions, with teachers eventually selecting the intervention(s), and (c) using a range of evidence-based practices that supported teacher-mediated, peer-mediated, computer-assisted, and self-mediated interventions in mathematics and/or reading for students at risk for school failure (e.g., students with LD and/or ADHD). The evidence-based practices were varied and focused on both basic skills (e.g., decoding, mathematics facts and computation) and higher-level cognitive skills (e.g., reading comprehension, word problem solving).

The two groups differed in that consultants for the IDAI group collaborated with classroom teachers to design academic interventions based on assessment data, monitored treatment integrity, and provided teachers with feedback regarding integrity and student progress (e.g., mastered, no progress, adequate progress, inadequate progress). The appropriateness of the intervention plan and decisions to maintain the intervention, intensify or simplify the intervention, change the intervention, redefine the goals, or retrain the teacher and/or students in the use of the intervention procedures were determined on the basis of the student progress monitoring data. In contrast, consultants for the TDAI group collaborated with classroom teachers to design academic interventions based on teacher choice, monitored treatment integrity but did not provide teachers with feedback regarding integrity or outcomes, and did not collect data on student progress. Any changes in intervention were based solely on teacher report of student progress.

Measures included scores on curriculum-based measurement (CBM) in reading and mathematics, reading and mathematics scores on an individualized, norm-referenced achievement test [Woodcock-Johnson III Tests of Achievement (WJ-III); Woodcock et al., 2001], teacher ratings of reading and mathematics skills [Academic Competency Evaluation Scale: ACES; DiPerna and Elliott, 2000], individualized academic goal attainment or progress of target behavior (POTB) scores, and report card grades. All measures other than POTB were collected on four occasions (baseline, 3-months, 12-months, 15-months) across two school years. For POTB, we collected teacher ratings of student performance on nine occasions during the study to provide pre-, mid-, and postintervention assessments between baseline and 3-months (Phase 1), 3- and 12-months (Phase 2), and 12- and 15-months (Phase 3).

Hierarchical linear modeling analyses were used to assess possible differences in academic growth between the two consultation groups. Although statistically significant ($P < 0.001$) positive growth was obtained for 18 of the 24 dependent variables (with the exception of WJ-III standard scores in calculation, math fluency, and reading comprehension; Math Report Card scores; and teacher ratings of reading and math skills), slopes did not differ between the two consultation groups. To estimate the magnitude of change from baseline to 15 months, we calculated within-group effect sizes that revealed small effects ($ES \leq 0.50$) for WJ-III standard scores (except for reading fluency), ACES math and critical thinking (math), report card grade in math (both groups) and reading (IDAI only), moderate effects ($0.50 < ES < 0.80$) for changes in WJ-III reading fluency standard score, ACES reading and academic enablers scores, and report card grade in reading (TDAI only), and large effects ($ES \geq 0.80$) for WJ-III reading and math raw scores, CBM scores in both math and reading, as well as all POTB scores for both groups. One explanation for the lack of trajectory differences between TDAI and IDAI is that both groups were similar in most aspects (particularly the use of evidence-based instructional practices) and differed primarily with regard to intensity of data utilization and feedback given to teachers. As such, we describe below the most frequently implemented teacher-mediated reading and mathematics interventions, with specific examples of interventions that addressed basic skills and higher-level cognitive skills.

Higher-level cognitive skills that focus on reading comprehension include collaborative strategic reading, story grammar/mapping, and generating questions.

READING INTERVENTIONS

Reading interventions that focused on basic skills (e.g., decoding) included activities to promote phonological awareness and alphabetic understanding [e.g., O' Connor et al., 1998; Blachman et al., 2000]. In addition, repeated readings [Tingstrom et al., 1995] and listening passage preview [Rathvon, 1999] interventions were aimed at increasing reading accuracy. Higher-level cognitive skills that focused on reading comprehension included, but were not limited to, collaborative strategic reading (CSR) [Vaughn and Klinger, 1999], story grammar or mapping [Idol, 1987], and generating questions [Rosenshine et al., 1996].

Phonological Awareness and Alphabetic Principle

Phonological awareness refers to "a general appreciation of the sounds of speech as distinct from their meaning. When that insight includes an understanding that words can be divided into a sequence of phonemes, this finer-grained sensitivity is termed phonemic awareness" [Snow et al., 1998, p. 51]. It is this phonemic awareness, a prerequisite to the alphabetic principle of reading, which plays a critical role in early literacy [National Reading Panel, 2000]. Some examples of instructional activities used to develop phonemic awareness focus on simple tasks such as rhyming, matching words with beginning sounds, and blending sounds into words [see O'Connor et al., 1998; Blachman et al., 2000]. Alphabetic principle is the understanding that words are composed of individual letters and that it involves the ability to use letter-sound relations (grapheme-phoneme) to read words. Students learn that the blending strategies for phonemic awareness and alphabetic understanding are not separate entities, but are related and lead to a complete and integrated strategy for decoding words.

Collaborative Strategic Reading

CSR is a promising intervention that is effective for promoting reading comprehension of expository text for students with reading disabilities [Kim et al., 2006]. This intervention is based on the principles (e.g., interactive teacher-student dialogue, collaborative group activities, well-articulated procedures) of reciprocal teaching [Palincsar and Brown, 1984]. Students in CSR learn to implement clearly specified prereading, during reading, and after reading strategies to monitor and comprehend text. For example, prereading strategies include previewing background knowledge about a topic and predicting what the topic is about. The click and clunk strategy during reading involves students monitoring their comprehension by identifying unknown words and applying fix-it strategies (e.g., context clues) to facilitate accurate reading and comprehension. At this time, students also learn to get the gist "by identifying the most important ideas about a topic in a section of text" [Kim et al., 2006, p. 236]. After reading strategies include generating questions and reviewing key ideas learned. Teacher and student think-alouds are used to model the strategies in collaborative groups, with students assigned specific roles (i.e., leader, clunk expert, announcer, encourager, timekeeper).

MATHEMATICS INTERVENTIONS

Unlike reading, the corpus of mathematics interventions is relatively few, with interspersal techniques such as cover-copy-compare (CCC) [Skinner et al., 1989] and folding-in [Shapiro, 2004] used to promote basic facts and computation skills. In contrast, interventions in the DuPaul et al. [2006] and Jitendra et al. [2007a] studies that promoted higher-level cognitive skills focused on word problem solving using schema-based instruction (SBI) [see Jitendra et al., 2007a].

Cover, Copy, Compare

The CCC approach, initially designed to improve spelling accuracy, is based on a skill mastery hierarchy theory [Haring and Eaton, 1978], which suggests that increasing response accuracy and automaticity (i.e., the ability to recall facts with minimal time and effort) is essential for learning a new skill. In this approach, target problems are presented on a worksheet, and students read the problem and answer given on the left side of the sheet. Next, students cover the left side of the sheet and answer the problem on the right side of the sheet. Finally, students uncover the left side of the sheet and evaluate their written response. The notion of immediate feedback inherent in the CCC procedure teaches students to correct an incorrect response by rewriting the correct answer or moving to the next problem when their response is accurate. The CCC procedure, when combined with reinforcement, can be powerful in preempting students from making errors repeatedly [Skinner and Smith, 1992; Skinner et al., 1993]. Variations of this procedure include the use of different types of responses, [i.e., verbal or cognitive responding; Skinner et al., 1993, 1997].

Schema-Based Instruction

A model of word problem solving that uses schema training and visual representations is known to be effective in enhancing the mathematical problem solving performance of students with and without disabilities [e.g., Jitendra et al., 1998, 2007b; Xin et al., 2005].

Mathematics interventions are relatively few (cover-copy-compare and folding-in typically promote basic facts and computation skills.) Schema-based instruction can address higher-level cognitive skills such as word problem solving.

In SBI, instruction focuses on identifying the underlying mathematical structure of word problems that is critical to problem comprehension and successful problem solving. Organizing problems on the basis of structural features (e.g., rate problem, compare problem) rather than surface features (e.g., the problem's cover story) can mediate problem solution. Schemata are domain specific organized knowledge structures "consisting of certain elements and relations" specific to the situations and how they relate to one another [Mayer, 1992, p. 228]. SBI facilitates mathematical modeling of word problems using semantic cues (e.g., both red crayons and yellow crayons are crayons) and schematic diagrams that depict the relations (red crayons and yellow crayons are subsets and all crayons are supersets) between objects in the problem text. Instruction highlights the importance of understanding these relations to set up the mathematical model (e.g., n red crayons $+$ m yellow crayons $=$ x crayons) and use it to select an appropriate mathematical operation (add to solve for the superset or subtract to solve for the subset) in order to solve the problem.

An additional feature of the SBI model is the use of student "think-alouds" to help in the development of metacognitive or self-monitoring skills [e.g., Kramarski and Mizrachi, 2006]. Teachers work with students to reflect on the problem before solving it. The self-monitoring component embedded in SBI has an added positive effect on students' mathematical problem solving performance as well as serves to promote productive and transferable knowledge [see Jitendra et al., 2007a].

IMPLICATIONS FOR PRACTICE AND FUTURE RESEARCH

The research literature pertaining to school-based academic interventions for students with ADHD suggests several implications for practice. First, it is crucial that educators and clinicians working with individuals with ADHD use evidence-based practices if the goal is to improve these students' academic achievement. Because both the IDAI and TDAI groups in the DuPaul et al. [2006] and Jitendra et al. [2007a] studies employed evidence-based instructional practices (with or without feedback and progress monitoring) that resulted in large effect sizes in reading and math, this primary prevention effort may be sufficient to address the needs of most students with ADHD. However, the undifferentiated academic outcomes for the two groups also suggest that the more intensive consultation support services integral to the IDAI approach is essential for only a small group of children with ADHD. At the same time, it is important to consider cost effectiveness of a specific consultation approach in light of the challenges of working with inadequate school resources. Future empirical studies conducted with a larger sample size and over longer periods of time are needed to explore optimal conditions that might enhance the outcomes for either or both treatment approaches and subsequently increase confidence in their effectiveness.

Another implication for practice is the need to focus on the practicality and feasibility of the intervention. Consideration should be given to teacher involvement in planning and selecting interventions as in the Jitendra et al.

[2007a] study, because teachers are more likely to implement interventions that they are invested in. Further, interventions should be easy to implement across settings (e.g., general education and special education classrooms) if they are to be sustained over time. This emphasis on practicality and feasibility of interventions must extend beyond elementary school and the domains of reading and mathematics, because ADHD is a chronic disorder that requires treatment in many areas throughout the school years. Future school-based treatment outcome studies should consider other content areas as well as the diverse needs of secondary students with ADHD. This would entail developing interventions that focus not only on content skills but also study skills to allow students with ADHD to successfully access information from secondary classes [Evans et al., 2007].

In summary, given the chronicity of ADHD as a disorder that adversely impacts school functioning, the need to identify effective school-based academic interventions is critical. Empirical studies of school-based interventions have supported teacher-mediated, peer-mediated, and CAI approaches in improving the academic outcomes for children with ADHD. Specifically, school-based professionals are urged to use evidence-based interventions in reading and mathematics that are also feasible and practical. Judicious selection and implementation of such interventions in actual school settings would more likely maximize the likelihood of school success and close the achievement gap for children with ADHD. ■

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