Exceptional Children

Vol. 71, No. 4, pp. 361-377.

Self-Regulation Interventions for Children With Attention Deficit/Hyperactivity Disorder

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ABSTRACT: *Current recommendations for the treatment of attention deficit/hyperactivity disorder (ADHD) call for a multimodal approach including a combination of medication, behavior modification, school accommodations, and ancillary services. One method that has been proposed as an effective and efficient means for increasing students' attention and academic productivity is self-regulation. This article reports the results of a meta-analysis of the literature on the use of four self-regulation interventions (self-monitoring, self-monitoring plus reinforcement, self-management, and self-reinforcement) for children with ADHD. Combined effect sizes for these four treatments were greater than 1.0 for on-task behavior, inappropriate behavior, and academic accuracy and productivity, indicating that self-regulation interventions are effective for children with ADHD.*

Attention deficit/hyperactivity disorder (ADHD) is a chronic disorder that is thought to affect from 3% to 7% of school-age children (American Psychiatric Association, 2000). Children with ADHD typically exhibit problems maintaining attention, sustaining effort, modulating motor activity, and organizing and finishing tasks (American Psychiatric Association). In addition, they often exhibit comorbid behaviors such as depression, anxiety, oppositional defiant disorders, and compulsive behaviors (National Institute of Mental Health, 1996; Whalen & Henker, 1991). As a result, many children with ADHD encounter difficulties in the school environment, often in the form of disciplinary problems or academic difficulties (e.g., underachievement, poor grades, or failure to complete assignments; DuPaul & Stoner, 2003). At present, the recommended treatment for children with ADHD involves a multimodal approach that combines medication (e.g., psychostimulants), behavior modification, accommodations, and ancillary services (e.g., counseling; Barkley, 1998; Reid, 1999). Of these approaches, probably the most well known and

widely used is medication (Goldman, Genel, Bezman, & Slanetz, 1998). Although the use of medication for the treatment of symptoms for ADHD has a documented record of effectiveness (MTA Cooperative Group, 1999), it is not recommended in isolation. There is evidence that other approaches (e.g., behavior management, educational accommodations) are useful both in isolation and in conjunction with medication (Conners et al., 2001; Pfiffner & Barkley, 1998).

One type of intervention that holds promise for children with ADHD is one that can help children self-regulate their behavior. Self-regulation describes a number of methods used by students to manage, monitor, record, and/or assess their behavior or academic achievement. Self-regulation can be used to decrease maladaptive or increase positive target behaviors (Kern, Ringdahl, Hilt, & Sterling-Turner, 2001) and has shown considerable success with children with learning disabilities (e.g., Graham & Harris, 2003; Reid, 1996), behavior disorders (e.g., Nelson, Smith, Young, & Dodd, 1991; Smith & Sugai, 2000), and mental retardation (e.g., Cole & Gardner, 1984).

Recently, Strayhorn (2002) argued that there is a need to develop systematic programs to enable self-regulated behavior among children with ADHD. This is consistent with recent theoretical work in ADHD that has begun to conceptualize ADHD as a deficit in self-regulated behavior (Barkley, 1997). From this perspective, ADHD results from a performance deficit rather than a skill deficit. In other words, ADHD is "not a disorder of knowing what to do, but of doing what one knows" (Barkley, 1998, p. 249). One important component of self-regulation is a conscious appraisal of immediate past behavior (Barkley, 1997). This information allows individuals to assess past behavior and, if necessary, change their pattern of responding (i.e., inhibit an automatic response). The feedback enables a comparison between what the child is doing and what the child should be doing, which in turn serves as a cue to maintain appropriate behavior or change inappropriate behavior. Ensuring a steady stream of feedback is important. As Barkley (1998) noted, one critical factor in self-regulation for children with ADHD is "more feedback more often" (p. 250).

Self-regulation describes a number of methods used by students to manage, monitor, record, and/or assess their behavior or academic achievement.

Self-regulation theory has long recognized the importance of a feedback cycle in which individuals systematically self-assess and self-evaluate their behavior (Pintrich, 2000; Zimmerman, 2000). These processes are seen as fundamental to the development of self-regulation. A discussion of the four common forms of self-regulation that incorporate these processes follow.

SELF-MONITORING

Self-monitoring (SM) is a multistage process of observing and recording one's behavior (Mace, Belfiore, & Hutchinson, 2001). Two steps are involved in SM. First the individual must discriminate the occurrence of a target response; second, the individual self-records some dimension of the target response (Mace et al.). Self-recording is seen as providing an immediate consequence (Mace et al.). Two types of self-monitoring interventions are commonly described in the literature: (a) self-monitoring of attention (SMA), and (b) self-monitoring of performance (SMP; Reid, 1996). SMA is used to encourage a child's awareness of his or her attention to a required task. Procedures for SMA typically involve the use of a prompt to cue the child to self-assess whether or not they were "paying attention." SMP interventions typically entail students performing an academic task (e.g., spelling practice), and then self-monitoring the amount of completion or accuracy of their work either during or following the task. In addition to recording the result, SMP interventions often include graphing as a major component (e.g., Reid & Harris, 1993).

SELF-MONITORING PLUS REINFORCEMENT

Self-monitoring plus reinforcement (SM+R) includes the steps described in SM, however, in ad-

dition to the self-assessment and self-recording of a target behavior, the student is awarded reinforcement from an external agent for a change in the target behavior. In theory, SM interventions do not require external reinforcers (Zimmerman, 2000). However, researchers do sometimes combine SM and an external reinforcer for children with ADHD (Barkley, 1998). The purpose of this combination is to increase the salience of the self-assessments.

SELF-REINFORCEMENT

Self-reinforcement (SRF) has been defined as a process in which a person performs a behavior to satisfy a predetermined performance standard or criteria and then comes in contact with a stimulus that increases the probability of the behavior (Mace et al., 2001). The procedures used in SRF are similar to SM+R in that they provide performance feedback through self-assessment and self-recording of whether or not a target behavior has occurred (e.g., looking at the teacher, working on an assignment) or that a performance standard was reached. However, SRF differs from SM+R in that in SRF students self-award themselves a reinforcer if they determine that they reached the predetermined target behavior or criterion (Graham, Harris, & Reid, 1992). The self-administered reinforcer is typically in the form of tokens or points, which are collected and redeemed at a predetermined time. Similar to self-recording in SM+R procedures, the use of reinforcers provides a running record of student performance.

SELF-MANAGEMENT

Self-management (SMGT, also termed self-evaluation) requires that a person monitor, rate, and compare some aspect of his or her behavior to an external standard or criteria (Mace et al., 2001). SMGT is similar to self-monitoring in that SMGT requires students to self-assess and self-record a behavior at set or cued intervals (Shapiro & Cole, 1994). However, SMGT procedures include an additional step of evaluating accuracy. In SMGT, the student's self-evaluations are matched to an evaluation of an external observer's (e.g., teacher, paraprofessional) rating of the student's behavior. Students are awarded reinforcement (e.g., points) when their self-evaluations closely match the evaluation of the external observers. It is important to note that the reinforcement is contingent upon accurate self-evaluation.

Self-regulation interventions offer a number of potential advantages to students with ADHD. First, the goal of these interventions is to instill self-regulated behavior. Many children with ADHD possess the skills needed to perform desired behaviors, but they may not be able to perform the behaviors consistently or maintain performance over time because of difficulties with self-regulation (Barkley, 1998). Second, self-regulation interventions have consistently resulted in improvements in problems commonly exhibited by children with ADHD, such as on-task behavior, academic productivity (i.e., amount of work completed), and accuracy (Reid, 1996). Third, as noted earlier, self-regulation interventions have been effective with children in other disability categories, including students with learning disabilities (Reid, 1996). As there is considerable diagnostic overlap among children with learning disabilities and ADHD (Barkley, 1998; DuPaul & Stoner, 2003), with similar behaviors exhibited in both disability categories (e.g., inattention, difficulty persisting with a task), it seems reasonable to expect that self-regulation techniques would also be effective for children with ADHD.

This article uses meta-analytic methods to examine the effectiveness of four self-regulation techniques (SM, SM+R, SRF, and SMGT) for students with ADHD. First, we describe the specific characteristics (e.g., age, method of diagnosis) of the children included in the meta-analysis. Second, we describe the techniques for each type of self-regulation procedure (i.e., SM, SM+R, SRF, and SMGT), setting, and dependent variables. Third, we report the effect sizes for each of the four types of self-regulation procedures. Finally, we report results of studies that examined whether self-regulation interventions provided additive effects to using medication alone.

METHOD

Study Selection

Only studies that were published in peer-reviewed journals were included in this review. There were two reasons for this decision. First, publication in a peer-reviewed journal ensures some degree of overall quality control (Weisz, Weiss, Han, Granger, & Morton, 1995). Second, unpublished manuscripts are not readily available to researchers. Several strategies were used to identify potential studies. First, a search of ERIC and PsycInfo databases from 1974 to March 2003 was conducted using the descriptors *self-monitoring, self-recording, self-management, self-regulation, self-reinforcement, self-evaluation,* and *self-assessment,* in combination with *attention deficit, ADD, ADHD, hyperactive,* and *attention.* Second, we examined previous reviews of the literature assessing educational treatment outcomes for children with ADHD to locate other articles that may meet inclusion criteria. Third, we searched the reference list of all articles identified to locate additional articles.

One important component of self-regulation is a conscious appraisal of immediate past behavior.

To be included in the review, the study must have (a) used one of the four self-regulation interventions, (b) reported observational data that included an academic (e.g., correct responses, number of problems completed) or behavioral (e.g., on task, verbal outbursts) outcome, (c) employed a quantitative research design, and (d) included participants age 18 or younger who were identified as having ADHD (e.g., by physician diagnosis, Diagnostic and Statistical Manual of Mental Disorders, rating scale) or were currently taking medication commonly prescribed for ADHD (e.g., methylphenidate). Examples of studies that were excluded included investigations that (a) examined self-regulation interventions for the monitoring of only medication (e.g., Ardoin & Martens, 2000) or social skills (Gumple & David, 2000), (b) assessed self-verbalization or self-instruction as the self-regulation technique (e.g., Douglas, Parry, Marton, & Garson, 1976; Eastman & Rasbury, 1981), or (c) provided results that did not allow for the calculation of effects (e.g., Hinshaw, Henker, & Whalen, 1984; McDougall & Brady, 1998; Shapiro, DuPaul, & Bradley-Klug, 1998). Finally, in cases where studies reported data on heterogeneous groups of children, we reported only the data on the participants with ADHD.

Operational Definition of Interventions

The following operational definitions were used to categorize studies. SM studies were defined as studies in which participants were required to self-assess whether or not a behavior occurred and then self-record the results. In SM studies, no external reinforcer was used. SM plus reinforcement studies (SM+R) were defined as those studies in which SM was combined with external reinforcement contingent on performance of the targeted behavior. For SM+R, reinforcement was provided by an outside agent (e.g., teacher, researcher). SMGT studies were defined as studies in which participants were required to self-evaluate (e.g., self-assess and self-record) some aspect(s) of their performance and then match their self-evaluations to an external criterion (typically the evaluation of a teacher or researcher). Participants received reinforcement based on the extent to which their self-evaluations agreed with the external criterion. SRF studies were defined as those studies in which participants self-assessed their performance on a task, compared performance to a criterion, and self-awarded themselves reinforcement based on that assessment.

Effect Sizes

The American Psychological Association (2001) now recommends that studies include a measure of the magnitude of effects of interventions. We computed effect sizes (ESs) for three classes of dependent measures that would directly impact classroom performance of children with ADHD and which were commonly reported in the literature, including (a) on-task behavior, (b) disruptive behaviors, and (c) rate of academic responses or

accuracy on academic tasks. As both single-subject and group designs were employed by the 16 studies, several methods of determining the magnitude of intervention effects were used.

Group Studies. Two studies included in this review reported group data (Ajibola & Clement, 1995; Bowers, Clement, Fantuzzo, & Sorensen, 1985). For these studies, we reported the ESs presented by the authors. In both cases ESs were Glass' *d*.

Small N *Studies.* The remainder of the studies included in this review used single-subject methods. To compute ESs, we used procedures detailed by Swanson (Swanson & Sachse-Lee, 2000). First, we recorded the last 3 points in baseline and the last 3 points in treatment for each participant for each dependent variable. Each study was coded independently by two raters who recorded values for the last 3 data points in baseline and treatment for each variable. We then correlated the recorded values of each rater for each of the 3 baselines and treatment data points across all studies and obtained the average correlation. The interrater correlation obtained (averaged across 6 data points) was .94 indicating a high degree of agreement across the raters. Second, we computed means for each baseline and treatment phase. Third, we computed the average standard deviation of the baseline and intervention phases (SD_g), and then calculated the pooled standard deviation (SD_p) using the formula $SD_p = SD_g$ / sqrt 2(1-*R*) (Rosenthal, 1994; where *R* is the observed correlation between baseline and treatment data points). The observed correlation between baseline and treatment was .67. This was due in part to the fact that there were a number of ceiling and floor effects that resulted in very low correlations. Because the .67 value could spuriously inflate the value for ESs, we used the more conservative .80 value for *R* suggested by Cohen (1988). Fourth, we computed an Initial ES that equaled mean treatment minus mean baseline divided by SD_p. Finally, we transformed the Initial ES to a scale using the following method: Adjusted ES = Initial ES times sqrt 2(1-*R*).

It is not uncommon for extremely high ES to be reported in single-subject studies (Busk & Serlin, 1992). In order to avoid the possibility of extreme scores skewing the results, we set an upper limit on all adjusted ES of 3.0. Any adjusted ES greater than this limit was recoded as 3.0. We considered each AB component of withdrawal designs separately by calculating separate ESs which were then averaged. We used the following scale described by Cohen (1988) to determine the magnitude of the effect: .20 small, .60 moderate, and .80 large. This scale was intended for group designs. However, it has also been used in studies that synthesized small *N* research that used the same procedure to compute ESs (Swanson & Saches-Lee, 2000).

RESULTS

Sixteen studies met inclusion criteria for this review. These studies included a total of 51 participants. Of the studies, 3 were SM (9 participants), 8 were SM+R (23 participants), 3 were SRF (15 participants), and 2 were SMGT (4 participants). One study used both SM and SRF (Varni & Henker, 1979). For purposes of discussion, this study was included under SRF. Table 1 details intervention types, dependent variables, number of participants, ages, placement, and a brief summary of results for each study.

Self-regulation theory has long recognized the importance of a feedback cycle in which individuals systematically self-assess and self-evaluate their behavior

Participants and Settings

As Table 1 shows, participants tended to be elementary students. Of the 51 participants, a total of 48 were described as being age 12 or younger. Only 3 were age 13 or older, and no participants were of high-school age. Of the total 51 participants, 48 (94%) were male, 3 (6%) were female. Nine studies reported participants with comorbid conditions. These included learning disabilities (n = 10), oppositional defiant disorder (n = 3), conduct disorder (n = 1), behavior disorder

TABLE 1
Self-Regulation Studies

Study	*Intervention Type*	*Number & Age of Participants*	*Setting*	*Dependent Variables*	*Results*
Ajibola & Clement, (1995)	SRF	*N* = 6 Ages 9-12	Resource	Inattention, impulsivity, hyperactivity, accurate counter usage, accurate self-reinforcement, academic productivity, and academic accuracy	Increased academic productivity. Combined treatment of medication and self-reinforcement was most effective.
Barkley, Copeland, & Sivage (1980)	SM+R	*N* = 6 Ages 7-10	Experimental classroom	Number of misbehaviors in large group activity, number of misbehaviors in individual work, % time on-task during individual work, actometer scores, and misbehaviors during regular school	Number of misbehaviors decreased in individual work, did not change during group work. Mean time on-task increased for 5 of 6 students, actometer measures indicated no change during intervention.
Bowers, Clement, Pantuzzo, & Sorensen (1985)	SM+R	*N* = 6 Ages 8-11	Resource	Accuracy, accurate reinforcer delivery, and on-task behavior	Increased on-task behavior. Self-administered reinforcers superior to teacher administered.
Chase & Clement (1985)	SRF	*N* = 6 Ages 9-12	Experimental classroom	Academic productivity and accuracy	Increased academic productivity and accuracy. Combined treatment of medication and self-reinforcement was most effective.
Christie, Hiss, & Lozanoff (1984)	SM	*N* = 3 Two 4th grade, one 3rd grade	General education	On-task behavior, inattentive behavior, inappropriate behavior	Self-recording increased on-task behavior and decreased both inattentive and inappropriate behavior.
Davies & Witte (2000)	SM+R	*N* = 4 Ages 8-10	General education	Inappropriate verbalizations during academic work	Decrease in inappropriate verbalizations during self-management/group contingency intervention program.
De Haas-Warner (1992)	SM+R	*N* = 1 Ages 6-8	Integrated preschool	On-task behaviors during readiness tasks	SMP increased on-task performance during readiness task.

TABLE 1 *(Continued)*

Edwards; Salant, Howard, Brougher, & McLaughlin (1995)	SM+R	*N* = 3 Ages 7-9	General education	On-task behavior, % correct for reading comprehension	Both on-task behavior and % correct increased during self-recording.
Ervin, DuPaul, Kern, & Friman (1998)	SMGT	*N* = 1 Age 14	Residential treatment center	Teacher rated on-task behavior during active and passive class work during math, science, and writing	% of on-task behavior increased in all three academic areas during self-evaluation intervention.
Hoff & DuPaul (1998)	SMGT	*N* = 3 Age 9	General education & recess	Observations of disruptive behavior in math, reading, social studies, and recess	% of disruptive behaviors decreased across all settings.
Horn, Chatoor, & Conners (1983)	SM+R	*N* = 1 Age 9	Psychiatric inpatient hospital	% off-task behaviors, % gross motor movements, % vocalizations and noise, and total errors	Mean total errors, % off-task behaviors, and % vocalizations and noise decreased during medication and self-monitoring intervention.
Kern, Ringdahl, Hilt, & Sterling-Turner (2001)	SM+R	*N* = 1 Age 7	Hospital	Number of problem behaviors and rate of appropriate requests per hour	Number of problem behaviors decreased and rate of appropriate requests increased during self-monitoring intervention.
Mathes & Bender (1997)	SM	*N* = 3 Ages 8–11	Resource room	% on-task behaviors during academic tasks	On-task behaviors increased for all students during self-monitoring intervention.
Shimabukuro, Prater, Jenkins, & Edelen-Smith (1999)	SM	*N* = 3 Ages 12-13	Self contained private school	Academic accuracy, productivity, and on-task behaviors in reading, math, and written expression	Academic accuracy, productivity and on-task behaviors increased in all three academic areas during self-monitoring intervention.
Stewart & McLaughlin (1992)	SM+R	*N* = 1 Age 15	Special education	Off-task behavior	% of off-task behavior decreased during self-recording intervention.
Varni & Henker (1979)	SRF	*N* = 3 Ages 8-10	Clinic and separate school	Number complete and % correct on math and reading tasks, and hyperactivity	Hyperactivity levels decreased, % correct increased, and number attempted increased during the self-reinforcement package intervention.

Note. SM = Self-monitoring; SM+R = Self-monitoring plus reinforcement; SRF = Self-reinforcement; SMGT = Self-management

(n = 1), seizure disorder (n = 1), and minimal brain dysfunction (n = 1).

The procedures used to identify participants as ADHD varied considerably. Five studies used multiple methods (e.g., rating scale, clinical interview) and informants (e.g., parent, teacher) to identify participants with ADHD (Barkley, Copeland, & Sivage, 1980; Chase & Clement, 1985; Ervin, DuPaul, Kern, & Friman, 1998; Hoff & DuPaul, 1998; Horn, Chatoor, & Conners, 1983). One study (Ajibola & Clement, 1995) identified participants based on a score of 15 or higher on the Conner's Teacher Rating Scale (Conners, 1969), and one study (Bowers et al., 1985) described the participants as being diagnosed with attentional deficits. The remaining 8 studies described the participants as being "identified as ADHD", or physician diagnosed as ADHD.

The settings in which the studies took place varied widely. Four studies took place in the general education classroom. The next most common setting was the resource room (n = 3), followed by experimental classrooms (n = 2), and hospital settings (n = 2). The remaining studies were conducted in a residential treatment center, integrated preschool, self-contained private school, clinic, and separate school or nonspecific special education setting.

Self-Monitoring Studies

All three SM studies focused on self-monitoring, on-task, or inappropriate behaviors. One study, however, also compared self-monitoring of accuracy on an academic task to self-monitoring of productivity (Shimabukuro, Prater, Jenkins, & Edelen-Smith, 1999). In both conditions participants received no prompting during the task, rather self-monitoring activities took place at the end of 10- to 15-min session. The Shimabukuro and colleagues study was also the only one that did not explicitly cue participants to self-assess and self-record. Christie, Hiss, & Lozanoff (1984) and Mathes and Bender (1997) used nonverbal and verbal prompts delivered at either random or several minute intervals to cue participants to self-assess and self-record. Mathes and Bender also used fading procedures in which cues to self-assess and self-recording materials were systematically withdrawn. Positive effects maintained through both fading conditions.

Self-Monitoring Plus Reinforcement

Eight studies used SM+R procedures. Several different forms of reinforcement were used. Participants (a) were reinforced with exchangeable tokens for accurate self-monitoring (Barkley et al., 1980); (b) received stickers and points for on-task behaviors and accuracy of SM (Edwards, Salant, Howard, Brougher, & McLaughlin, 1995); (c) exchanged poker chips (used to self-monitor) for reinforcers (Horn et al., 1983); (d) received their choice of tangible, edible, social, or activity reinforcers for appropriate behaviors (Kern et al., 2001); (e) received bonus points to be exchanged for nickels (Bowers et al., 1985); (f) received teacher praise and good behavior marks that were sent home to the participant's parents (Stewart & McLaughlin, 1992); (g) selected from a menu of material, social, and activity reinforcers (Davies & Witte, 2000); or (h) were rewarded with praise and stickers for appropriate behavior (De Haas-Warner, 1992).

Self-Management Studies

SMGT procedures were used in two studies. Settings were general education classrooms and recess settings (Hoff & DuPaul, 1998), and a residential treatment center (Ervin et al., 1998). Dependent variables varied. Ervin and colleagues assessed the effects of SMGT on the improvement of on-task behavior during academic tasks, whereas Hoff and DuPaul assessed disruptive behaviors in classroom and recess settings. Both SMGT studies asked students to rate behaviors on 0 to 5 Likert-type scales to indicate the extent to which they exhibited appropriate behaviors (e.g., follow rules, attention seeking behaviors) during academic tasks and recess play. Both SMGT studies also used time intervals (ranging from 5 min to an entire academic period) for performing the SMGT procedures.

Self-Reinforcement Studies

Three studies assessed the effects of SRF on participants' academic or on-task behaviors. Participants were between the ages 8 to 12 and were either served in the resource room (Ajibola & Clement, 1995), experimental classroom (Chase

& Clement, 1985), or clinic and school setting (Varni & Henker, 1979). All three studies assessed the effects of SRF on participants' academic accuracy and/or productivity, and two also assessed other variables such as inattention, hyperactivity, impulsivity, on-task behavior, and accuracy of self-reinforcement (Ajibola & Clement; Varni & Henker).

Similar self-cuing methods were employed across the studies. For example, wrist counters were used in all three of the studies to cue participants to self-assess, self-record, and self-reinforce performance. Unlike the other self-regulation procedures, all three SRF studies did not require additional auditory or visual prompts because the participants were asked to record behaviors immediately after completion of the task (e.g., completion of reading comprehension question).

The participants were also provided with small monetary payments and exchangeable points for participating in each of the SRF studies. In two of the SRF studies, students were "hired" as participants or "research assistants" and daily wages (e.g., 5 cents to 1 dollar/day) were administrated by the "employers" for punctuality and attendance. Backup reinforcers were also awarded to participants for meeting academic goals (Ajibola & Clement, 1995; Chase & Clement, 1985). Finally, Ajibola and Clement added an additional component by employing a response-cost system for the management of aggressive, destructive, or dangerous behavior during the daily session.

Effect Sizes

Table 2 presents the ES for studies included in this review. A total of 27 within-study ESs were calculated. The majority (n = 19, 70%) of the effects were moderate to large (i.e., .6 or greater), with 18 reaching .8 or larger. Of the remaining 8 ESs, 6 were small, 1 showed no effect, and 1 was a negative effect (Ajibola & Clement, 1995). Maintenance data were reported for three studies (Edwards et al., 1995; Horn et al., 1983; Mathes & Bender, 1997). For these studies, maintenance levels were consistent with treatment levels. However, because there was only a single data point for each maintenance check, no ES could be calculated.

On-Task, Inappropriate Behavior, and Academic Performance. Table 3 presents averaged ESs for the four self-regulation procedures for on-task behavior, inappropriate behavior, and academic accuracy and productivity.

A total of 11 studies provided data that allowed for the calculation of ES on measures of participants' on-task behaviors. Of the 11 ESs calculated, 3 used SM procedures, 6 used SM+R, 1 used SRF, and 1 used SMGT. Overall, the average ESs showed that all four self-regulation methods were very effective at increasing participants' on-task behaviors. However, variability across the studies was large. For example, the range of average ESs for SM studies was .59 to 2.96. In SM+R interventions, the range of ESs was .40 to 3.00.

Six studies provided data on participants' inappropriate behavior that allowed for calculation of ES. A total of 6 ESs were calculated. The overall effectiveness of SM+R on decreasing participants' inappropriate behaviors was very strong across measures. The effect sizes for SM+R (range = .20 to 1.88) showed marked variability. SM and SMGT also showed large effects (2.36 and 1.38, respectively), however both ESs were based on only one study. Finally, SRF revealed little or no effect (.02) on inappropriate behavior, however, again this finding is based on the outcomes of only one study.

Six studies presented data allowing for the calculation of ES on participants' academic accuracy and productivity. A total of 11 ESs were calculated. Because some studies reported both accuracy and productivity data, the number of ESs is greater than the number of studies. Five of the studies presented data on both accuracy and productivity, whereas the remaining investigations presented data for only academic accuracy. For SM, participants' ES were very strong and consistently positive (range = 2.02–2.74). Although all outcomes were positive for SM+R, ESs ranged from moderate to large (range = .42–1.46). Studies assessing SRF showed the greatest range of ESs (-1.3–2.66), yet the results still indicated a strong positive effect. Finally, in SMGT, no studies assessed academic accuracy and productivity; thus, the effects of these procedures on participants' academic outcomes are unknown.

TABLE 2
Mean Effect Sizes by Study

Study	*Dependent Variable*	*Effect Size*
Ajibola & Clement (1995)	Academic productivity	2.66
	Academic accuracy	- 1.30
	On-task	0.34
	Inappropriate behavior	0.02
Barkley, Copeland, & Sivage (1980)	On-task	0.74
Bowers, Clement, Fantuzzo, & Sorensen (1985)	On-task	1.87
	Academic accuracy	0.42
Chase & Clement (1985)	Academic accuracy	0.57
	Academic productivity	1.10
Christie, Hiss, & Lozanoff (1984)	On-task	0.59
	Inappropriate behavior	2.36
Davies & Witte (2000)	Inappropriate behavior	1.76
De Haas-Warner (1992)	On-task	1.26
Edwards, Salant, Howard, Brougher, & McLaughlin (1995)	On-task	1.74
	Academic accuracy	1.46
Ervin, DuPaul, Kern, & Friman (1998)	On-task	2.53
Hoff & DuPaul (1998)	Inappropriate behavior	1.38
Horn, Chatoor, & Conners (1983)	On-task	0.40
	Inappropriate behavior	0.20
Kern, Ringdahl, Hilt, & Sterling-Turner (2001)	Inappropriate behavior	1.88
Mathes & Bender (1997)	On-task	2.96
Shimabukuro, Prater, Jenkins, & Edelen-Smith (1999)	On-task	2.27
	Academic productivity	2.74
	Academic accuracy	2.02
Stewart & McLaughlin (1992)	On-task	3.00
Varni & Henker (1979)	Academic accuracy	1.74
	Academic productivity	1.83

TABLE 3
Mean Effect Sizes and Number of Participants Across Interventions

Behavior	*SM* *ES* (SD)	*SM+R* *ES* (SD)	*SMGT* *ES* (SD)	*SRF* *ES* (SD)	*Total* *ES* (SD)
On-task	1.94 (1.22) n = 9	1.50 (0.93) n = 18	2.53 (NA) n = 1	.34 (NA) n = 6	1.61 (1.01) N = 34
Inappropriate behavior	2.36 (NA) n = 2	1.28 (0.94) n = 6	1.38 (NA) n = 3	.02 (NA) n = 6	1.26 (0.95) N = 17
Academic accuracy & productivity	2.38 (0.51) n = 6	0.94 (0.74) n = 9	NA	1.10 (1.37) n = 15	1.32 (1.20) N = 30

Note. NA = information not available, either because dependent variable was not used for intervention or could not be calculated.

Medication and Self-Regulation

Nine studies reported that some or all of the students were taking medication. A total of 24 students (47% of the total participants) were taking medication during the interventions. For 13 (25%) participants, medication was manipulated as part of the intervention. For 16 (31%) of the participants, the status of medication was not provided in the article. The remaining 11 (22%) participants were identified as not taking medications during the self-regulation interventions.

Because five studies reported some students were taking medication throughout the course of the study, we could make a comparison across baseline (medication alone) and the treatment phase that added self-regulation to medication. Overall, self-regulation interventions showed strong effects: For inappropriate/disruptive behaviors, ES ranged from 1.76 to 1.88 (M = 1.82, SD = .08). On-task behavior demonstrated even larger effects, ranging from 1.26 to 2.96 (M = 2.25, SD = .88).

Discussion

This review investigated the use of self-regulation interventions for children with ADHD. The results of this review suggest that SM, SM+R, SMGT, and SRF interventions can be a useful component in an intervention program for children with ADHD.

Participants and Setting

The number of the participants and the settings in which they were studied constitute a major limitation. Data from only 51 participants were available for this review. This small number of participants limits the extent to which results of this review can be generalized. Other concerns are also evident. First, only 3 of the 51 participants were female. Thus, we have very limited knowledge of the effectiveness of self-regulation for females with ADHD. This is of concern, because females with ADHD may exhibit more serious problems with intellectual and cognitive impairments, attention problems, and higher rates of internalizing problems than boys with ADHD (Gershon, 2002; Sharp et al., 1999). Second, the ages of the participants was heavily weighted to

children 12 years and under. Only 3 participants were 13 years or older, and none were high-school age. ADHD is a chronic disorder and although problems with hyperactivity may abate during adolescence (Barkley, 1998), problems with organization, impulsivity, and distractibility are likely to continue. These are the very problems that self-regulation interventions address. We have no knowledge at present whether the self-regulation techniques that were effective for younger students would be effective and/or acceptable for older students. This represents a major gap in self-regulation research.

The nature of participants is also a serious concern for three reasons. First, nearly half of the participants had little or no diagnostic information available. An ADHD diagnosis should be made based on multiple information sources from multiple informants (American Pyschiatric Association, 2000). Also, there is good evidence to suggest that misdiagnosis of ADHD is not uncommon (e.g., Cotugno, 1992; Sabatino & Vance, 1994). Thus, we cannot assess the extent to which these participants are representative of children with ADHD. Second, the lack of participant information precludes any analysis of whether there are different responses to self-regulation among types of ADHD (e.g., ADHD combined type, ADHD predominantly hyperactive, or ADHD predominantly inattentive) and, if so, which would be most likely to profit from self-regulation interventions. This is a concern, as there is reason to believe that there are differences in academic achievement and cognitive abilities across subgroups (e.g., Todd et al., 2002). Third, there is no information on the severity of the ADHD symptoms. Thus, we cannot assess whether self-regulation is successful with severe, moderately, or mildly involved students.

Dependent Measures

The great majority of studies focused on three outcome measures: (a) on-task, (b) academic productivity or accuracy, and (c) inappropriate behaviors. Given the nature of children with ADHD, this is understandable as these are major areas of concern. However, the coverage of dependent measures addressed did differ across interventions. SM interventions focused primarily on on-task behavior with only one study addressing academics, and one addressing inattentive and inappropriate behavior. This is consistent with SM research with other populations that has also focused on on-task behavior (Reid, 1996). No SMGT studies addressed academics; rather the focus was on inappropriate, disruptive, or on-task behaviors. Similarly, SRF studies addressed academic productivity and accuracy as well as inattentive, hyperactive behaviors, yet on-task performance was neglected. Finally, only SM+R addressed on-task, disruptive behavior, and academics. Only six studies reported data on academic productivity or accuracy. Thus, our knowledge base of the effect of self-regulation on academic outcomes is quite small. This is a serious omission, as academic problems are common among children with ADHD (Barkley, 1998); nearly half of children with ADHD qualify for special education services (Reid, Maag, Vasa, & Wright, 1994). Finally, because most studies used discrete measures (e.g., words written per min, math problems correct), some important aspects of academic performance, notably higher order academic skills, have not been addressed

Effects of Self-Regulation

The results of this study suggest that self-regulation interventions can produce meaningful improvements in student on-task behavior, academic productivity and accuracy, and reduction of inappropriate or disruptive behaviors. Using Cohen's (1988) scale for interpretation of ES, the effects on all these areas would be classified as large. That is to say, on average, student increases would be greater than one standard deviation. The results do suggest the possibility of differential effectiveness on some dependent measures. For example, SRF was effective for academic accuracy and productivity, but did not appear to improve on-task or disruptive behavior. Clearly, further investigations are needed to compare these methods to determine if one method appears to induce greater effects across dependent variables and to determine why these treatments may produce greater effects in one domain over the other. The effects of SM and SM+R interventions appeared to be pronounced on all three measures. Finally, although SMGT procedures were very effective for on-task and inappropriate behaviors, we have no

data on the effect of SMGT on academic outcomes.

Once again, we note that these results should be viewed with caution. First, our review was limited to published studies. Thus, our results may be positively biased because studies with significant results are more likely to be published. It is possible that the findings would change if unpublished studies were included. Second, few studies investigated either SRF or SMGT, and as previously noted, coverage of dependent variables across interventions was uneven (e.g., no SMGT study addressed academic outcomes). Third, there is not sufficient data to make comparisons of the effects of one self-regulation method to another to determine whether differences are statistically significant. Fourth, the interpretation of the magnitude of the ESs should be judicious. As yet there are no established, empirically supported guidelines for interpretation of the magnitude of ESs for small-*N* studies. However, we would note that even if we doubled Cohen's 1988 criteria of .80 (i.e., used 1.60 as the criterion for a large effect), many of the ESs would still fall in the large range.

Combining Self-Regulation and Medication

Medication is the most common treatment for children with ADHD. The question of whether behavioral or cognitive-behavior interventions provide additive effects is still a matter of study. The recent MTA study (1999) found that combining a behavioral and medication treatment was not superior to medication alone for reducing ADHD symptoms; however, combination approaches were more effective for some outcomes (e.g., reading achievement). The results of this study suggest that the effects of medication combined with self-regulation may be more effective than medication alone. Interestingly, adding self-regulation to medication appeared to have the effect of stabilizing behavior or markedly reducing variability in behavior in some cases. Decreasing the variability in problem behavior could be an important factor for students in an inclusion setting. These findings, although preliminary, support the use of self-regulation techniques in combination with medication. Despite these promising findings, however, it is important to note that we have no means of assessing whether children were receiving optimal treatment in terms of appropriate medication and dosage. This is an important omission as there is good evidence that many students' medication treatment is not optimized (MTA).

Future Research

Analysis of the studies in this review suggest several areas for future research. First, self-regulation intervention research with students with ADHD has been extremely limited in terms of gender and age range. Across the 16 studies, only 3 of the 51 participants were female, and participants were primarily within the age range of 7 to 13. These limited samples do not allow for conclusions to be made about the effects of self-regulation procedures on females, young children at school entry (i.e., kindergarten), and secondary students (i.e., junior high and high school). Future researchers should make every effort to expand the range of participants. Second, the range of outcome measures could be greatly expanded. For some measures (e.g., on task) we can have a fair degree of confidence in the effectiveness of self-regulation interventions. However, much less attention has been paid to academics. Outcome measures were lower-level (e.g., number of math problems correct, number of words written) as opposed to higher-level skills (e.g., problem-solving, finding main ideas). No studies examined the effects of self-regulation strategies on more advanced academic skills such as strategy usage, study skills, and test-taking behaviors or advanced behavioral expectations such as following classroom rules. Given the well-documented effectiveness of strategy instruction (Swanson, & Sachse-Lee, 2000), this would seem an important area for future researchers.

The results of this study suggest that self-regulation interventions can produce meaningful improvements in student on-task behavior, academic productivity and accuracy, and reduction of inappropriate or disruptive behaviors.

Third, there is a need for systematic investigation into procedures used in self-monitoring interventions. The differences across the self-regulation procedures included in this review were minimal. There are two obvious avenues for research. First, many studies included the combination of self-monitoring and reinforcement. Researchers should investigate the effects of self-regulation interventions alone and in combination with reinforcement, taking severity of behavior into consideration. Second, there is a need to investigate whether there are differences across types of self-monitoring interventions. Research has suggested that for children with learning disabilities there are differences in the effects of SMA and SMP (e.g., Harris, 1986). Recent work suggests that there also may be differences between SMA and SMP for children with ADHD (Harris, Friedlander, Saddler, Frizzelle, & Graham, in press). Finally, only a few of the studies (Edwards et al., 1995; Horn et al., 1983) conducted follow-up examinations on the maintenance of the effects of self-regulation. None of the studies provided data on whether self-regulation interventions would generalize across settings. Thus, we may draw few conclusions about the long-term effects and generalizability of self-regulation procedures on students' academic skills and social behaviors.

Implications for Practice

Previous reviews of self-regulation literature suggested that self-regulation techniques were effective for students with high incidence disabilities (e.g., Graham & Harris, 2003; Nelson et al., 1991; Reid, 1996). Although there are a number of limitations in the literature, the present study extends those findings to students with ADHD, and suggests that self-regulation techniques that incorporate self-assessment and self-recording can have marked positive effects on behavioral and academic outcomes of students with ADHD. Because the four self-regulation techniques are well validated, have well-established implementation procedures, and are acceptable to classroom teachers, the results of this study strongly suggest that self-regulation interventions should be considered as a component of multimodal treatment programs aimed at improving the success of children with ADHD in the classroom.

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