

Attention Deficit Hyperactivity Disorders and Classroom-Based Interventions: Evidence-Based Status, Effectiveness, and Moderators of Effects in Single-Case Design Research

Judith R. Harrison 

Rutgers, The State University of New Jersey

Denise A. Soares

The University of Mississippi

Stephen Rudzinski

Rider University

Rachel Johnson

Peace Corps

Students with attention deficit hyperactivity disorder (ADHD) experience symptoms of inattention, impulsivity, and hyperactivity that often manifest as academic impairment. As such, teachers must select interventions to increase the probability of success for students with ADHD in their classes. Prior meta-analyses have evaluated school-based intervention effects; however, no systematic review meta-analysis has evaluated the effectiveness of interventions implemented in classrooms with students with ADHD. Additionally, classroom-based studies are frequently conducted through single-case design methodology, and recent advances in meta-analytic techniques provide the opportunity to explore intervention effectiveness as evaluated through quality research. Therefore, to inform selection of evidence-based interventions to be implemented in classroom settings, the current systematic review with meta-analysis of single-case design studies was conducted to evaluate intervention effectiveness, evidence-based status, and moderators of effects for four intervention types (behavioral, instructional, self-management, and environmental) when implemented with students with ADHD in classroom settings. The analysis included 27 articles published from 1971 to 2018. Overall and specific to each intervention type, the results indicate that classroom-based interventions for students with ADHD were moderately effective. Instructional and self-management

interventions were deemed evidence based by What Works Clearinghouse standards and potentially evidence based by Council for Exceptional Children standards. Behavioral interventions were found to be potentially evidence based by Council for Exceptional Children criteria and were most effective when selected through functional behavior analysis and implemented by researchers in secondary settings. Instructional interventions were more effective when implemented in special education settings targeting academic outcomes. Implications for research and practice are discussed.

KEYWORDS: meta-analysis, attention deficit hyperactivity disorder, ADHD, interventions, classroom-based

Attention deficit hyperactivity disorder (ADHD) is a neurobiological disorder that negatively affects 6.1 million children and adolescents in the United States (Centers for Disease Control and Prevention, 2016). Students with ADHD demonstrate inattention, hyperactivity, and/or impulsivity, and they experience impairment in academic and behavioral performance, family and peer relations, and self-esteem (Power et al., 2017). Academic impairment manifests as increased risk of earning poor grades and standardized test scores, being retained in a grade, and leaving school prior to graduation (Loe & Feldman, 2007). To address the challenges faced by students with ADHD in schools, researchers are tasked with developing effective interventions to inform teacher practice in classrooms.

The effectiveness of school/classroom-based interventions for students with ADHD has been explored in prior systematic reviews and meta-analyses. However, no systematic review with meta-analysis has focused solely on exploration of the types of interventions that are effective when implemented in classrooms through single-case design (SCD), the methodology frequently utilized to evaluate classroom-based interventions (Byiers, Reichle, & Symons, 2012; DuPaul, Eckert, & Vilaro, 2012; Horner et al., 2005; Reid, Hagaman, & Graham, 2014). Pyle and Fabiano (2017) conducted a SCD meta-analysis on the effectiveness of one behavioral intervention, Daily Report Card (DRC), and reported overall large effects, however, the focus of the study was not on all potential classroom-based interventions.

SCD research is experimental and has a long and productive history of use for identifying interventions to be implemented in classrooms with students with disabilities and to establish the evidence-based status of interventions (Horner et al., 2005). In SCD research, the subject (e.g., student, classroom) serves as the control. Outcomes are measured across time, typically beginning with the measurement of baseline behavior followed by the introduction of an intervention. SCD allows for the analysis of causal relations evident in a change in the dependent variable as a result of manipulation of the independent variable while controlling for extraneous variables (Barlow, Nock, & Hersen, 2009; Kazdin, 2011). Furthermore, SCD research methods control for threats to internal validity through within- and between-subject comparisons and threats to external validity with

systematic replication across participants and/or settings (Horner et al., 2005; Martella, Nelson, & Marchand-Martella, 1999). As such, SCD methodology is appropriate to answer questions regarding effective classroom practices for students with disabilities.

SCD research is particularly relevant to questions regarding the effectiveness of interventions implemented for students with ADHD in classroom settings, as the behavior of students with ADHD is known to be variable within and between students (Aase & Sagvolden, 2005). With SCD, the individual is the unit of measurement, and intervention effects are measured frequently and can be evaluated across time, individuals, and settings. As such, SCD is sensitive to the small and variable changes in behavior (Byiers et al., 2012) frequently observed when measuring the effects of interventions for students with ADHD. Because of these characteristics of SCD, a majority of research that has evaluated the effectiveness of interventions implemented in classrooms with students with ADHD has been conducted with SCD methodology (DuPaul & Eckert, 1997; DuPaul et al., 2012; Harrison, Thompson, & Vannest, 2009; Pyle & Fabiano, 2017; Reid et al., 2014).

The prevalence of SCD studies in research on interventions implemented in school settings is evident in the meta-analyses conducted by DuPaul and Eckert (1997) and DuPaul et al. (2012). DuPaul et al. (2012) updated the findings of the 1997 meta-analysis and analyzed school-based interventions evaluated with single-case, within-group, and between-group methodology. The authors calculated the effects of four intervention types: contingency management (e.g., reinforcement, time-out, response cost), cognitive-behavioral (e.g., social skills training, behavioral education, cognitive training, self-evaluation), academic (e.g., peer-mediated reading instruction, computer-assisted instruction [CAI]), and combined (e.g., multimodal, multiple interventions). Across both meta-analyses, the authors found that 60% to 65% of source studies were SCD.

The results indicated that, when findings from SCD studies were evaluated, all interventions types were moderately to highly effective at increasing both academic and behavioral outcomes, with behavioral interventions being less effective than instructional and self-management. This finding was critical as ADHD has a large impact on academic performance and the effect was not found in the prior meta-analysis (i.e., DuPaul & Eckert, 1997) or when interventions were evaluated through between-subject or within-subject design studies. This difference was possibly a function of group design focus on changes in group means and SCD focus on individual differences with sensitivity to changes across time. These findings are encouraging; however, the authors did not specifically disaggregate the results from interventions solely implemented in classrooms or evaluate the methodological rigor and scientific quality of the literature included in the meta-analysis. Because the quality of the research was not addressed, it is possible that the meta-analytic results were skewed by findings from source studies without sufficient rigor.

Recent advances to identify evidence-based interventions have led to the development of standards for evaluating the rigor and transparency of SCD studies, combining the effects of individual studies, and considering the quality of the research in evidence-based decision making (Jamshidi et al., 2018; Kratochwill

et al., 2010; Maggin, Pustejovsky, & Johnson, 2017; Shadish, Hedges, & Pustejovsky, 2014). In addition, although the effects of interventions evaluated through SCD are typically determined through visual analysis (Brossart, Parker, Olson, & Mahadevan, 2006; Kazdin, 2011), nonoverlap effect sizes have been developed and refined to address the unique characteristics of SCD research and allow for moderator analyses.

Advances in the Quality of SCD Intervention Studies

Advances in SCD quality are outlined in recent appraisal guidelines developed to guide meta-analysts in the evaluation of the methodological rigor, soundness, and trustworthiness of the cumulative body of research and the source studies. According to Jamshidi et al. (2018), the most frequently used protocols are the Standards for Evidence Based Practice of the Council for Exceptional Children (CEC, 2014) and the What Works Clearinghouse (WWC) standards of the Institute of Education Sciences (Kratochwill et al., 2010). Each set of standards includes similar and unique criteria to (a) evaluate the methodological and design quality of source studies (i.e., individual studies included in the meta-analysis), (b) analyze data to determine intervention effectiveness in source studies, and (c) determine the evidence-based status of an intervention. CEC and WWC standards have unique criteria, and as a field, we have not agreed on the best standards. Therefore, in this meta-analysis, we follow the recommendation of Maggin and Chafouleas (2013) and apply both CEC and WWC criteria to determine the evidence-based status of the interventions.

Evidence-Based Status of an Intervention

Determining the evidence-based status of interventions is based on moderately consistent criteria across CEC and WWC protocols, with two specific differences. Through the application of CEC standards to the available research on specific interventions as a whole, interventions are deemed evidence based, potentially evidence based, or with insufficient evidence. Specifically, interventions are deemed (a) evidence-based if the combined source studies include five methodologically sound (described below) SCD studies with positive effects and 20 participants across studies, (b) potentially evidence based if the research includes two to four methodologically sound studies with positive effects, and (c) with insufficient evidence if fewer than two methodologically sound studies are found. Utilizing WWC standards, interventions are deemed evidence based if there are five SCD studies that meet standards with or without reservations, were published by three different research teams, and included 20 participants. The criteria were developed through 4 years of study by researchers with expertise in SCD methodology with the goal of identifying measurable indicators of quality studies (de Bruin, Deppeler, Moore, & Diamond, 2013). Although, no explanation is given for the specific criteria, such as the requirement for 20 participants across studies, the authors state that the standards are conservative and represent a high number of replications. Specific differences between the two sets of criteria are found in the number of options for evidence-based status and the requirement for the number of research teams. Further differences are found in the criteria for the scientific quality of source studies.

Scientific Quality of Source Studies

CEC standards for methodologically sound studies are described as the minimal criteria necessary for quality SCD research and include eight indicators for methodological and design quality (CEC, 2014). Methodological quality indicators focus on transparent reporting for replication (e.g., adequate description of context and setting, participants, intervention agents); whereas design quality indicators focus on controlling for threats to internal validity (e.g., systematically manipulating the independent variable, measuring fidelity of implementation, calculating interobserver agreement). In contrast, WWC standards are the gold standard of SCD methodology. The standards do not include specific criteria for reporting; however, they do include rigorous design criteria to document experimental control (e.g., systematic manipulation of the independent variable, interobserver agreement, number of opportunities for effect, number of phases and data points; Kratochwill et al., 2010). See Table 1 for comparison of the standards.

TABLE 1
Criteria for scientific quality (descriptions)

Indicators/Visual Analysis Features	CEC	WWC
Methodological quality indicators		
Participants	Yes	No
Setting	Yes	No
Independent variable	Yes	Yes
Dependent variable	Yes	No
Baseline condition	Yes	No
Intervention agent	Yes	No
Practice	Yes	No
Design quality indicators		
Experimental control	Yes	Yes
Number of data points	Yes	Yes
Interobserver agreement	Yes	Yes
Treatment fidelity	Yes	No
Internal validity	Yes	Yes
Social validity	Yes	No
Visual analysis		
Level	Yes	Yes
Trend	Yes	Yes
Overlap	Yes	Yes
Variability	Yes	Yes
Immediacy of effects	No	Yes
Consistency of data in similar phases	No	Yes

Note. Quality indicator criteria for single-case research were adapted from Maggin, Briesch, Chafouleas, Ferguson, and Clark (2014), CEC (2014), and Kratochwill et al. (2010). CEC = Council for Exceptional Children standards; WWC = What Works Clearinghouse standards.

Visual Analysis

In relation to analysis of the effectiveness of the intervention in source studies, CEC standards include the criteria that authors report the effects of the intervention on all measures, include a measure of the direction of intervention effects, and provide clearly graphed outcomes. CEC standards require that studies should include a graph and the graph should be clear enough for reviewers to use visual analysis procedures to draw conclusions. In contrast, WWC standards require strict adherence to visual analysis procedures, including analysis of level, trend, variability (stability) within phases and level, variability, overlap, immediacy of effect, and consistency across similar phases on single-case graphs (Kratochwill et al., 2010).

Effect Size

Recent effect sizes for SCD have been developed and refined. In the meta-analyses published by DuPaul and Eckert (1997) and DuPaul et al. (2012), the research teams calculated mean weighted least squares effect sizes (ES) (Busk & Serlin, 1992) for the included SCD studies. The results indicated overall large effects for academic ($ES = 0.82, 3.48$) and behavioral ($ES = 1.16, 2.20$) outcomes. However, the calculation of weighted least squares effect sizes assumes a normal distribution and equality of variances with no intercorrelations across baseline and treatment phases (DuPaul et al., 2012). These assumptions can be problematic for SCD short data sets (Parker & Hagan-Burke, 2007). Furthermore, as noted by the authors (DuPaul et al., 2012), the effect sizes were likely to be influenced by substantial interstudy variability. As such, nonoverlap effect sizes that address the unique qualities of SCD have been developed. Reid et al. (2014) calculated the effectiveness of Self-Regulated Strategy Development (SRSD), an instructional model to teach writing strategies, as the percentage of nonoverlapping data for studies of interventions for students with ADHD and found moderate to large effects. Pyle and Fabiano (2017) calculated SCD effect sizes in a meta-analysis of the effects of using DRC with students with ADHD, including percentage of nonoverlapping data, percentage of all nonoverlapping data, percentage of Phase B data points exceeding the median, improvement rate difference, and Tau-U. The authors found that all were similar and highly correlated, showing improvement in outcomes. However, in a review of nine nonoverlap improvement indices, Tau-U has been deemed as one of the most robust effect sizes (Parker, Vannest, & Davis, 2011). Tau-U is a bottom-up approach designed to explain the impact of changes at the individual level on the overall effect and has sufficient statistical power to control for nonoverlap between phases and undesirable positive baseline trend (Parker et al., 2011).

Moderators

In addition to synthesizing the literature, assessing the quality, and quantifying effects, current meta-analysis methodology provides the opportunity to examine moderators of intervention effects. DuPaul et al. (2012) evaluated publication type, intervention type, educational placement, and school setting as

possible moderators of intervention effects for school-based interventions for students with ADHD. Pyle and Fabiano (2017) evaluated age, gender, diagnostic criteria, level of home-school communication, study quality, and class type as moderators of the effects of DRC. In the current study, we further explore the moderating effects of school type (elementary, secondary), classroom setting (general, special), and outcome (academic, behavioral); and we are the first to evaluate the differentiating effects of the role of the interventionist (teacher, researcher) and the use of functional behavioral analysis (FBA) for intervention selection.

Classroom and School Setting

Children with ADHD are four to five times more likely to have supports and services provided through special education than their typically developing peers (Jensen et al., 2007; LeFever, Villers, Morrow, & Vaughn, 2002); however, a majority of services are provided in general education settings. Both settings have unique characteristics that might contribute to differential intervention outcomes. For example, although it is variable across states, the teacher-to-student ratio in special education settings is smaller and teachers have more flexibility in curriculum, pacing, and grading than in general education settings (Zigmond, 2003). When evaluating setting as a moderator, DuPaul et al. (2012) found that academic interventions were more effective when implemented in general education settings than in special education settings and that behavioral interventions were equally effective in general and special education settings. Furthermore, Pyle and Fabiano (2017) found that interventions implemented in special education were more effective; however, the study only included one source study in special education. Thus, preliminary evidence is mixed but minimal and potentially suggests that interventions may be robust against classroom differences; however, further exploration is needed.

In addition to type of setting, grade level (i.e., elementary, secondary) has been proposed to moderate intervention effects as both child and school characteristics are different in elementary and secondary schools. As children grow, hyperactivity and impulsivity appear to decrease, and inattention remains constant (Fischer, Barkley, Fletcher, & Smallish, 1993; Hart, Lahey, Loeber, Applegate, & Frick, 1995). Furthermore, expectations for independent functioning increase. In secondary settings, students are responsible for initiating and maintaining attention for extended periods of time, managing time across different settings, and completing assignments within the expected time frame—all tasks known to challenge students with ADHD. However, although Pyle and Fabiano (2017) did not directly evaluate the influence of grade level, they did evaluate age as a moderator and found no differential effects on outcomes of DRC. In addition, prior meta-analyses have noted insufficient data to evaluate grade level as a moderator as the majority of source studies were conducted with children in elementary schools (e.g., DuPaul et al., 2012).

Interventionist

Many educational studies are conducted with the researcher as the interventionist in schools (e.g., Fuchs & Fuchs, 2001). Questions have been proposed

regarding the generalizability of research findings when trained experts implement the intervention with prescribed fidelity. It is frequently noted that interventions tested with a researcher as the interventionist might not be feasible for implementation by teachers in schools. Forman, Olin, Hoagwood, Crowe, and Saka (2009) explored the factors related to the successful implementation and sustainability of evidence-based interventions by interviewing the developers of interventions. The interviewees reported that many intervention procedures had to be modified for effective implementation in schools. Although mentioned by DuPaul et al. (2012), no prior research has evaluated the interventionist as a potential moderator in studies of classroom-based interventions for students with ADHD.

Functional Behavioral Assessment

FBA is the process of collecting data to evaluate the relations between events in the environment and specific behaviors (Dunlap & Kern, 2018) and is conducted as a first step to developing behavior intervention plans based on the function of the targeted behavior (Drasgow, Yell, Bradley, & Shriner, 1999). For more than two decades, SCD studies with researchers conducting the FBA have found strong effects when interventions were selected based on the identified function (Crone, Hawken, & Bergstrom, 2007; Dunlap, Kern-Dunlap, Clarke, & Robbins, 1991). In a SCD literature review of academic interventions for students with emotional and behavioral disorders, Vannest, Harrison, Temple-Harvey, Ramsey, and Parker (2011) found that interventions selected by FBA had an overall moderate improvement rate difference (Parker, Vannest, & Brown, 2009). Furthermore, Miller and Lee (2013) conducted a quantitative synthesis of SCD studies with students with ADHD and found that interventions selected through FBA were associated with larger effects. It appears that implementation of FBA leads to the selection of effective interventions; however, the efficiency of FBA in schools has been questioned (Scott et al., 2004) because of its resource- and time-intensive procedures (Borgmeier, Horner, & Koegel, 2006). As such, further evaluation of the moderating effects to determine if the benefits outweigh the resources needed is critical. No prior meta-analysis has evaluated the use of FBA to select interventions as a moderator of intervention effectiveness for students with ADHD.

In summary, prior meta-analyses indicate that classroom-based interventions for students with ADHD are moderately to highly effective; and behavioral interventions are potentially less effective than instructional and self-management interventions. However, a majority of studies of classroom-based interventions for students with ADHD are SCD, and no prior meta-analysis has been conducted solely with those studies. With the current advances in SCD meta-analysis techniques, an opportunity exists to conduct a rigorous systematic review and meta-analysis to update prior findings.

Purpose of the Current Study

The purpose of the current systematic review with meta-analysis was to evaluate (a) the types of interventions implemented in classrooms that have been evaluated through SCD research, (b) the scientific quality of individual studies based

on WWC and CEC standard protocols, (c) intervention effectiveness through visual analysis procedures and nonoverlap effect size calculation, (d) the evidence-based status of interventions implemented in classrooms with students with ADHD, and (e) moderators of intervention effectiveness. As such, this systematic review with meta-analysis addresses the following research questions:

1. What types of interventions implemented in classrooms have been evaluated through SCD research, and what is the overall effect of the types of interventions identified?
2. What are the overall effects of the types of interventions implemented in classroom settings with students with ADHD and the effect for each type of intervention?
3. What is the scientific quality and evidence-based status of each type of intervention?
4. Do grade level, class setting, type of interventionist, use of FBA to select interventions, and/or outcome moderate the overall effects and/or effects of different types of interventions implemented in classroom settings?

Method

This study was conducted in three phases: systematic literature review, coding, and data analysis. The following methods are organized accordingly.

Phase 1: Systematic Literature Review

Inclusion/Exclusion Criteria

Studies were included and excluded based on the following predefined criteria (see Appendix A in the online version of the journal): (a) study characteristics (year, location, language, location, setting), (b) participant characteristics (age, diagnosis, psychotropic medication), (c) setting characteristics (grade, setting), and (d) design characteristics.

Study characteristics. First, studies were included that were published between the years 1971 and 2018 in the United States. We selected the years 1971 and 2018 as delimiters to be inclusive of and update the prior school-based intervention meta-analyses by DuPaul and Eckert (1997) and DuPaul et al. (2012) utilizing current SCD meta-analytic strategies. In addition, we included studies published in English and conducted in the United States at or around the time of the enactment of Section 504 of the Rehabilitation Act of 1973—which prohibits discrimination against individuals with disabilities by programs, such as public schools, that receive federal funding—and the Education for All Handicapped Children Act, 1975 (Guernsey, 1989). The latter act guaranteed all children with disabilities the right to a free, appropriate public education and was reauthorized in 2004 as the Individuals with Disabilities Education Improvement Act (2004). Prior to the passage of these mandates, many children with disabilities in the United States were excluded from public schools, either placed in institutions or cared for by parents (Martin, Martin, & Terman, 1996). As such, the landscape for classroom-based interventions was quite different after the passage of these mandates.

In addition, we excluded studies that were without peer review as studies subjected to the peer review process had been filtered for quality to maintain research standards, scientific merit, and validity (Voight & Hoogenboom, 2012). For example, we excluded dissertations and theses (e.g., Ahmed, 2015) and white papers (e.g., Zwi, Jones, Thorgaard, York, & Dennis, 2011) and government reports (e.g., U.S. Department of Education, 2008). However, we assessed for publication bias statistically to account for the potential of studies not published because of lack of evidence of positive outcomes (Shadish, Hedges, Horner, & Odom, 2015; see the section “Publication Bias”).

Participant characteristics. Studies were included when the participants identified by the source study authors had been diagnosed with ADHD. If studies included participants with and without ADHD, data from only the participants with ADHD were included. For example, Cramer and Mason (2014) included a total of eight participants with emotional and behavioral disorders; however, only three had been diagnosed with ADHD, so outcomes for these three participants were included in the analyses in the current study. Finally, studies were excluded that did not include graphs that were clear enough for the data points to be digitally aligned with a point on the horizontal x -axis and vertical y -axis for extraction (Shadish et al., 2009).

Setting characteristics. In addition, we included studies with students in elementary and secondary schools (K–12). We limited the studies to those with participants in kindergarten through 12th-grade classrooms as the focus of the study was interventions to be implemented in classroom settings. Studies implemented in settings other than classrooms were not included. For example, studies conducted in after-school programs (e.g., Challenging Horizons Program–After School; Evans, Serpell, Schultz, & Pastor, 2007) or summer treatment programs (e.g., STP; Hart, Massetti, Fabiano, Pariseau, & Pelham, 2011) were not included as these settings attempt to mimic classrooms settings; however, they have the potential to have more experimental control than that found in classrooms.

Design characteristics. We included studies that were conducted with SCD methodology. We elected to include only SCD studies for the following reasons. First, the purpose of the study was to evaluate the effects of interventions implemented in classrooms, which are typically stand-alone and commonly evaluated through SCD, as opposed to multimodal interventions, which are often implemented in multiple settings by various professionals and are typically evaluated through within- and between-group design studies (DuPaul et al., 2012; Pyle & Fabiano, 2017). For example, we excluded a study (Evans et al., 2007) in which researchers evaluated the effects of a multimodal intervention, Challenging Horizons Program–Consultation, through a group design study. This program includes multiple interventions implemented by mentors, teachers, counselors, and paraprofessionals potentially in different environments throughout the academic day. Second, SCD is sensitive to individual differences across time demonstrated by

students with ADHD, whose behavior is known to be variable (Barlow et al., 2009; Horner et al., 2005; Kazdin, 2011), as opposed to group designs, which are less sensitive to individual differences (Byiers et al., 2012). Finally, recent advances in SCD research methodology have provided the tools necessary for a quality SCD systematic review with meta-analysis.

Systematic Search and Study Selection

Electronic database searches were completed through the following procedures. First, we followed the electronic search methods discussed by Cooper and Hedges (1994). We searched the EBSCOhost, PsycINFO, and Education Resource Information Center databases. The following keywords, Boolean strings, and truncated words were used in the search: *ADHD**, *interventions**, *attention deficit hyperactivity disorder**, *accommodations**, *strategies**, *school-based treatment**, *classroom-based**, *classroom**, *classroom accommodations**, *school-based intervention**, *test accommodations**, *behavior management**, *instruction**, *teacher training**, and *non-pharmacological interventions/treatments**.

We conducted historical searches of the reference lists of all the resulting screened articles and identified meta-analyses, and the process was repeated to include studies with the potential to meet the inclusion criteria. Eight meta-analyses and literature reviews were identified: (a) one systematic review of meta-analyses of psychosocial treatment (Fabiano, Schatz, Aloe, Chacko, & Chronis-Tuscano, 2015), (b) two systematic literature reviews of group design studies of psychosocial treatments (Evans et al., 2017; Purdie, Hattie, & Carroll, 2002), (c) one group meta-analysis of behavior parent training (Lee, Niew, Yang, Chen, & Lin, 2012), (d) two SCD meta-analyses of the effects of self-management (Briesch & Briesch, 2016) and DRC (Pyle & Fabiano, 2017), and (e) two meta-analyses that reported an overall effect of between-subject, within-subject, and SCD studies of school-based interventions (DuPaul & Eckert, 1997; DuPaul et al., 2012). Each author searched independently, and simple agreement between the two was calculated at 95%.

Phase 2: Coding

Data from the source studies were coded to identify intervention characteristics, indicators of scientific quality, and moderator variables, as described in the following sections (see Appendix A in the online version of the journal).

Intervention Characteristics

We coded intervention characteristics by listing the names of the interventions as reported by the source authors (e.g., Self-Regulated Strategy Development) on the coding document. Next, we listed the source authors' definition and description of the intervention and intervention components.

Indicators of Scientific Quality

We coded the data needed to determine the scientific quality of the source studies through the application of two sets of standards, the WWC design standards and the CEC standards for evidence-based practices in special education. See Appendices B and C for decision guides for the WWC and CEC standards, respectively (available in the online version of the journal). The first author conducted coding training for

each set of criteria with all the coauthors. Specifically, the author reviewed the codes and the raters identified one example and one nonexample of each coding variable. If codes were not clearly defined, the team deliberated until clarity was achieved with 100% agreement. Independent coding began when simple agreement was above 80% (Hartmann, Barrios, & Wood, 2004).

Coding was conducted through three sets of procedures. First, two raters simultaneously coded 100% of the articles for the WWC design quality indicators following the procedures described by Maggin, Briesch, and Chafouleas (2013). Using the WWC standards, studies were deemed to have met the standards, met the standards with reservations, or not met the standards. Studies that met the criteria included at least three opportunities to demonstrate effects with 5 or more data points per phase and reported interobserver agreement. Studies that met the standards with reservations included at least three opportunities to demonstrate effects with at least 3 data points per phase for reversal or multiple baseline designs and 4 for multi-element designs. Simultaneous/multiple probe designs were coded as their underlying design. Studies that did not meet the WWC standards with or without reservations were excluded from the study and were not further coded.

Second, two raters independently coded the remaining articles of the studies using the CEC standards of 22 components under eight quality indicators dichotomously as present or not present. Two raters coded 20% for reliability. Interrater reliability was calculated as 96% across all variables. Coding was completed simultaneously to allow for discussion when questions arose. When disagreement arose, discussion continued until 100% consensus was reached for all codes. Third, the authors assigned CEC design ratings to each outcome from each source study. Using CEC (2014) standards, studies were deemed methodologically sound if they met all the eight indicators.

Moderators

We dichotomously coded the moderator variables by listing the information reported by the source study authors in the categories of (a) type of school/grade level—elementary (K–5) or secondary (6–12); (b) setting—general or special education; (c) interventionist—teacher, researcher, or both; (d) use of FBA—yes or no; and (e) outcome—academic (e.g., task accuracy, task completion, essay length) or behavioral (e.g., disruptions, on task, off task).

Phase 3: Data Analysis

Publication Bias

We used the Eggers test (Egger, Smith, Schneider, & Minder, 1997) to determine publication bias in the final set of selected studies (i.e., the tendency of studies with null effects to not be published; Rosenthal & DiMatteo, 2001). The Egger's test evaluates Y intercept = 0 using linear regression of the effect against precision.

Intervention Categorization

As a team, we iteratively categorized the interventions into types. Iterative categorization involved four processes. First two authors identified significant

stand-alone heuristic information (e.g., theoretical orientation, procedures) and grouped like interventions into categories (Erlandson, Harris, Skipper, & Allen, 1993; Lincoln & Guba, 1985). Second, the authors developed a definition of the interventions the team grouped together and compared the categories with the types of interventions established in prior meta-analyses. Third, the author team identified agreement and disagreement between prior categories and categories established in the current literature review with meta-analysis and prior meta-analysis (e.g., DuPaul et al., 2012; Evans et al., 2017). Fourth, the team developed and reached consensus definitions and labels for each category (i.e., behavioral, instructional, self-management, environmental). When disagreement between team members occurred, discourse continued until a consensus definition was established.

Evidence-Based Status and Scientific Quality

We evaluated the evidence-based status of each intervention type according to the WWC and CEC criteria through the following procedures. The authors deemed the intervention type to have met the WWC design standards with or without reservations based on the number of articles, research groups, and number of participants. Following the procedures of Maggin et al. (2013), studies without author overlap were coded as independent-author teams. Studies were coded as evidence based on WWC if five papers were included from at least three unique research teams and with 20 participants. The authors coded the intervention type to have achieved evidence-based status using the CEC standards if the studies included five methodologically sound studies and potentially evidence based if the studies included two to four methodologically sound studies.

Visual Analysis

We visually analyzed data from each outcome to determine whether a functional relation existed between the independent and dependent variables based on the procedures described in the WWC protocol (Kratochwill et al., 2010). The first and second authors visually analyzed the data following the procedures recommended by Kratochwill et al., (2010) with additional guidance from Lane and Gast (2014). We analyzed SCD data by visually inspecting (a) baseline level, variability, and trend; (b) within-phase data points, variability, and trend; (c) between-phase overlap, level, and immediacy of effect; (d) consistency of the data across phases; and (e) opportunities to demonstrate treatment effect and ratio of effects to noneffects. We coded the evidence for each study outcome per the WWC standards as strong if the study provided three demonstrations of effect with no instances of noneffects, moderate if the study provided three demonstrations of effect with one demonstration of noneffect, and no evidence if the study did not provide three demonstrations of effect.

Effect Size and Confidence Intervals

To calculate Tau-U effects, raw data were extracted from graphs in the included studies (i.e., by digitizing the graphs) using Getdata Graph Digitizer (Version 2.21) from <http://www.getdata-graph-digitizer.com/download.php>, and five procedures were used to calculate the overall effect and the effect for each intervention type

(i.e., behavioral, instructional, self-management, environmental). First, we calculated the effect size between the baseline and adjacent intervention phase(s) for all individual cases in each source study by using an online calculator (Vannest, Parker, Gonen, & Adiguzel, 2016; <http://www.singlecaseresearch.org>). Second, we combined the individual effect size for each outcome in the source studies using the Tau-U calculator. The calculator calculates Tau-U by merging trend and non-overlap data (see Parker et al., 2011). Fourth, we combined individual effect sizes into an omnibus overall effect size (Abramson, 2011) with 95% confidence intervals (CI) using WinPEPI (Abramson, 2011), a statistical program. Fifth, overall effect sizes were calculated to represent the effect for (a) all interventions on all outcomes, and (b) each type of intervention (i.e., behavioral, instructional, self-management, environmental) on all outcomes. The algorithm for WinPEPI to calculate the overall effect size is the weighted average of all individual effect sizes, with weights equaling the inverse of the variance (i.e., not standard error [SE]). Finally, although we acknowledge that categorization of effect size quantity depends on the context of the effects being measured (Vannest & Ninci, 2015), we elected to use the following codes for comparison across studies and intervention types. Therefore, we coded Tau-U effects as weak (0–0.20), moderate (0.20–0.60), and strong (0.60–1.00) (Vannest & Ninci, 2015).

Moderator Analyses

We coded moderator data for grade level (elementary, secondary), setting (general education, special education), interventionist (teacher, researcher), FBA (yes or no), and outcome (academic, behavior). Following the procedures of Soares, Harrison, Vannest, and McClelland (2016), Bowman-Perrot, Burke, Zhang, and Zaini (2014), and Briesch and Briesch (2016), we analyzed moderator effects by dichotomously coding the moderator variables within the studies and examining statistically significant differences between the effect sizes (Tau-U) of studies within each category.

We calculated the reliable difference (i.e., difference that cannot be accounted for solely by chance) for each moderator pair overall and within each type of intervention to determine if the differences were statistically significant, using the following formula: $(L_1 - L_2) / \sqrt{[(SE_{\text{Tau}})^2 + (SE_{\text{Tau}})^2]}$, where L_1 is the first level of the moderator (e.g., academic outcome) and L_2 is the second level of the moderator (e.g., behavioral outcome).

Results

Publication Bias

The intercept for Egger's test (-0.052 ; $CI_{90\%} [-1.51, 0.47]$; $p = .501$) indicated that statistically significant publication bias was not found in this sample. Heterogeneity was measured using H and I_2 (Higgins & Thompson, 2002), where $H = 1.8$ ($CI_{95\%} [1.5, 2.1]$) and $I_2 = 68.8\%$ ($CI_{95\%} [57.8\%, 76.6\%]$), indicating less than notable heterogeneity in the sample (Abramson, 2011).

Literature Review and Study Selection

During the systematic literature review, the initial search yielded a high number of results ($n = 6,064$). Following the initial search, hand searches were

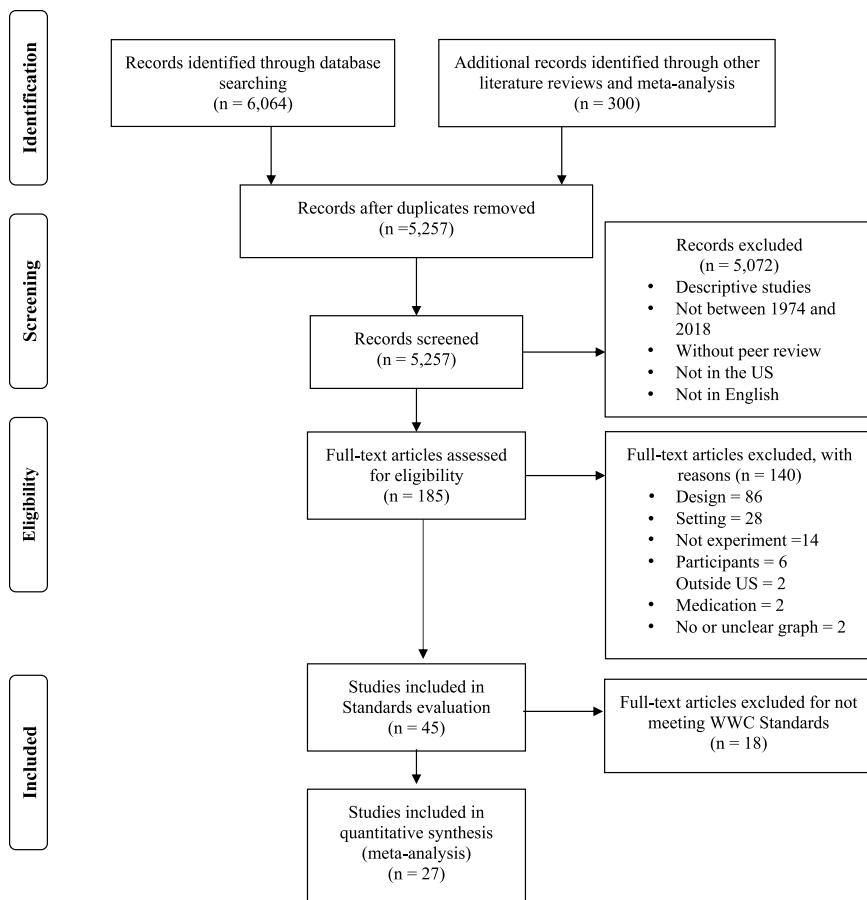


FIGURE 1. *PRISMA flow diagram.*
 Note. WWC = What Works Clearinghouse.

conducted of previous meta-analyses and literature reviews, which resulted in the addition of 300 additional studies, totaling 6,364 articles. Next, article titles and abstracts were screened, and duplicates were removed, resulting in 5,257 articles for article screening review (see Figure 1; Moher, Liberati, Tetzlaff, Altman, & The PRISMA Group, 2009). After studies were excluded during the screening phase, 185 articles remained for full coding (see Appendix D in the online version of the journal).

Finally, we excluded 140 studies for the following reasons. Studies were excluded for their design ($n = 86$), having a setting other than schools ($n = 28$), not being intervention studies ($n = 14$), having participants not diagnosed with having ADHD or not enrolled in K–12 classrooms ($n = 6$), not having been conducted in the United States ($n = 2$), evaluating the effectiveness of psychotropic

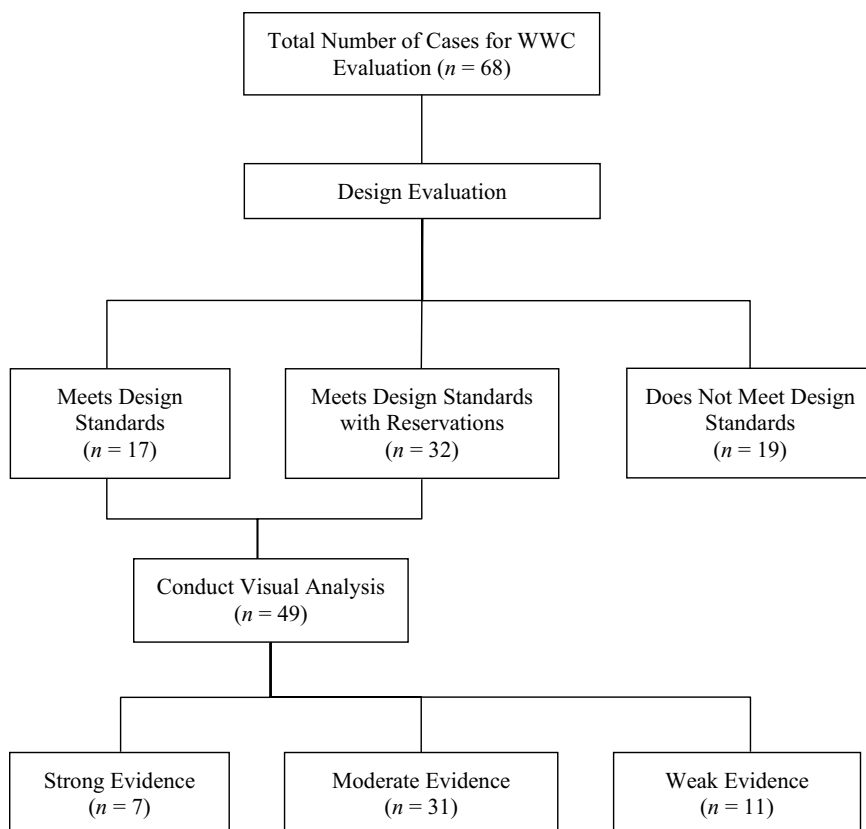


FIGURE 2. *What Works Clearinghouse flowchart.*

Note. All the numbers are based on cases. WWC = What Works Clearinghouse.

medication ($n = 2$), or having a graph that was not sufficiently clear for data extraction ($n = 1$) or not including a graph ($n = 2$). After excluding these studies, the literature search resulted in 45 SCD. During the collection of articles, reliability checks were conducted and reliability was assessed using simple percentage of agreement (sum of agreements/total number of agreements + disagreements $\times$ 100] (House, House, & Campbell, 1981). Initial agreement was 96%.

Forty-five studies with 68 cases met the inclusion criteria (see Figure 2). Eighteen studies with 19 cases did not meet the WWC standards and were excluded from further coding, resulting in 27 studies with 49 cases (i.e., total outcomes), 78 participants, and 199 phase contrasts. Seven studies evaluated behavioral strategies and included 11 cases, 10 studies evaluated the effects of self-management and included 16 cases, 9 studies evaluated the effects of instructional interventions and included 21 cases, and 1 study evaluated the effect of environmental interventions and produced one case. Eighteen studies with 32

cases were implemented in general education, and 8 studies with 17 cases were implemented in special education classrooms. Fifteen studies with 26 cases included children in elementary schools, and 12 studies with 23 cases included adolescents in secondary schools. Nine studies with 20 cases included the classroom teacher as the interventionist, and 18 with 29 cases included the researcher as the interventionist. Five studies with 5 cases included FBA, and 22 studies with 44 cases did not. Eighteen studies with 32 cases measured behavior performance (e.g., disruptive, talking out, not in seat), and 9 studies with 17 cases measured academic behavior (e.g., on task, task accuracy, task completion, engagement).

Intervention Categorization

Four intervention types were identified; behavioral, instructional, self-management, and environmental. Behavioral interventions included interventions designed to change behavior by adapting contingencies. Studies included in the instructional category were designed to teach a skill. Studies included in the self-management utilized to teach students to observe, document, and self-regulate behavior. Studies were included in the environmental category if the intervention was an antecedent intervention developed to adapt the environment.

Overall Effects

An omnibus Tau-U was calculated for 199 phase contrasts and combined across participants and same outcomes (i.e., cases) for a Tau-U of 0.87 ($SE = 0.02$, $CI_{95\%} [0.84, 0.90]$). Table 2 illustrates the range of effect sizes and 95% confidence interval for each case. For purposes of comparison, we qualify effects below 0.20 as a small change in the dependent variable, from 0.21 to 0.59 as a moderate change, 0.60 and above as a large change (Vannest & Ninci, 2015). Findings per intervention type follow.

Findings by Intervention Type

Results are reported below by intervention type. For each type, we provide the number of studies, independent research teams, number of cases, and total number of participants, followed by a list of interventions in the category. Next, we provide the scientific quality of the source studies and the evidence-based status of the type of intervention (see Table 3). With regard to evidence-based status per WWC, standards are reported by case, as each case (i.e., outcome in the study) in the study could potentially be qualified differently. For CEC standards, we report the results by study, as then standards include measures of author reporting throughout the manuscript. Finally, we report the effect size (see Table 4 for all intervention type effects) and the results of visual and moderator analyses (see Table 5). Figure 3 is a forest plot that represents a comparison of the overall effect, intervention type effects, and moderator effects.

Behavioral

The behavioral category included seven studies conducted by six independent research teams with 11 cases and a total of 13 participants in strategies that adapted contingencies. The studies evaluated the effects of (a) response cost contingencies through an attention training system (ATS) with and without direct

TABLE 2
Characteristics of each study by intervention type and author

Intervention type	Author(s)	Year	<i>n</i>	Intervention	Outcome	WWC	CEC	VA	Tau-U	95% CI
Behavioral	Banda and Sokolosky	2012	1	FBA noncontingent attention	Disruptions	MS	Yes	Strong	1.00	[0.54, 1.00]
Behavioral	DuPaul, Guevremont, and Barkley	1992	2	Attention training	On task	MS	No	Weak	0.05	[0.00, 0.25]
Behavioral	DuPaul et al.	1992		Attention training	ADHD symptoms	MS	No	Weak	0.17	[0.00, 0.47]
Behavioral	DuPaul et al.	1992		Attention training + direct rehearsal	On task	MS	No	Moderate	0.63	[0.30, 0.96]
Behavioral	DuPaul et al.	1992		Attention training + direct rehearsal	ADHD symptoms	MS	No	Moderate	0.72	[0.38, 1.00]
Behavioral	Germer et al.	2011	1	FBA contingency management	On task	MSR	Yes	Moderate	0.87	[0.31, 1.00]
Behavioral	Majeika et al.	2011	1	FBA behavioral strategies	On task	MS	Yes	Strong	1.00	[0.48, 1.00]
Behavioral	Nolan and Filter	2012	1	FBA noncontingent reinforcement	Problem behavior	MSR	No	Moderate	1.00	[0.64, 1.00]
Behavioral	Vilardo, DuPaul, Kern, and Hojnoski	2013	4	Peer tutoring with CM	Positive behavior	MSR	Yes	Weak	0.11	[0.00, 0.58]
Behavioral	Vilardo et al.	2013		Peer tutoring with CM	Negative behavior	MSR	Yes	Weak	0.37	[0.15, 0.77]
Behavioral	Whitford, Liaupsin, Umbreit, and Ferro	2013	3	FBA behavioral strategies	On task	MSR	No	Moderate	1.00	[0.64, 1.00]
Environmental	Cook, Johnson, and Bradley-Johnson	2015	1	White noise	Verbalizations	MS	No	Weak	0.97	[0.32, 1.00]
Instructional	Brasch, Williams, and McLaughlin	2008	2	Flash cards	Accuracy	MSR	No	Moderate	1.00	[0.72, 1.00]
Instructional	Cramer and Mason	2014		SRSD	Primary traits	MSR	Yes	Moderate	0.19	[0.00, 0.82]
Instructional	Cramer and Mason	2014	3	SRSD	Quality	MSR	Yes	Moderate	0.82	[0.40, 1.00]
Instructional	Cramer and Mason	2014	3	SRSD	Number of words	MSR	Yes	Weak	0.30	[0.00, 0.76]
Instructional	Jacobson and Reid	2010	3	SRSD	Essay length	MSR	No	Moderate	1.00	[0.53, 1.00]
Instructional	Jacobson and Reid	2010		SRSD	Quality	MSR	No	Moderate	1.00	[0.53, 1.00]
Instructional	Jacobson and Reid	2010		SRSD	Supporting details	MSR	No	Moderate	1.00	[0.53, 1.00]
Instructional	Johnson, Reid, and Mason	2012	3	SRSD	Main idea	MSR	Yes	Moderate	0.96	[0.57, 1.00]
Instructional	Johnson et al.	2012		SRSD	Supporting details	MSR	Yes	Moderate	0.88	[0.43, 1.00]
Instructional	Lienemann and Reid	2008	4	SRSD	Essay elements	MSR	Yes	Moderate	1.00	[0.62, 1.00]
Instructional	Lienemann and Reid	2008		SRSD	Essay length	MSR	Yes	Moderate	1.00	[0.62, 1.00]
Instructional	Mautone, DuPaul, and Jitendra	2005		CAI	Engagement	MSR	No	Moderate	0.80	[0.40, 1.00]
Instructional	Mautone et al.	2005	3	CAI	Math fluency	MSR	No	Moderate	1.00	[0.61, 1.00]
Instructional	Mautone et al.	2005		CAI	Off task	MSR	No	Moderate	0.78	[0.39, 1.00]
Instructional	Moser, Fishley, Konrad, and Hessler	2012	4	CCC	Accuracy	MSR	Yes	Moderate	0.91	[0.51, 1.00]

(continued)

TABLE 2 (continued)

Intervention type	Author(s)	Year	<i>n</i>	Intervention	Outcome	WWC	CEC	VA	Tau-U	95% CI
Instructional	Ota and DuPaul	2002	3	CAI	Active engagement	MSR	No	Moderate	1.00	[0.63, 1.00]
Instructional	Ota and DuPaul	2002		CAI	Passive engagement	MSR	No	Moderate	0.97	[0.60, 1.00]
Instructional	Ota and DuPaul	2002		CAI	Off task	MSR	No	Moderate	0.89	[0.52, 1.00]
Instructional	Woltersdorf	1992	4	Video modeling	Fidgeting	MS	No	Weak	0.33	[0.00, 0.71]
Instructional	Woltersdorf	1992		Video modeling	Distracted	MS	No	Moderate	0.66	[0.01, 0.64]
Instructional	Woltersdorf	1992		Video modeling	Vocalizations	MS	No	Weak	0.53	[0.21, 0.84]
Self-management	Davies and Witt	2000	4	Self-management/peer monitoring	Verbalizations	MSR	No	Moderate	1.00	[0.66, 1.00]
Self-management	Graham-Day, Gardner, and Hsin	2010	3	Self-monitoring	On task	MS	No	Strong	0.99	[0.62, 1.00]
Self-management	Graham-Day et al.	2010		Self-monitoring	On task	MS	No	Strong	0.72	[0.38, 1.00]
Self-management	Gureasko-Moore, DuPaul, and White	2006	3	Self-management	Classroom preparation	MSR	Yes	Moderate	1.00	[0.60, 1.00]
Self-management	Gureasko-Moore, DuPaul, and White	2007	6	Self-management	Classroom preparation	MSR	No	Moderate	0.94	[0.68, 1.00]
Self-management	Gureasko-Moore et al.	2007		Self-management	Homework behavior	MSR	No	Moderate	0.82	[0.54, 1.00]
Self-management	Harris, Friedlander, Saddler, Frizzelle, and Graham	2005	6	Self-monitoring	On task	MS	No	Strong	0.91	[0.70, 1.00]
Self-management	Harris et al.	2005		Self-monitoring	Accuracy	MS	No	Strong	0.91	[0.69, 1.00]
Self-management	Hoff and Ervin	2013	3	Classwide self-management	Disruptions	MSR	Yes	Moderate	0.73	[0.35, 1.00]
Self-management	Mathes and Bender	1997	3	Self-monitoring	Completion	MSR	No	Moderate	1.00	[0.65, 1.00]
Self-management	Morrison, McDougall, Black, and King-Sears	2014	2	Tactile cued self-monitoring	Completion	MS	Yes	Moderate	0.84	[0.50, 1.00]
Self-management	Shimabukuro, Prater, Jenkins, and Edelen-Smith	1999	3	Self-monitoring	Accuracy	MSR	No	Moderate	0.93	[0.76, 1.00]
Self-management	Shimabukuro et al.	1999		Self-monitoring	Productivity	MSR	No	Moderate	0.92	[0.69, 1.00]
Self-management	Shimabukuro et al.	1999		Self-monitoring	On task	MSR	No	Moderate	0.93	[0.76, 1.00]
Self-management	Wills and Mason	2014		Technology-based self-monitoring	On task	MS	No	Strong	0.99	[0.54, 1.00]
Self-management	Wills and Mason	2014	2	Technology-based self-monitoring	Disruptions	MS	No	Weak	0.34	[0.16, 0.85]

Note. Total number of participants (*n*) for the study is listed for the first case of the study only. CI = confidence interval; WWC = What Works Clearinghouse; CEC = Council for Exceptional Children; VA = Visual Analysis; FBA = functional behavioral analysis; ADHD = attention deficit hyperactivity disorder; CM = contingency management; CAI = computer-assisted instruction; CCC = cover-copy-compare; SRSD = Self-Regulated Strategy Development; WWC design standards; MS = meets standards; MSR = meets standards with reservations.

TABLE 3
Evidence-based status of intervention types

Intervention type	Partic- ipants	Research teams	CEC meth- odologi- cally sound studies (<i>n</i>)	WWC MS/MSR	CEC EB	WWC EB
Behavioral	17	6	4	7	Potentially EB	Did not meet
Instructional	25	6	3	9	Potentially EB	Met
Self-Management	35	8	3	10	Potentially EB	Met
Environmental	1	1	0	1	Insufficient evidence	Did not meet

Note. WWC = What Works Clearinghouse; CEC = Council for Exceptional Children; MS = meets standards; MSR = meets standards with reservations; EB = evidence based; SCD = single-case design. To determine EB status, WWC requires a minimum of five SCD papers that meet evidence standards/meet evidence standards with reservations, three unique research teams, and 20 participants. CEC EB practice requires five methodologically sound SCD studies with positive effects and 20 participants, and potentially EB requires two to four methodologically sound SCD studies with positive effects.

TABLE 4
Combined Tau-U effect sizes for each intervention type

Intervention type	Studies (<i>n</i>)	Demo of effects ^a	ES (<i>n</i>)	Tau-U	<i>SE</i>	95% CI
Behavioral	7	27	11	0.67	0.04	[0.59, 0.74]
Instructional	9	92	21	0.87	0.03	[0.82, 0.92]
Self-management	10	77	16	0.93	0.02	[0.88, 0.97]
Environmental	1	3	1	0.97	0.03	[0.32, 1.00]
Overall	27	199	49	0.87	0.02	[0.84, 0.90]

Note. ES = effect size; *SE* = standard error; CI = confidence interval.
a. Demo = number of demonstrations of effect; number of phase contrasts.

rehearsal (DuPaul & Eckert, 1997) and contingent/behavioral interventions selected through FBA (Germer et al., 2011; Majeika et al., 2011; Whitford et al., 2013) on on-task behavior; (b) noncontingent reinforcement selected through FBA (Banda & Sokolosky, 2012; Nolan & Filter, 2012) and peer tutoring with contingency management on problem behaviors; and (c) response cost contingencies through attention training with and without direct rehearsal (DuPaul & Eckert, 1997) on ADHD symptoms.

Intervention evidence-based status and source study scientific quality. The behavioral interventions did not meet the WWC evidence-based standards and were potentially evidence based according to the CEC standards. Six cases met the WWC design standards, five met the WWC design standards with

TABLE 5
Tau-U moderator analyses

Intervention type	Study characteristic	Category	Cases (<i>n</i>)	Tau-U	<i>SE</i>	95% CI lower	95% CI upper	<i>z</i> Score
Overall	Grade level	Elementary	26	0.80	0.02	0.76	0.85	
		Secondary*	23	0.93	0.02	0.88	0.97	4.60*
	Setting	General education	32	0.84	0.02	0.79	0.88	
		Special education	17	0.92	0.02	0.87	0.97	-2.83*
	Interventionist	Teacher	20	0.82	0.03	0.77	0.87	
		Researcher	29	0.89	0.02	0.85	0.93	-1.94
	FBA	No	44	0.86	0.02	0.82	0.89	
		Yes*	5	0.99	0.06	0.88	1.00	-2.06*
	Outcome	Academic*	17	0.92	0.03	0.87	0.98	
		Behavioral	32	0.84	0.02	0.75	0.88	2.22*
Behavioral	Grade level	Elementary	9	0.53	0.05	0.44	0.63	
		Secondary*	2	1.00	0.08	0.85	1.00	4.98*
	Setting	General education	11	0.67	0.04	0.59	0.74	
		Special education	0					
	Interventionist	Teacher	4	0.34	0.07	0.20	0.47	
		Researcher*	7	0.68	0.04	0.60	0.76	4.22*
	FBA	No	6	0.32	0.06	0.21	0.38	
		Yes*	5	0.99	0.06	0.88	1.00	-7.90*
	Outcome	Academic	0					
		Behavioral	11	0.67	0.04	0.59	0.74	

(continued)

TABLE 5 (continued)

Intervention type	Study characteristic	Category	Cases (n)	Tau-U	SE	95% CI lower	95% CI upper	z Score
Instructional	Grade level	Elementary	12	0.84	0.03	0.77	0.90	
		Secondary	9	0.91	0.04	0.84	0.99	1.40
	Setting	General education	10	0.83	0.04	0.75	0.90	
		Special education*	11	0.95	0.03	0.88	1.00	-2.40*
	Interventionist	Teacher	12	0.87	0.03	0.80	0.93	
Self-management		Researcher	9	0.95	0.04	0.88	1.00	-1.60
	FBA	No	21	0.87	0.03	0.82	0.92	
		Yes	0					
	Outcome	Academic*	13	0.93	0.03	0.86	0.99	-3.20*
		Behavioral	8	0.77	0.04	0.69	0.85	
Interventionist	Grade level	Elementary	4	0.92	0.04	0.83	1.00	
		Secondary	12	0.93	0.03	0.87	0.98	0.20
	Setting	General education	10	0.92	0.03	0.85	0.98	
		Special education	6	0.93	0.03	0.87	1.00	-0.24
	Interventionist	Teacher	6	0.94	0.03	0.87	1.00	
FBA		Researcher	10	0.91	0.03	0.85	0.97	-0.71
	FBA	No	16	0.92	0.02	0.88	0.97	
		Yes	0					
	Outcome	Academic	4	0.93	0.04	0.85	1.00	
		Behavioral	12	0.92	0.03	0.87	0.98	-0.20

Note. SE = standard error; CI = confidence interval; FBA = functional behavior analysis.
*Indicates statistically significant results, $p < .01$.

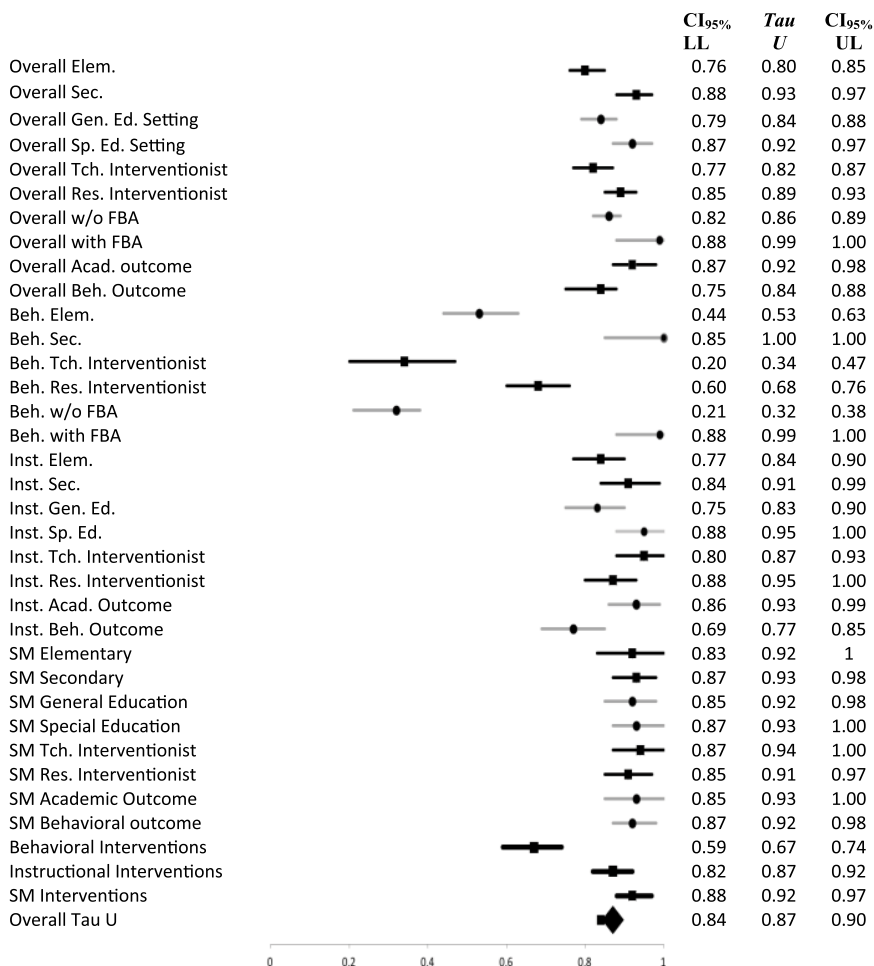


FIGURE 3. *Forest plot of overall, intervention type, and moderator effects.*

Note. Elem. = elementary; Sec. = secondary; Gen. Ed. = general education; Sp. Ed. = special education; Tch. = teacher; Res. = researcher; Acad. = academic; Beh. = behavioral; Inst. = instructional; SM = self-monitoring; FBA = functional behavior analysis.

reservations, and four were considered methodologically sound according to the CEC standards.

Visual analysis and effect size. Visual analysis was conducted, and Tau-U was calculated with the 11 cases. According to the visual analysis, 2 had strong evidence, 3 had moderate evidence, and 6 had weak evidence. The weighted mean effect size for the behavioral overall Tau-U was 0.67 ($SE = 0.04$, $CI_{95\%} [0.59, 0.74]$).

Moderators. For grade level, two studies with two cases were conducted in secondary schools, and five studies with nine cases were conducted in elementary schools. The results indicated that the studies in elementary schools had a lower Tau-U = 0.53 ($SE = 0.05$, $CI_{95\%} [0.44, 0.63]$) than those in secondary schools, Tau-U = 1.00 ($SE = 0.08$, $CI_{95\%} [0.85, 1.00]$). When the two categories were compared for parameter estimates, the overlapping confidence intervals indicated that there was a statistically significant difference, which was confirmed by the reliable difference: $z = 4.98$, $p < .01$. For setting, moderator analysis was not conducted as no studies were implemented in special education self-contained settings.

With regard to the interventionist, interventions in six studies with seven cases were implemented by the researcher, and one study with four cases was implemented by the teacher. The results indicated that studies with the teacher as the interventionist had a lower Tau-U = 0.34 ($SE = 0.07$, $CI_{95\%} [0.20, 0.47]$) than those with the researcher, Tau-U = 0.68 ($SE = 0.04$, $CI_{95\%} [0.60, 0.76]$). When the two categories were compared for parameter estimates, the overlapping confidence intervals indicated that there was a statistically significant difference, which was confirmed by the reliable difference: $z = 4.22$, $p < .01$.

For FBA, interventions in two studies with six cases were selected without FBA, and interventions in five studies with five cases were selected through FBA. The results indicated that the effects of the interventions selected without FBA were lower, with Tau-U = 0.32 ($SE = 0.06$, $CI_{95\%} [0.21, 0.38]$), than the effects of the interventions selected with FBA, Tau-U = 0.99 ($SE = 0.06$, $CI_{95\%} [0.88, 1.00]$). When the two categories were compared for parameter estimates, the overlapping confidence intervals indicated that there was a statistically significant difference, which was confirmed by the values from the reliable difference formula: $z = -7.90$, $p < .01$. For outcome, no moderator analysis was conducted as no studies measured academic outcomes.

Instructional

The instructional category included nine studies conducted by six independent research teams with 21 cases and 34 participants of strategies designed to teach a skill. The studies measured the effects of (a) the use of CAI (Mautone et al., 2005; Ota & DuPaul, 2002) on task engagement/on- and off-task behavior; (b) video modeling (Woltersdorf, 1992) on problem behavior (i.e., fidgeting, being distracted, and vocalizations); (c) SRSD (Cramer & Mason, 2014; Jacobson & Reid, 2010; Johnson et al., 2012; Lienemann & Reid, 2008) on qualities of writing tasks (i.e., primary traits, quality, number of words, essay length, supporting details, essay elements); and (d) the use of flash cards (Brasch et al., 2008) and cover-copy-compare (CCC; Moser et al., 2012) on task accuracy.

Intervention evidence-based status and source study scientific quality. Instructional interventions met the WWC evidence standards and were considered potentially evidenced based according to the CEC standards. Three cases met the design standards without reservations (WWC), 18 met the design standards with reservations (WWC), and 3 studies were considered methodologically sound (CEC).

Visual analysis and effect size. Tau-U and visual analysis were conducted with 21 cases. According to the visual analysis, no cases had strong evidence, 18 had moderate evidence, and 3 had weak evidence. The weighted mean effect size for the instructional overall Tau-U was 0.87 ($SE = 0.03$, $CI_{95\%} [0.82, 0.92]$).

Moderators. For grade level, four studies with 9 cases were conducted in secondary schools, and five studies with 12 cases were conducted in elementary schools. The results indicated that interventions in elementary settings had a lower Tau-U = 0.84 ($SE = 0.03$, $CI_{95\%} [0.77, 0.90]$) than those in secondary settings, Tau-U = 0.91 ($SE = 0.04$, $CI_{95\%} [0.84, 0.99]$). When the two categories were compared for parameter estimates, the overlapping confidence intervals indicated no statistically significant difference, which was confirmed by the reliable difference: $z = 1.40$, $p > .05$.

For setting, four studies with 10 cases were implemented in general education settings, and five studies with 11 cases were implemented in special education self-contained settings. The results indicated that interventions in general education had a lower Tau-U = 0.83 ($SE = 0.04$, $CI_{95\%} [0.75, 0.90]$) than those in special education, Tau-U = 0.95 ($SE = 0.03$, $CI_{95\%} [0.88, 1.00]$). When the two categories were compared for parameter estimates, the overlapping confidence intervals indicated that there was a statistically significant difference, which was confirmed by the reliable difference: $z = -2.40$, $p < .01$.

With regard to the interventionist, five studies with 12 cases were implemented by teachers and four studies with 9 cases by researchers. The results indicated that the interventions implemented by teachers had a lower Tau-U = 0.87 ($SE = 0.03$, $CI_{95\%} [0.80, 0.93]$) than those implemented by researchers, Tau-U = 0.95 ($SE = 0.04$, $CI_{95\%} [0.88, 1.00]$). When the two categories were compared for parameter estimates, the overlapping confidence intervals indicated that there was no statistically significant difference, which was confirmed by the reliable difference: $z = -1.60$, $p > .05$. For FBA, no moderator analysis was conducted as no studies were conducted with FBA.

For outcome, six studies with 8 cases reported behavior outcomes, and three studies with 13 cases reported academic outcomes. The results indicated that the interventions with behavioral outcomes had a lower Tau-U = 0.77 ($SE = 0.04$, $CI_{95\%} [0.69, 0.85]$) than the interventions with academic outcomes, Tau-U = 0.93 ($SE = 0.04$, $CI_{95\%} [0.86, 0.99]$). When the two categories were compared for parameter estimates, the overlapping confidence intervals indicated that there was a statistically significant difference, which was confirmed by the reliable difference: $z = -3.20$, $p < .05$.

Self-Management

The self-management category included 10 studies with eight independent research teams with 16 cases and 35 participants in strategies designed to teach students to observe, document, and self-regulate behavior. The studies evaluated the effects of (a) self-monitoring (Graham-Day et al., 2010; Harris et al., 2005; Shimabukuro et al., 1999) and technology-based self-monitoring (Wills & Mason, 2014) on on-task behavior; (b) self-management/peer monitoring (Davies & Witt, 2000), classwide self-management (Hoff & Ervin, 2013), and technology-based

self-management (Wills & Mason, 2014) on problem behavior (i.e., disruptions, verbalizations); (c) self-monitoring (Harris et al., 2005; Mathes & Bender, 1997; Shimabukuro et al., 1999) and tactile-cued self-monitoring (Morrison et al., 2014) on task quality (productivity, task accuracy, and completion); and (d) self-management (Gureasko-Moore et al., 2006, 2007) on classroom preparation and homework behavior.

Intervention evidence-based status and source study scientific quality. Self-management strategies met the WWC evidence-based standards and were considered to be potentially evidenced by the CEC standards. Seven cases met the design standards (WWC), nine met the design standards with reservations (WWC), and three studies were deemed methodologically sound (CEC).

Visual analysis and effect size. Tau-U and visual analysis were conducted with 16 cases. According to the visual analysis, 5 cases had strong evidence, 10 had moderate evidence, and 1 had weak evidence. The weighted mean effect size for the self-management overall Tau-U was 0.93 ($SE = 0.02$, $CI_{95\%} [0.88, 0.97]$).

Moderators. For grade level, six studies with 12 cases were implemented in secondary settings, and four studies with 4 cases were implemented in elementary settings. The results indicated that the studies conducted in secondary and elementary settings had fairly equivalent effects, Tau-U = 0.93 ($SE = 0.03$, $CI_{95\%} [0.87, 0.98]$) and Tau-U = 0.92 ($SE = 0.04$, $CI_{95\%} [0.83, 1.00]$), respectively. When the two categories were compared for parameter estimates, the overlapping confidence intervals indicated that there was no statistically significant difference, which was confirmed by the reliable difference: $z = 0.20$, $p > .05$.

For setting, seven studies with 10 cases were conducted in general education, and three studies with 6 cases were conducted in special education settings. The results indicated that general education and special education had fairly equivalent effects, Tau-U = 0.92 ($SE = 0.03$, $CI_{95\%} [0.85, 0.98]$) and Tau-U = 0.93 ($SE = 0.03$, $CI_{95\%} [0.87, 1.0]$), respectively. When the two categories were compared for parameter estimates, the overlapping confidence intervals indicated no statistically significant difference, which was confirmed by the reliable difference: $z = -0.24$, $p > .05$.

For the interventionist, seven studies with 10 cases were implemented by researchers, and three studies with 6 cases were implemented by teachers. The results indicated that studies with researchers as the interventionist had a slightly lower Tau-U = 0.91 ($SE = 0.03$, $CI_{95\%} [0.85, 0.97]$) than those with teachers, Tau-U = 0.94 ($SE = 0.03$, $CI_{95\%} [0.87, 1.00]$). When the two categories were compared for parameter estimates, the overlapping confidence intervals indicated that there was no statistically significant difference, which was confirmed by the reliable difference: $z = -0.71$, $p > .05$. For FBA, moderator analysis could not be conducted as no cases were conducted with FBA.

For outcome, seven studies with 12 cases reported behavioral outcomes, and three studies with 4 cases reported academic outcomes. The results indicated that studies with behavioral and academic outcomes had fairly equivalent effects, Tau-U = 0.92 ($SE = 0.03$, $CI_{95\%} [0.87, 0.98]$) and Tau-U = 0.93 ($SE = 0.04$,

CI_{95%} [0.85, 1.00]), respectively. When the two categories were compared for parameter estimates, the overlapping confidence intervals indicated that there was no statistically significant difference, which was confirmed by the reliable difference: $z = -0.20, p > .05$.

Environmental

The environmental category included one study (Cook et al., 2015) with one participant. The study evaluated the effects of a strategy that adapted the environment by playing background white noise on inappropriate verbalizations. Moderator analyses were not conducted as only one study was included.

Intervention evidence-based status and source study scientific quality. Environmental interventions did not meet the WWC evidence-based standards and had insufficient evidence to be considered methodologically sound (CEC).

Visual analysis and effect size. Visual analysis and Tau-U were conducted with one case. According to the visual analysis, this study had weak evidence. The weighted mean effect size for the environmental overall Tau-U was 0.97 ($SE = 0.03$, CI_{95%} [0.32, 1.00]).

Discussion

The current systematic review with meta-analysis updated prior findings and contributed new information to the field from the SCD literature evaluating classroom-based interventions. The results revealed four intervention types (i.e., behavioral, instructional, self-management, and environmental) implemented in K–12 classroom settings with students with ADHD that, overall, produced a moderate effect on behavior and academic performance. Within the context of SCD studies, instructional and self-management interventions yielded large effects and were designated as evidence based by the WWC standards and potentially evidence based by the CEC standards. The behavioral interventions were moderately effective, did not meet the evidence per the WWC standards, and were potentially evidence based by the CEC standards. In the following discussion, we situate the findings from the current SCD systematic review with meta-analysis within the context of the extant literature that included reviews and meta-analyses that explored findings from SCD and group studies. As such, we encourage readers to consider all the available findings with the understanding that prior meta-analyses have found that SCD studies produced larger effects than group design (DuPaul et al., 2012).

Intervention Types

The intervention categories revealed in the current study are not new; however, changes and advances are evident across the decades. Most noteworthy, an increase in the strategies, the number of studies that evaluated the effectiveness of instructional interventions, and the content areas covered, even with the elimination of less than quality studies, is evident. DuPaul and Eckert (1997) identified one study of peer tutoring with mathematics content and one of peer-mediated reading instruction. Fifteen years later, DuPaul et al. (2012) identified three

studies of CAI and mathematics instruction and one of SRSD writing instruction (Jacobson & Reid, 2010). In the current meta-analysis, including two overlapping studies with DuPaul et al., we identified nine studies of the effects of four interventions (CAI, CCC, SRSD, and video modeling) that were utilized to address behavior and academic performance during reading, mathematics, spelling, and writing instruction. Interestingly, four of the studies conducted between the years 2008 and 2014 evaluated the use of SRSD. The requirement to maintain and shift attention for writing tasks is difficult for students with ADHD; however, this is a content area that was not substantially targeted with intervention prior to 2008. This increase in academic interventions targeting multiple content areas across the years is important as targeted intervention to address the academic impairment associated with ADHD is likely to positively affect the known negative long- and short-term outcomes for individuals with ADHD (e.g., grade retention, failing grades, leaving school prior to graduation).

In contrast to instructional interventions, teaching students with ADHD to self-regulate behavior has been a common theme in the group and SCD intervention research across the years (e.g., Barkley, Copeland, & Sivage, 1980; Varni & Henker, 1979). Prior meta-analyses have identified an overarching theme of cognitive-behavioral strategies to teach skills needed for self-regulation, including self-management and other strategies. For example, DuPaul and Eckert (1997) and DuPaul et al. (2012) identified studies of self-evaluation procedures, cognitive training, and self-regulation. However, in the current meta-analysis, we identified studies that specifically evaluated the effects of self-monitoring or self-management in classroom settings. The difference in findings between prior meta-analyses and the current one might be attributed to the inclusion of only SCD studies or the focus on strategies that can be implemented in classroom settings. However, the concentrated focus on self-management strategies is likely associated with an increased focus on teaching students with ADHD the skills needed for independent functioning (see Evans, Owens, Mautone, DuPaul, & Power, 2014; Harrison, Bunford, Evans, & Owens, 2013). ADHD researchers are encouraging the development and evaluation of strategies to teach the skills needed to independently self-regulate behavior and successfully navigate not only the school environment and expectations but also the expectations of future settings that are imperative to individual success.

The effectiveness of behavioral interventions has been studied for years and was a focus of the largest randomized controlled trial to evaluate strategies for students with ADHD (Jensen et al., 2001). Consistent findings have demonstrated positive short-term outcomes when using behavioral strategies with youth with ADHD. As such, all meta-analyses to date have included behavioral strategies (e.g., response cost, contingent and positive reinforcement); however, no prior meta-analysis has evaluated the effectiveness of behavioral strategies specifically selected through FBA. When students receiving special education services demonstrate behaviors that interfere with academic performance, schools are mandated to conduct FBA to select interventions to include in behavioral intervention plans. Students with ADHD are known to engage in behaviors for teacher and peer attention and to avoid or escape classroom demands (DuPaul & Weyandt, 2006). This was confirmed within the five studies in the current meta-analysis that

included strategy selection through FBA. Specifically, strategies were selected to address disruptive (e.g., talking out) and off-task behaviors with the functions of attention and escape. Strategies selected when the function of the behavior identified through FBA was to gain attention included noncontingent attention/reinforcement and behavior-specific praise. When the function identified was escape, strategies implemented included allowing the student the opportunity to earn brief breaks and maintaining the task demand (Germer et al., 2011; Whitford et al., 2013). All these strategies are known to be effective behavioral interventions; however, when the function of the behavior was identified, the strategies were more likely to be effective. Our results support those of Miller and Lee (2013), who found that the use of FBA increased the effects of behavioral strategies, and we were encouraged that studies of strategies selected through FBA for students with ADHD have increased between the years 2011 and 2016. Concerns exist regarding questionable feasibility in schools (e.g., Gable, Hendrickson, & Sasso, 1995; Nelson, Roberts, Mathur, & Rutherford, 1999). The FBA process is very resource intensive and individualized, and the feasibility of implementation by classroom teachers is minimal as it requires the support of specialized professionals. However, results here continue to support its use.

Only one environmental SCD study was identified in the current meta-analysis, and no environmental studies were evaluated in prior meta-analyses. However, historically, environmental changes as antecedent interventions have been suggested for students with ADHD. For example, Reid (1999) suggested that students with ADHD need physical activity, which could be provided through the physical setup in the classroom. The author recommended allowing students to move around the class from a study carrel to a standard desk, to a stand-up desk. More recently, within the popular literature (e.g., Entwistel & Fallowfield, 2017) and in classrooms across the United States, teachers are implementing environmental strategies, such as flexible seating (e.g., Kercood & Banda, 2012; Schilling, Washington, Billingsley, & Deitz, 2003) and use of flexible tangle toys (Kercood & Grskovic, 2010); however, no SCD studies were found that met the inclusion criteria that evaluated these strategies.

Evidence-Based Status of Intervention Types

The current study was the first to apply meta-analytic procedures for SCD studies to determine the overall evidence-based status of each category of intervention by considering both WWC and CEC standards. Evaluating interventions through the application of two sets of standards allowed us to provide a layer of rigor that increased the likelihood of credible and trustworthy findings (Kratochwill & Levin, 2010; Kratochwill et al., 2010). However, it also focused attention on the need for agreement regarding the indicators of quality SCD research as differences exist between the two sets of standards, resulting in different outcomes for the intervention types. Specifically, instructional and self-management interventions met sufficient SCD WWC indicators to be considered evidence based; however, both were considered potentially evidence based according to CEC. On the contrary, behavioral interventions did not meet sufficient WWC indicators to be considered evidence based, because of an inadequate number of participants; however, based on the CEC criteria, behavioral interventions were potentially

evidence based. These discrepancies were expected as the standards focus on somewhat different criteria; however, the mixed findings introduce ambiguity into the knowledge of evidence-based interventions for students with ADHD in classroom settings, and as such, a consensus set of quality indicators would be beneficial.

Scientific Quality of the Source Studies

Overall, the scientific quality of the SCD source studies supporting the use of classroom-based interventions for students with ADHD was fairly strong and appears to be improving with time, indicating that researchers are committed to conducting quality education research. The change across time is evident as 10 studies included in the DuPaul et al. (2012) meta-analysis and published between 1998 and 2007 were excluded from the current study at the standards evaluation stage. Furthermore, only 4 of the 18 studies that did not meet the WWC standards and were eliminated in the current meta-analysis were published after the standards. Studies were excluded primarily because of insufficient number of data points per phase, which is understandable as some experts question the need for additional data points in a phase when data are stable or moving in the opposite direction of the desired effect. Another area of weakness was found in reporting fidelity. Forty-one percent ($n = 11$) of the source authors did not report fidelity. Although these two weaknesses were found, the overall findings indicate that the research base is strong and that researchers are attending to established quality criteria.

Similar to the discrepancies in the evidence-based status of the intervention types when applying two sets of standards, discrepancies were found between the two sets of standards for 16 individual studies (59%). The quality of each of these studies was sufficient to meet the WWC standards with or without reservations. However, the studies did not meet the quality standards established by CEC. Specifically, the studies did not sufficiently report study characteristics for replication. As mentioned previously, this discrepancy has the potential to confuse educators searching for evidence-based interventions.

Effectiveness

To determine the effectiveness of the interventions, the source studies were evaluated through Tau-U and visual analysis, and effect sizes were combined for each intervention type. Our findings support those of DuPaul et al. (2012), indicating that all the intervention types had moderate to large effects, with self-management having the strongest effect (environmental intervention, with only one study, was not considered). SRSD, CAI, and CCC were found to have moderate effects on essay writing, math fluency, and academic engagement. Furthermore, our findings of overall moderate to large effects of SRSD support the findings of Reid et al. (2014) suggesting that teaching students with ADHD strategies for writing is likely to increase accurate essay writing. These findings indicate that increasing the academic success of students with ADHD is a critical goal for both researchers and educators.

Similar to the findings of DuPaul et al. (2012), we found that behavioral interventions evaluated through SCD had smaller effects than the other categories. The

overall Tau-U derived from individual studies of behavioral interventions was negatively affected by four very small effects. Specifically, small effects were found for (a) the use of the response-cost contingencies delivered through an ATS without direct rehearsal (DuPaul et al., 1992) on ADHD symptoms and on-task behavior and (b) peer tutoring with contingency management on positive and negative behavior (Vilardo et al., 2013). The small effect associated with the ATS can likely be attributed to the novelty of the system and distractions in the classroom during the first phase. The authors indicated that during the initial intervention phase, several additional students were placed in the classroom and one student was distracted by the presence of the ATS. As both Tau-U and visual analysis consider the effects during all the intervention phases, the effect size was small. The small effects associated with peer tutoring with contingency management can be attributed to variability and overlap in the data. As such, our findings and the findings of prior meta-analyses suggest that behavioral strategies are moderately effective and less effective than instructional and self-management interventions.

These results indicate a focus on increasing successful independent functioning of students with ADHD in classroom settings, with less focus on external contingencies. Specifically, effective instructional strategies were found that can be used to teach students learning strategies (e.g., SRSD) and others that explicitly teach content (e.g., flash cards) with the potential to engage and motivate students with ADHD in content learning. To further decrease the negative effects associated with ADHD symptomology and impairment, self-management strategies teach students to self-regulate behavior during instruction. These findings are encouraging and speak to the likelihood that with the correct instructional and self-management interventions implemented with fidelity, students with ADHD can learn the content standards being taught to typically developing peers and to self-regulate their own behavior.

Moderators

The results from moderator analyses in the current study support findings from prior meta-analyses and provide new information to the field. As in DuPaul et al. (2012), results in the current study suggest that, overall, interventions are as effective in general education as in special education settings. As a majority of students with ADHD receive all services in general education settings, and with the current emphasis on inclusion, this finding is encouraging. General and special education teachers are likely to find that implementation of self-management and behavioral interventions will be beneficial to students with ADHD regardless of setting. The only exception in the current study was that instructional interventions were more effective in special education settings than in general education settings. This finding provides preliminary evidence that the characteristics of special education settings may be more conducive to learning than those of general education settings for students in need of minimal distraction and specialized services.

The results for behavioral interventions produced a majority of the variability in this and prior meta-analyses. First, the results suggest that behavioral interventions were more effective when implemented in secondary settings; however, this

finding must be interpreted with caution as a large majority (82%) of cases were implemented in elementary settings, as in prior meta-analyses (DuPaul et al., 2012; Pyle & Fabiano, 2017). More research is needed in secondary settings as it is not clear whether implementation continues to be effective as children move through developmental phases.

Second, behavioral interventions were more likely to be effective when implemented by researchers than teachers. The difference was large. This study is the first to evaluate the moderating effects of the interventionist with this population, and this finding is in line with concerns about the feasibility of teachers implementing interventions with fidelity when researchers no longer provide support (e.g., Forman et al., 2009). Behavioral interventions, in particular, bring about a unique set of challenges for teachers, such as having the appropriate skills or training for implementation and the lack of resources and supports to meet the multiple student needs. This appears to be evident in the doubled effect when these interventions were implemented by researchers in comparison with teachers (i.e., $\text{Tau-U} = 0.68$ vs. 0.34 , respectively). This is an area in need of further empirical work.

Third, our findings suggest that behavioral interventions were more likely to be effective when selected through FBA. Although FBA has a strong research base (Carr et al., 1999; Sugai, Lewis-Palmer, & Hagan-Burke, 2000), this was the first study to our knowledge that evaluated its use as a moderator of effects for classroom-based interventions for students with ADHD. The findings are notable, with five cases selecting interventions through FBA having a strong Tau-U and six studies not employing FBA having a weak Tau-U . Although, some have questioned the efficiency of FBA in schools (see Scott et al., 2004), these findings provide preliminary evidence that conducting FBA to select interventions is worth the time and effort involved. Given the variability of behavioral interventions with this population, more research is needed to determine if these results are replicable and generalizable. Furthermore, as recommended by Dunlap and Kern (2018), experts need to evaluate methods for making the FBA process more efficient, feasible, and acceptable for educator implementation.

Although moderators of effect were found for behavioral and instructional interventions, the results here suggest that self-management was equally effective in secondary and elementary grades, in general- and special education settings, when implemented by researchers and teachers, and in targeting behavioral and academic outcomes. These outcomes are encouraging and support the findings of others (e.g., Reid, Trout, & Schartz, 2005). With each meta-analysis, further data are developed to provide support for interventions that can be implemented to teach students with ADHD the skills they need to be successful in classroom settings.

Limitations

This systematic review with meta-analysis is not without limitations. First, as we were only interested in classroom-based interventions, it is possible that we excluded rigorous studies that were implemented in similar settings (e.g., summer treatment programs, residential treatment programs). However, the goal here was to evaluate studies implemented in typical authentic education settings. Second,

studies were only included if published in peer-reviewed journals, as we were particularly interested in the quality of the published literature in this area. However, we did conduct Egger's test to measure publication bias in the sample. Third, Tau-U is limited by the potential for ceiling effects, with 16 cases reaching the upper ceiling. Fourth, as results of previous meta-analyses indicate that interventions evaluated through SCD had larger effects than those evaluated through within-or between-subject designs, it is possible that effects in the current study are larger than would be found if other methodologies are used.

Implications for Research and Practice

Implications for research can be drawn from the results of this meta-analysis. First, it is clear that researchers have been studying the effects of interventions that can be implemented in classrooms with students with ADHD for more three decades. Changes have occurred over time, with a focus that appears to be moving from behavioral strategies to address classroom behaviors to instructional strategies to increase learning, as well as self-management strategies to increase self-regulation. We encourage researchers to continue this trend, replicating studies and findings to increase content mastery and self-regulation in order to encourage independent functioning among youth with ADHD. Second, research is needed to determine the effects of SRSD on distal outcomes, such as grades and high-stakes achievement tests. In the current climate of high-stakes testing and accountability, it is important to understand the effects of learning strategies on such outcomes. Third, research is needed to further explore the use of FBA to select interventions for students with ADHD in classroom settings. Specifically, researchers are encouraged to continue the process of developing strategies to increase the acceptability, feasibility, and usability of FBA to select interventions for students with ADHD for teacher use. Fourth, research on environmental strategies is needed as our experience indicates that such strategies are being implemented without empirical support in classrooms with students with ADHD. Finally, we recommend that researchers continue collaboration and strive for a consensus set of standards for quality SCD research. Based on the findings here, we recommend combining the two sets of criteria into one. The focus on transparency and quality of study procedures is vital to ensuring that studies can be replicated. In addition, procedures found in the WWC standards to ensure that studies are conducted that control for threats to internal and external validity must be included. Increasing the quality of SCD studies is vital to its continued use to determine the evidence-based status of interventions. SCD studies have a long history in education research, and strides to increase their quality are commended and should continue.

Implications for educators are also evident in this meta-analysis. First, classroom teachers are encouraged to utilize the instructional strategies described in this study to increase the likelihood that students with ADHD have access to the general education curriculum. Specifically, teachers are encouraged to monitor the effects of SRSD as a strategy to teach students with ADHD to write, as results here suggest a strong likelihood of increasing student mastery. Second, CAI is a viable instructional option. Teachers are encouraged to carefully select computer-based programs by reviewing the empirical support for the specific

program. Third, we recommend that teachers instruct and guide students to use self-management strategies to increase independent and academic functioning. It is likely that teachers will need consultation to effectively teach this skill, and they will need assistance, feedback, and coaching. However, the results of the current and prior studies indicate that these strides will likely be worth the effort. Fourth, the findings here and from prior research indicate that behavioral strategies are effective for students with ADHD; however, we recommend that teachers carefully monitor student progress and adjust behavioral interventions based on student achievement. Finally, we stress the importance of using strategies with empirical evidence. Strategies with sufficient evidence gathered through quality research have been identified that potentially have a strong likelihood of increasing learning and positive behavioral outcomes in students with ADHD in classroom settings.

Conclusion

In conclusion, although the exploration of school-based interventions is not new, students with ADHD continue to struggle in academic environments and teachers continue to be challenged to address student needs. In the past, research has primarily focused on external strategies to change behavior without focusing on instructional strategies, which have the potential to ultimately derail the secondary and/or postsecondary academic performance of students with ADHD and further the trajectory toward poor long-term outcomes. The findings here suggest that this focus has shifted to address both academic and behavioral challenges and to explore strategies to teach students to manage their own behavior and learning. Furthermore, the quality of the supporting SCD research appears to be improving, increasing the trustworthiness of the findings. These advances are encouraging, and next steps include expanding intervention development with consideration of the moderators of effects. In summary, the results of this study suggest that promising classroom-based interventions evaluated through quality research that have the potential to increase positive outcomes are available to address the needs of students with ADHD in classroom settings.

ORCID iD

Judith R. Harrison  <https://orcid.org/0000-0003-1530-6857>

References

- *References marked with an asterisk indicate studies included in the meta-analysis.
- Aase, H., & Sagvolden, T. (2005). Moment-to-moment dynamics of ADHD behaviour. *Behavioral and Brain Functions*, 1(1), 12. doi:10.1186/1744-9081-1-12
- Abramson, J. H. (2011). WINPEPI updated: Computer programs for epidemiologists, and their teaching potential. *Epidemiological Perspective & Innovations*, 8, 1–9. doi:10.1186/1742-5573-8-1.
- Ahmed, A. (2015). *The effectiveness of using computer-assisted instruction for reading intervention on reading comprehension and on-task behavior of students with attention deficit hyperactivity disorders in a second language classroom* (Electronic dissertation). Retrieved from OhioLINK (Document No. ohio1427805350)

- *Banda, D. R., & Sokolosky, S. (2012). Effectiveness of noncontingent attention to decrease attention-maintained disruptive behaviors in the general education classroom. *Child & Family Behavior Therapy*, 34, 130–140. doi:10.1080/07317107.2012.684646
- Barkley, R. A., Copeland, A. P., & Sivage, C. (1980). A self-control classroom for hyperactive children. *Journal of Autism and Developmental Disorders*, 10(1), 75–89. doi:10.1007/BF02408435
- Barlow, D. H., Nock, M., & Hersen, M. (2009). *Single case experimental designs: Strategies for studying behavior for change* (3rd ed.). Upper Saddle River, NJ: Pearson Education.
- Borgmeier, C., Horner, R. H., & Koegel, R. L. (2006). An evaluation of the predictive validity of confidence ratings in identifying functional behavioral assessment hypothesis statements. *Journal of Positive Behavior Interventions*, 8, 100–105. doi:10.1177/10983007060080020101
- Bowman-Perrott, L., Burke, M., Zhang, N., & Zaini, S. (2014). Direct and collateral benefits of peer tutoring on social and behavioral outcomes: A meta-analysis of single-case studies. *School Psychology Review*, 43, 260–285.
- *Brasch, T. L., Williams, R. L., & McLaughlin, T. F. (2008). The effects of a direct instruction flashcard system on multiplication fact mastery by two high school students with ADHD and ODD. *Child & Family Behavior Therapy*, 30(1), 51–59. doi:10.1300/j019v30n01_04
- Briesch, A. M., & Briesch, J. M. (2016). Meta-analysis of behavioral self-management interventions in single-case research. *School Psychology Review*, 45(1), 3–18. doi:10.17105/spr45-1.3-18
- Brossart, D. F., Parker, R. I., Olson, E. A., & Mahadevan, L. (2006). The relationship between visual analysis and five statistical analyses in a simple AB single-case research design. *Behavior Modification*, 30, 531–563. doi:10.1177/0145445503261167
- Busk, P. L., & Serlin, R. C. (1992). Meta-analysis for single-case research. In T. R. Kratochwill & J. R. Levin (Eds.), *Single-case research design and analysis: New directions for psychology and education* (pp. 187–212). Hillsdale, NJ: Lawrence Erlbaum.
- Byiers, B. J., Reichle, J., & Symons, F. J. (2012). Single-subject experimental design for evidence-based practice. *American Journal of Speech-Language Pathology*, 21, 397–414. doi:10.1044/1058-0360(2012/11-0036
- Carr, E. G., Horner, R. H., Turnbull, A. P., Marquis, J. G., McLaughlin, D. M., McAttee, M. L., . . . Braddock, D. (1999). *Positive behavior support for people with developmental disabilities: A research synthesis*. Washington, DC: American Association on Mental Retardation.
- Centers for Disease Control and Prevention. (2016). *Attention-deficit/hyperactivity disorder (ADHD)*. Retrieved from <https://www.cdc.gov/ncbddd/adhd/data.html>
- *Cook, A., Johnson, C., & Bradley-Johnson, S. (2015). White noise to decrease problem behaviors in the classroom for a child with attention deficit hyperactivity disorder (ADHD). *Child & Family Behavior Therapy*, 37(1), 38–50. doi:10.1002/jaba.79
- Cooper, H. M., & Hedges, L. V. (Eds.). (1994). *The handbook of research synthesis*. New York, NY: Russell Sage Foundation.
- Council for Exceptional Children. (2014). *Council for Exceptional Children standards for evidence-based practices in special education*. Arlington, VA: Author. Retrieved from <https://www.cec.sped.org/~media/Images/Standards/CEC%20EBP%20Standards%20cover/CECs%20Evidence%20Based%20Practice%20Standards.pdf>

- *Cramer, A. M., & Mason, L. H. (2014). The effects of strategy instruction for writing and revising persuasive quick writes for middle school students with emotional and behavioral disorders. *Behavioral Disorders*, 40(1), 37–51. doi:10.17988/0198-7429-40.1.37
- Crone, D. A., Hawken, L. S., & Bergstrom, M. K. (2007). A demonstration of training, implementing, and using functional behavioral assessment in 10 elementary and middle school settings. *Journal of Positive Behavior Interventions*, 9(1), 15–29. doi:10.1177/10983007070090010301
- *Davies, S., & Witte, R. (2000). Self-management and peer-monitoring within a group contingency to decrease uncontrolled verbalizations of children with attention-deficit/hyperactivity disorder. *Psychology in the Schools*, 37, 135–147. doi:10.1002/(sici)1520-6807
- de Bruin, C., Deppeler, J., Moore, D., & Diamond, N. (2013). Public school-based interventions for adolescents and young adults with an autism spectrum disorder: A meta-analysis. *Review of Educational Research*, 83, 521–550. doi:10.3102/0034654313498621
- Dragow, E., Yell, M. L., Bradley, R., & Shriner, J. G. (1999). The IDEA amendments of 1997: A school-wide model for conducting functional behavioral assessments and developing behavior intervention plans. *Education & Treatment of Children*, 22, 244–266.
- Dunlap, G., & Kern, L. (2018). Perspectives on functional (behavioral) assessment. *Behavioral Disorders*, 43, 316–321. doi:10.1177/0198742917746633
- Dunlap, G., Kern-Dunlap, L., Clarke, S., & Robbins, F. R. (1991). Functional assessment, curricular revision, and severe behavior problems. *Journal of Applied Behavior Analysis*, 24, 387–397. doi:10.1901/jaba.1991.24-387
- DuPaul, G. J., & Eckert, T. L. (1997). The effects of school-based interventions for attention deficit hyperactivity disorder: A meta-analysis. *School Psychology Review*, 26(1), 5–27.
- DuPaul, G. J., Eckert, T. L., & Vilardo, B. (2012). The effects of school-based interventions for attention deficit hyperactivity disorder: A meta-analysis 1996–2010. *School Psychology Review*, 41, 387–412.
- *DuPaul, G. J., Guevremont, D. C., & Barkley, R. A. (1992). Behavioral treatment of attention-deficit hyperactivity disorder in the classroom: The use of the attention training system. *Behavior Modification*, 16, 204–225. doi:10.1177/01454455920162004
- DuPaul, G. J., & Weyandt, L. L. (2006). School-based intervention for children with attention deficit hyperactivity disorder: Effects on academic, social, and behavioural functioning. *International Journal of Disability, Development and Education*, 53, 161–176. doi:10.1080/10349120600716141
- Egger, M., Smith, G. D., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *British Medical Journal*, 315, 629–634. doi:10.1136/bmj.315.7109.629
- Entwistle, J., & Fallowfield, E. (2017). *The fidget spinner: Useful or distracting?* Retrieved from <http://solutionsforliving.ca/2017/09/the-fidget-spinner-useful-or-distracting/>
- Erlandson, D. A., Harris, E. L., Skipper, B. L., & Allen, S. D. (1993). *Doing naturalistic inquiry: A guide to methods*. Thousand Oaks, CA: Sage.
- Evans, S. W., Owens, J. S., Mautone, J. A., DuPaul, G. J., & Power, T. J. (2014). Toward a comprehensive life-course model of care for youth with attention-deficit/

- hyperactivity disorder. In M. D. Weist, N. A. Lever, C. P. Bradshaw, & J. Sarno Owens (Eds.), *Issues in clinical child psychology. Handbook of school mental health: Research, training, practice, and policy* (pp. 413–426). New York, NY: Springer Science + Business Media.
- Evans, S. W., Serpell, Z. N., Schultz, B. K., & Pastor, D. A. (2007). Cumulative benefits of secondary school-based treatment of students with attention deficit hyperactivity disorder. *School Psychology Review*, 36, 256–273. Retrieved from <https://psycnet.apa.org/record/2007-10860-005>
- Fabiano, G., Schatz, N., Aloe, A., Chacko, A., & Chronis-Tuscano, A. (2015). A systematic review of meta-analyses of psychosocial treatment for attention-deficit/hyperactivity disorder. *Clinical Child and Family Psychology Review*, 18(1), 77–97. doi:10.1007/s10567-015-0178-6
- Fischer, M., Barkley, R. A., Fletcher, K. E., & Smallish, L. (1993). The adolescent outcome of hyperactive children: Predictors of psychiatric, academic, social, and emotional adjustment. *Journal of the American Academy of Child & Adolescent Psychiatry*, 32, 324–332. doi:10.1097/00004583-199303000-00013
- Forman, S. G., Olin, S. S., Hoagwood, K. E., Crowe, M., & Saka, N. (2009). Evidence-based interventions in schools: Developers' views of implementation barriers and facilitators. *School Mental Health*, 1(1), 26–36. doi:10.1007/s12310-008-9002-5
- Fuchs, D., & Fuchs, L. S. (2001). One blueprint for bridging the gap: Project PROMISE (practitioners and researchers orchestrating model innovations to strengthen education). *Teacher Education and Special Education*, 24, 304–314. doi:10.1177/088840640102400405
- Gable, R., Hendrickson, J. M., & Sasso, G. M. (1995). Toward a more functional analysis of aggression. *Education & Treatment of Children*, 18, 226–242.
- *Germer, K. A., Kaplan, L. M., Giroux, L. N., Markham, E. H., Ferris, G. J., Oakes, W. P., & Lane, K. L. (2011). A function-based intervention to increase a second-grade student's on-task behavior in a general education classroom. *Beyond Behavior*, 20(3), 19–31. Retrieved from <https://go.galegroup.com/ps/anonymou?id=GALE%7CA325091255&sid=googleScholar&v=2.1&it=r&linkaccess=abs&issn=10742956&p=AONE&sw=w>
- *Graham-Day, K. J., Gardner, R., III, & Hsin, Y. W. (2010). Increasing on-task behaviors of high school students with attention deficit hyperactivity disorder: Is it enough? *Education & Treatment of Children*, 33, 205–221. doi:10.1353/etc.0.0096
- Guernsey, T. F. (1989). *The Education for All Handicapped Children Act, 42 U.S.C. § 1983, and Section 504 of the Rehabilitation Act of 1973: Statutory interaction following the Handicapped Children's Protection Act of 1986*, 68 Neb. L. Rev. Retrieved from <https://digitalcommons.unl.edu/nlr/vol68/iss2/5>
- *Gureasko-Moore, S., DuPaul, G. J., & White, G. P. (2006). The effects of self-management in general education classrooms on the organizational skills of adolescents with ADHD. *Behavior Modification*, 30, 159–183. doi:10.1177/0145445503259387
- *Gureasko-Moore, S., DuPaul, G. J., & White, G. P. (2007). Self-management of classroom preparedness and homework: Effects on school functioning of adolescents with attention deficit hyperactivity disorder. *School Psychology Review*, 36, 647–664.
- *Harris, K. R., Friedlander, B. D., Saddler, B., Frizzelle, R., & Graham, S. (2005). Self-monitoring of attention versus self-monitoring of academic performance: Effects among students with ADHD in the general education classroom. *Journal of Special Education*, 39, 145–157. doi:10.1177/00224669050390030201

- Harrison, J., Thompson, B., & Vannest, K. J. (2009). Interpreting the evidence for effective interventions to increase the academic performance of students with ADHD: Relevance of the statistical significance controversy. *Review of Educational Research, 79*, 740–775. doi:10.3102/0034654309331516
- Harrison, J. R., Bunford, N., Evans, S. W., & Owens, J. S. (2013). Educational accommodations for students with behavioral challenges: A systematic review of the literature. *Review of Educational Research, 83*, 551–597. doi:10.3102/0034654313497517
- Hart, E. L., Lahey, B. B., Loeber, R., Applegate, B., & Frick, P. J. (1995). Developmental change in attention-deficit hyperactivity disorder in boys: A four-year longitudinal study. *Journal of Abnormal Child Psychology, 23*, 729–749. doi:10.1007/BF01447474
- Hart, K. C., Massetti, G. M., Fabiano, G. A., Pariseau, M. E., & Pelham, W. E., Jr. (2011). Impact of group size on classroom on-task behavior and work productivity in children with ADHD. *Journal of Emotional and Behavioral Disorders, 19*(1), 55–64. doi:10.1177/1063426609353762
- Hartmann, D. P., Barrios, B. A., & Wood, D. D. (2004). Principles of behavioral observation. In S. N. Haynes & E. M. Heiby (Eds.), *Comprehensive handbook of psychological assessment: Vol. 3. Behavioral assessment* (pp. 108–127). Hoboken, NJ: Wiley.
- Higgins, J. P., & Thompson, S. G. (2002). Quantifying heterogeneity in a meta-analysis. *Statistics in Medicine, 21*, 1539–1558. doi:10.1002/sim.1186
- *Hoff, K. E., & Ervin, R. A. (2013). Extending self-management strategies: The use of a classwide approach. *Psychology in the Schools, 50*, 151–164. doi:10.1002/pits.21666
- Horner, R. H., Carr, E. G., Halle, J., McGee, G., Odom, S., & Wolery, M. (2005). The use of single-subject research to identify evidence-based practice in special education. *Exceptional Children, 71*, 165–179. doi:10.1177/001440290507100203
- House, A. E., House, B. J., & Campbell, M. B. (1981). Measures of interobserver agreement: Calculation formulas and distribution effects. *Journal of Behavioral Assessment, 3*, 37–57. doi:10.1007/BF01321350
- Individuals with Disabilities Education Improvement Act, 20 U.S.C. § 1400 (2004).
- *Jacobson, L. T., & Reid, R. (2010). Improving the persuasive essay writing of high school students with ADHD. *Exceptional Children, 76*, 157–174. doi:10.1177/001440291007600202
- Jamshidi, L., Heyvaert, M., Declercq, L., Fernández-Castilla, B., Ferron, J. M., Moeyaert, M., . . . Van den Noortgate, W. (2018). Methodological quality of meta-analyses of single-case experimental studies. *Research in Developmental Disabilities, 79*, 97–115. doi:10.1016/j.ridd.2017.12.016
- Jensen, P. S., Arnold, L. E., Swanson, J. M., Vitiello, B., Abikoff, H. B., Greenhill, L. L., . . . Conners, C. K. (2007). 3-Year follow-up of the NIMH MTA study. *Journal of the American Academy of Child & Adolescent Psychiatry, 46*, 989–1002. doi:10.1097/CHI.0b013e3180686d48
- Jensen, P. S., Hinshaw, S. P., Kraemer, H. C., Lenora, N., Newcorn, J. H., Abikoff, H. B., . . . Elliott, G. R. (2001). ADHD comorbidity findings from the MTA study: Comparing comorbid subgroups. *Journal of the American Academy of Child & Adolescent Psychiatry, 40*, 147–158.
- *Johnson, J. W., Reid, R., & Mason, L. H. (2012). Improving the reading recall of high school students with ADHD. *Remedial and Special Education, 33*, 258–268. doi:10.1177/001440291007600202

- Kazdin, A. E. (2011). *Single-case research designs: Methods for clinical and applied settings*. New York, NY: Oxford University Press.
- Kercood, S., & Banda, D. R. (2012). The effects of added physical activity on performance during a listening comprehension task for students with and without attention problems. *International Journal of Applied Educational Studies*, 13(1), 19–32.
- Kercood, S., & Grskovic, J. A. (2010). Reducing the effects of auditory and visual distraction on the math performances of students with attention deficit hyperactivity disorder. *Australian Journal of Learning Difficulties*, 15(1), 1–11. doi:10.1080/19404150903524515
- Kratochwill, T. R., Hitchcock, J., Horner, R. H., Levin, J. R., Odom, S. L., Rindskopf, D. M., & Shadish, W. R. (2010). *Single-case designs technical documentation*. Retrieved from <https://ies.ed.gov/ncee/wwc/Document/229>
- Kratochwill, T. R., & Levin, J. R. (2010). Enhancing the scientific credibility of single-case intervention research: Randomization to the rescue. *Psychological Methods*, 15, 124–144. doi:10.1037/a0017736
- Lane, J. D., & Gast, D. L. (2014). Visual analysis in single-case experimental design studies: Brief review and guidelines. *Neuropsychological Rehabilitation*, 24, 445–463. doi:10.1080/09602011.2013.815636
- Lee, P., Niew, W., Yang, H., Chen, V. C., & Lin, K. (2012). A meta-analysis of behavioral parent training for children with attention deficit/hyperactivity disorder. *Research in Developmental Disabilities*, 33, 2040–2049. doi:10.1016/j.ridd.2012.05.011
- LeFever, G. B., Villers, M. S., Morrow, A. L., & Vaughn, E. S., III. (2002). Parental perceptions of adverse educational outcomes among children diagnosed and treated for ADHD: A call for improved school/provider collaboration. *Psychology in the Schools*, 39(1), 63–71. doi:10.1002/pits.20099
- *Lienemann, T. O., & Reid, R. (2008). Using self-regulated strategy development to improve expository writing with students with attention deficit hyperactivity disorder. *Exceptional Children*, 74, 471–486. doi:10.1177/001440290807400404
- Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry* (Vol. 75). Beverly Hills, CA: Sage.
- Loe, I. M., & Feldman, H. M. (2007). Academic and educational outcomes of children with ADHD. *Journal of Pediatric Psychology*, 32(6), 643–654. doi:10.1016/j.ambp.2006.05.005
- Maggin, D. M., Briesch, A. M., & Chafouleas, S. M. (2013). An application of the What Works Clearinghouse standards for evaluating single-subject research: Self-management interventions. *Remedial and Special Education*, 34, 44–58. doi:10.1177/0741932511435176
- Maggin, D. M., Briesch, A. M., Chafouleas, S. M., Ferguson, T. D., & Clark, C. (2014). A comparison of rubrics for identifying empirically supported practices with single-case research. *Journal of Behavioral Education*, 23, 287–311. doi:10.1007/s10864-013-9187-z
- Maggin, D. M., & Chafouleas, S. M. (2013). Introduction to the special series: Issues and advances of synthesizing single-case research. *Remedial and Special Education*, 34, 3–8. doi:10.1177/0741932512466269
- Maggin, D. M., Pustejovsky, J. E., & Johnson, A. H. (2017). A meta-analysis of school-based group contingency interventions for students with challenging behavior: An update. *Remedial and Special Education*, 38, 353–370. doi:10.1177/0741932517716900

- *Majeika, C. E., Walder, J. P., Hubbard, J. P., Steeb, K. M., Ferris, G. J., Oakes, W. P., & Lane, K. L. (2011). Improving on-task behavior using a functional assessment-based intervention in an inclusive high school setting. *Beyond Behavior*, 20(3), 55–67.
- Martella, R., Nelson, J. R., & Marchand-Martella, N. (1999). *Research methods: Learning to become a critical research consumer*. Boston, MA: Allyn & Bacon.
- Martin, E. W., Martin, R., & Terman, D. L. (1996). The legislative and litigation history of special education. *The Future of Children*, 6(1), 25–39. doi:10.2307/1602492
- *Mathes, M. Y., & Bender, W. N. (1997). The effects of self-monitoring on children with attention-deficit/hyperactivity disorder who are receiving pharmacological interventions. *Remedial and Special Education*, 18, 121–128. doi:10.1177/074193259701800206
- *Mautone, J. A., DuPaul, G. J., & Jitendra, A. K. (2005). The effects of computer-assisted instruction on the mathematics performance and classroom behavior of children with ADHD. *Journal of Attention Disorders*, 9, 301–312. doi:10.1177/1087054705278832
- Miller, F. G., & Lee, D. L. (2013). Do functional behavioral assessments improve intervention effectiveness for students diagnosed with ADHD? A single-subject meta-analysis. *Journal of Behavioral Education*, 22, 253–282. doi:10.1007/s10864-013-9174-4
- Moher, D., Liberati, A., Tetzlaff, J., & Altman, D., & The PRISMA Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *Annals of Internal Medicine*, 151, 264–269. doi:10.7326/0003-4819-151-4-200908180-00135
- *Morrison, C., McDougall, D., Black, R. S., & King-Sears, M. E. (2014). Impact of tactile-cued self-monitoring on independent biology work for secondary students with attention deficit hyperactivity disorder. *Journal of College Teaching & Learning (Online)*, 11(4), 181. doi:10.19030/tlc.v11i4.8856
- *Moser, L. A., Fishley, K. M., Konrad, M., & Hessler, T. (2012). Effects of the copy–cover–compare strategy on acquisition, maintenance, and generalization of spelling sight words for elementary students with attention deficit/hyperactivity disorder. *Child & Family Behavior Therapy*, 34, 93–110. doi:10.1080/07317107.2012.684644
- Nelson, J. R., Roberts, M. L., Mathur, S. R., & Rutherford, R. B., Jr. (1999). Has public policy exceeded our knowledge base? A review of the functional behavioral assessment literature. *Behavioral Disorders*, 24, 169–179. doi:10.1177/019874299902400207
- *Nolan, J. D., & Filter, K. J. (2012). A function-based classroom behavior intervention using non-contingent reinforcement plus response cost. *Education & Treatment of Children*, 35, 419–430. doi:10.1353/etc.2012.0017
- *Ota, K. R., & DuPaul, G. J. (2002). Task engagement and mathematics performance in children with attention-deficit hyperactivity disorder: Effects of supplemental computer instruction. *School Psychology Quarterly*, 17, 242–257. doi:10.1521/scpq.17.3.242.20881
- Parker, R. I., & Hagan-Burke, S. (2007). Useful effect size interpretations for single-case research. *Behavior Therapy*, 38, 95–105. doi:10.1016/j.beth.2006.05.002
- Parker, R. I., Vannest, K. J., & Brown, L. (2009). The improvement rate difference for single-case research. *Exceptional Children*, 75, 135–150. doi:10.1177/001440290907500201

- Parker, R. I., Vannest, K. J., & Davis, J. L. (2011). Effect size in single-case research: A review of nine nonoverlap techniques. *Behavior Modification*, 35, 303–322. doi:10.1177/0145445511399147
- Power, T. J., Watkins, M. W., Anastopoulos, A. D., Reid, R., Lambert, M. C., & DuPaul, G. J. (2017). Multi-informant assessment of ADHD symptom-related impairments among children and adolescents. *Journal of Clinical Child & Adolescent Psychology*, 46, 661–674. doi:10.1080/15374416.2015.1079781
- Purdie, N., Hattie, J., & Carroll, A. (2002). A review of the research on interventions for attention deficit hyperactivity disorder: What works best? *Review of Educational Research*, 72, 61–99. doi:10.3102/00346543072001061
- Pyle, K., & Fabiano, G. A. (2017). A meta-analysis of single-subject design studies utilizing the Daily Report Card intervention for students with ADHD. *Exceptional Children*, 83, 378–395. doi:10.1177/0014402917706370
- Reid, R. (1999). Attention deficit hyperactivity disorder: Effective methods for the classroom. *Focus on Exceptional Children*, 32(4), 1–20.
- Reid, R., Hagaman, J. L., & Graham, S. (2014). Using self-regulated strategy development for written expression with students with attention deficit hyperactivity disorder. *Learning Disabilities: A Contemporary Journal*, 12(1), 21–42.
- Reid, R., Trout, A., & Schartz, M. (2005). Self-regulation interventions for children with attention deficit/hyperactivity. *Exceptional Children*, 71, 361–377.
- Rosenthal, R., & DiMatteo, M. R. (2001). Meta-analysis: Recent developments in quantitative methods for literature reviews. *Annual Review of Psychology*, 52, 59–82. doi:0.1002/0471214426.pas0410
- Schilling, D. L., Washington, K., Billingsley, F. F., & Deitz, J. (2003). Classroom seating for children with attention deficit hyperactivity disorder: Therapy balls versus chairs. *American Journal of Occupational Therapy*, 57, 534–541. doi:10.5014/ajot.57.5.534
- Scott, T. M., Bucalos, M., Liaupsin, C., Nelson, C. M., Jolivette, K., & DeShea, L. (2004). Using functional behavior assessment in general education settings: Making a case for effectiveness and efficiency. *Behavioral Disorders*, 29, 189–201. doi:10.1177/019874290402900207
- Shadish, W. R., Brasil, I. C., Illingworth, D. A., White, K. D., Galindo, R., Nagler, E. D., & Rindskopf, D. M. (2009). Using UnGraph to extract data from image files: Verification of reliability and validity. *Behavior Research Methods*, 41, 177–183. doi:10.3758/BRM.41.1.177
- Shadish, W. R., Hedges, L. V., Horner, R. H., & Odom, S. L. (2015). *The role of between-case effect size in conducting, interpreting, and summarizing single-case research* (NCER 2015-002). Washington, DC: U.S. Department of Education, National Center for Education Research, Institute of Education Sciences. Retrieved from <https://files.eric.ed.gov/fulltext/ED562991.pdf>
- Shadish, W. R., Hedges, L. V., & Pustejovsky, J. E. (2014). Analysis and meta-analysis of single-case designs with a standardized mean difference statistic: A primer and applications. *Journal of School Psychology*, 52, 123–147. doi:10.1016/j.jsp.2013.11.005
- *Shimabukuro, S. M., Prater, M. A., Jenkins, A., & Edelen-Smith, P. (1999). The effects of self-monitoring of academic performance on students with learning disabilities and ADD/ADHD. *Education & Treatment of Children*, 22, 397–414.
- Soares, D. A., Harrison, J. R., Vannest, K. J., & McClelland, S. S. (2016). Effect size for token economy use in contemporary classroom settings: A meta-analysis of

- single-case research. *School Psychology Review*, 45, 379–399. doi:10.17105/spr45-4.379-399
- Sugai, G., Lewis-Palmer, T., & Hagan-Burke, S. (2000). Overview of the functional behavioral assessment process. *Exceptionality*, 8(3), 149–160. doi:10.1207/S15327035EX0803_2
- U.S. Department of Education, Office of Special Education and Rehabilitative Services, Office of Special Education Programs. (2008). *Teaching children with attention deficit hyperactivity disorder: Instructional strategies and practices*. Washington, DC: Author.
- Vannest, K. J., Harrison, J. R., Temple-Harvey, K., Ramsey, L., & Parker, R. I. (2011). Improvement rate differences of academic interventions for students with emotional and behavioral disorders. *Remedial and Special Education*, 32, 521–534. doi:10.1177/0741932510362509
- Vannest, K. J., & Ninci, J. (2015). Evaluating intervention effects in single-case research designs. *Journal of Counseling & Development*, 93, 403–411. doi:10.1002/jcad.12038
- Vannest, K. J., Parker, R. I., Gonen, O., & Adiguzel, T. (2016). *Single case research: Web-based calculators for SCR analysis* (Version 2.0). College Station: Texas A&M University.
- Varni, J. W., & Henker, B. (1979). A self-regulation approach to the treatment of three hyperactive boys. *Child Behavior Therapy*, 1, 171–192. doi:10.1300/J473v01n02_04
- *Vilardo, B. A., DuPaul, G. J., Kern, L., & Hojnoski, R. L. (2013). Cross-age peer coaching: Enhancing the peer interactions of children exhibiting symptoms of ADHD. *Child & Family Behavior Therapy*, 35(1), 63–81. doi:10.1080/07317107.2013.761043
- Voight, M. L., & Hoogenboom, B. J. (2012). Publishing your work in a journal: Understanding the peer review process. *International Journal of Sports Physical Therapy*, 7, 452–460. Retrieved from <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3474310/>
- *Whitford, D. K., Liaupsin, C. J., Umbreit, J., & Ferro, J. B. (2013). Implementation of a single comprehensive function-based intervention across multiple classrooms for a high school student. *Education & Treatment of Children*, 36, 147–167. doi:10.1353/etc.2013.0036
- *Wills, H. P., & Mason, B. A. (2014). Implementation of a self-monitoring application to improve on-task behavior: A high-school pilot study. *Journal of Behavioral Education*, 23, 421–434. doi:10.1007/s10864-014-9204-x
- *Woltersdorf, M. A. (1992). Videotape self-modeling in the treatment of attention-deficit hyperactivity disorder. *Child & Family Behavior Therapy*, 14(2), 53–73. doi:10.1300/j019v14n02_04
- Zigmond, N. (2003). Where should students with disabilities receive special education services? Is one place better than another? *Journal of Special Education*, 37, 193–199. doi:10.1177/00224669030370030901
- Zwi, M., Jones, H., Thorgaard, C., York, A., & Dennis, J. (2011). Parent training interventions for attention deficit hyperactivity disorder (ADHD) in children aged 5 to 18 years. *Cochrane Developmental, Psychosocial and Learning Problems Group*, (12), CD003018. doi:10.1002/14651858.CD003018.pub3

Authors

JUDITH R. HARRISON, PhD, is an assistant professor in the Department of Educational Psychology, Special Education at Rutgers University in New Brunswick, 10 Seminary Place, New Brunswick, NJ 08901-8554, USA; email: *judith.harrison@gse.rutgers.edu*. Her research interests include the effectiveness, acceptability, and feasibility of assessment, interventions, and other services for youth with emotional and behavioral disorders and attention deficit hyperactivity disorder.

DENISE A. SOARES, PhD, is an assistant chair for the Department of Teacher Education, Special Education Program Coordinator, and Associate Professor of Special Education at the University of Mississippi, P.O. Box 1835, Oxford, MS 38677, USA; email: *dasoares@olemiss.edu*. Her research agenda includes emotional behavior disorders, cognitive-behavioral interventions, and teachers' competing time demands. The majority of her publications and research have focused on the development of emotional competence in children and youth, particularly those who have or are at risk for emotional behavior disorders.

STEPHEN RUDZINSKI, BS, graduated from Rutgers University with a bachelor's degree in psychology, New Brunswick, NJ; email: *rudzinskis@rider.edu*. His research interests include academic interventions for students with attention deficit hyperactivity disorder and prekindergarten curriculum development.

RACHEL JOHNSON is a volunteer at Peace Corps, Washington, DC, USA; email: *rtj34@scarletmail.rutgers.edu*. She graduated from Rutgers University with a bachelor's degree in psychology and is interested in international educational services.