Review of Educational Research
October 2021, Vol. 91, No. 5, pp. 718–760
DOI: 10.3102/00346543211025092
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Comprehensive Meta-Analysis of Attention-Deficit/Hyperactivity Disorder Psychosocial Treatments Investigated Within Between Group Studies

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Interventions for attention-deficit/hyperactivity disorder (ADHD) include positive behavior supports (e.g., parent training, school-based contingency management, behavioral peer interventions), training interventions (e.g., organizational skills training, social skills training, etc.), and other interventions (e.g., academic accommodations/modifications, self-monitoring). There is a need to conduct a comprehensive meta-analysis of psychosocial treatments for ADHD given discrepancies between meta-analyses. The present meta-analysis reports the results of between-group studies that compared a psychosocial treatment to a control condition from 1968 to 2016. In total, 226 studies were identified that met inclusion criteria. Results of the meta-analysis were organized by treatment type, rater, and domain of outcome assessed. Results indicated considerable variability across these parameters, with the strongest effects for proximal outcomes of behavioral parent training (improvements in parenting behaviors yielded a standardized mean difference of 0.70) and improvements in child behavior following implementation of behavioral school intervention (standardized mean difference of 0.66 and 0.72 for teacher ratings of ADHD symptoms and impairment, respectively). Other interventions were not extensively studied as stand-alone approaches. Results are discussed in light of current support for the use of psychosocial interventions for individuals with ADHD.

Keywords: attention-deficit/hyperactivity disorder, school intervention, meta-analysis

Attention-deficit/hyperactivity disorder (ADHD) is a chronic disorder, with childhood onset, that results in impaired functioning across important domains of daily life (American Psychiatric Association, 2013). An ADHD diagnosis represents excessive levels of inattention, overactivity, and impulsivity along a dimension of these characteristic behaviors. ADHD is notable in that it is a high incidence disorder, with an average of one to two children in every classroom in the United States estimated as having behaviors consistent with ADHD (Fabiano et al., 2013; Polanczyk et al., 2014; Visser et al., 2010). The challenges associated with ADHD result in considerable social, occupational, and academic problems for children and their families (Fabiano et al., 2006; Kent et al., 2011), as well as long-term economic consequences (Gordon & Fabiano, 2019; Pelham et al., 2007; Pelham, Altszuler et al., 2020; Robb et al., 2011). The personal and societal

costs of ADHD have resulted in efforts to identify and disseminate effective interventions, particularly in educational settings.

At the present time two broad treatment modalities are commonly employed—stimulant medication (e.g., Conners, 2002) and psychosocial interventions (defined broadly; DuPaul & Eckert, 1997; DuPaul et al., 2012; Evans et al., 2014; Evans et al., 2018; Fabiano et al., 2015; Pelham et al., 1998; Pelham & Fabiano, 2008; Pfiffner & Haack, 2014). In addition, numerous other treatments have been employed for ADHD, including cognitive training, academic accommodations, and other psychosocial approaches. Although it is taken for granted that the field has a clear understanding of the best approach for recommending best practice interventions for ADHD, there is considerable disagreement among professionals, discrepant findings among systematic reviews and meta-analyses, conflicting policy documents and practice guides produced by professional organizations (e.g., Pliszka, & American Academy of Child and Adolescent Psychiatry [AACAP] Work Group on Quality Issues, 2007; U.S. Department of Education, 2004; Wolraich et al., 2019), and a need to pull together a literature that is represented by varied treatment types, assessments of outcomes, and raters of outcomes. Together, these varied parameters make meta-analytic procedures of the psychosocial treatment literature for ADHD complicated.

Rationale for the Need for a Comprehensive ADHD Treatment Meta-analysis

Fabiano et al. (2015) reported major differences in the type of treatment included in a meta-analysis ranging from a focus on single treatments such as behavioral parent training (Corcoran & Dattalo, 2006) to a heterogeneous combination of treatments (Hodgson et al., 2014). This variability among meta-analyses of psychosocial treatments produces challenges for practitioners and families attempting to choose viable treatment approaches. In contrast to pharmacological treatment, which is defined as a distinct intervention (e.g., stimulant medication), psychosocial treatments are composed of varied components, and often combined with one another idiosyncratically in systematic reviews, making the review and discussion of efficacy within this class of interventions challenging. This is compounded by inconsistent, and at times contrary, findings within meta-analyses, systematic reviews, and practice guidelines of ADHD treatment (American Academy of Pediatrics, 2011; Fabiano et al., 2015; Pliszka & AACAP Work Group on Quality Issues, 2007; Wolraich et al., 2019). Sources of potential variability in meta-analytic research design include the type(s) of psychosocial interventions for ADHD included in meta-analyses, and specific constructs and measures used as indicators of treatment response. Each of these issues will be addressed briefly, in turn.

Type of Treatments Included in Meta-Analyses

The category of psychosocial interventions represents a heterogeneous group of approaches. Terms such as "counseling," "academic intervention," or "behavior modification" do not accurately reflect the complexity of intervention, or represent the treatment components that may be present. In other fields, this approach to treatment categorization would be considered *inappropriate*—physicians would not combine effect sizes for stimulants, antihypertension drugs, and

antihistamines to determine whether a drug was effective for a specific behavior. In education, teachers would not combine effect sizes for a small group reading intervention, a math skills training computer program, and an indirect consultation approach to judge the effectiveness of these interventions on an untargeted outcome like school attendance. However, this is exactly what has been routinely done within the ADHD meta-analytic literature for psychosocial treatments (Fabiano et al., 2015), and it is a situation that needs remediation through careful application of rigorous and comprehensive meta-analytic methods.

The most commonly studied treatments are behavioral interventions that include training parents and teachers to manipulate environmental antecedents and consequences to promote appropriate child behavior and improve parenting. Criterion-based reviews strongly support the efficacy of these interventions (Abramowitz & O'Leary, 1991; Evans et al., 2014; Evans et al., 2018; Pelham & Fabiano, 2008; Pelham et al., 1998). Psychosocial treatments may also include interventions to train youth in adaptive functioning skills, typically adolescents (e.g., organizational skills; Evans et al., 2014; Schultz & Evans, 2015). Other psychosocial interventions such as cognitive therapy (Abikoff, 1991) or individual neurocognitive training (Chacko et al., 2013; Rapport et al., 2013) have not evinced comparable levels of empirical support (DuPaul et al., 2019; Pliszka & AACAP Work Group on Quality Issues, 2007), but are also included in the broad category of psychosocial treatment in some meta-analytic work (e.g., Hodgson et al., 2014). To the extent that a meta-analysis combines studies of these interventions with varying levels of empirical support into an overall effect of psychosocial treatment, the impact of the more effective intervention will be diluted by the inclusion of the less efficacious intervention (e.g., Goode et al., 2018). In addition, promising treatments may be missed when combined in an overall, aggregate effect size. Thus, meta-analyses need to disentangle independent psychosocial treatments to better identify efficacious approaches (see DuPaul et al., 2012, and DuPaul & Eckert, 1997, as examples).

Measurement of Outcome

The approach used for measurement of treatment outcome is also an important parameter to consider in the review of meta-analyses of ADHD treatment. Psychosocial treatment studies utilize a broad array of outcome measures (e.g., symptom ratings, observations of child behavior and parenting behavior, academic outcomes; DuPaul et al., 2012; Fabiano et al., 2009) and there are typically multiple sources for these measures including parent and teacher ratings, observations, and behavioral products from the child (e.g., seatwork assignments completed; academic grades). This presents a unique challenge for the synthesis of findings across studies and may contribute to variability in conclusions drawn across meta-analyses. Also contributing to the variability in outcome measurement, some meta-analyses emphasize the use of masked measures of treatment effect common in studies of pharmaceutical treatment (e.g., Sonuga-Barke et al., 2013), though masking is difficult to maintain within treatments that are often focused on skills training and active involvement of the participants.

In addition, the alignment of specific measures with the overarching conceptual model guiding the treatment approach is important to consider. For instance,

observations of parenting are proximal outcomes in studies of behavioral parent training, but they are distal or peripheral in a study of behavioral treatment implemented by teachers within a classroom. Thus, to the extent that meta-analyses include different outcome measures, and these measures are either proximal or distal to the target of treatment, findings may vary. Therefore, measures should not be combined into a meta-analysis of overall effectiveness as has been done previously (e.g., Fabiano et al., 2009) as this may dilute or confound the estimates of treatment efficacy—the alignment of the measure should be considered when judging the effectiveness of a treatment.

Furthermore, a comprehensive meta-analysis must address diverse study measures, informants, research designs, and approaches for generating estimates of effect size, which is a problem also present in the stimulant medication literature (Faraone et al., 2006). Meta-analyses that include only randomized, controlled trials generally tend to have a lower risk of selection bias, and for that reason the present meta-analysis focuses on between-group designs that for the most part include random assignment to treatment group. Meta-analyses must also incorporate procedures for calculating robust standard errors if multiple measures from a single study are to be incorporated (Hedges et al., 2010). A transparent, replicable approach applied to the entire population of between-group ADHD studies is needed, especially because other meta-analyses have not incorporated all relevant empirical articles (Fabiano et al., 2015).

Review of Current, Relevant Meta-Analyses

The meta-analytic literature on ADHD psychosocial treatment reports inconsistent recommendations for treatment. Fabiano et al. (2015) reviewed 12 meta-analyses of ADHD psychosocial treatment. This review indicated that there was little overlap across meta-analyses. Indeed, when all the studies were recorded across the meta-analyses, overlap was low for the inclusion of all possible studies, ranging from 2% (Zwi et al., 2011) to 46% (Fabiano et al., 2009). This is problematic, as a key tenet in any meta-analysis is the inclusion of the entire population of relevant studies to prevent publication and source bias in the results (Hunter & Schmidt, 2015). Due to the large differences in included studies, it is difficult for a reader to trust the findings of any single meta-analysis, as it is unlikely to be consistent with others. This leaves a need in the field for a *comprehensive* meta-analysis that includes all relevant treatment research.

The information in Table 1 illustrates the meta-analytic literature for psychosocial treatments to date that reviewed group design studies. Table 1 includes 26 meta-analyses published up to September 2019. As can be readily observed in Table 1, there is considerable variability in the number of studies included within each meta-analysis, the definition of the ADHD psychosocial treatment covered via the meta-analysis, and the range of outcomes reported. Three meta-analyses that include behavioral interventions have varied numbers of analyzed studies (range from 15 to 32). Meta-analyses that consider parenting interventions range from 5 to 40. There is likely to be overlap across the studies included in Table 1, but there is also considerable nonoverlap, creating a concern that these meta-analyses do not represent a comprehensive overview of the psychosocial

TABLE 1

Overview of prior meta-analyses of ADHD psychosocial treatment in group design studies

Study	Number of studies included	ADHD psychosocial treatment	Measures
Sonuga-Barke et al. (2013)	15	Behavioral intervention	Proximal assessment (d = .40); probably blinded assessment (d = .02)
Fabiano et al. (2009)	20	Behavioral interventions	Combined measures (d = .74)
Daley et al. (2014)	32	Behavioral interventions	Unblinded: Positive parenting (d = .68); Negative parenting (d = .57); Parenting self-concept (d = .37); Child ADHD (d = .35); Child conduct problems (d = .31); Child social skills (d = .47); Child academic performance (d = .28). Probably blinded: Positive parenting (d = .63); Negative parenting (d = .43); Child conduct problems (d = .31)
Van der Oord et al. (2008)	24	Behavioral or cognitive-behavioral	Parent-rated ADHD symptoms (d = .87), ODD ratings (d = .66), social behavior (d = .54); teacher-rated ADHD symptoms (d = .75), ODD ratings (d = .43), social behavior (d = .71); academic performance (d = .19)
Cortese et al. (2015)	16	Cognitive training	Probably unblinded raters: total ADHD symptoms (d = .37), inattentive symptoms (d = .47); Probably blinded raters: total ADHD symptoms (d = .20), inattentive symptoms (d .32); Hyperactive/impulsive symptoms and academic performance not significantly improved
Iznardo et al. (2017)	7	Daily report card	Teacher-rated ADHD symptoms (g = .36); Teacher-rated externalizing behavior (g = .34); Observation of ADHD behavior (g = 1.05)
Theule et al. (2018)	9	Medication and psychosocial treatments combined	Parenting stress (d = .53)
Xue et al. (2019)	11	Mindfulness-based interventions	Measure of inattention (d = .83); Measure of hyperactivity/impulsivity (d = .68)
Cairncross & Miller (2016)	10[a]	Mindfulness-based therapies	Inattention (d = .66); hyperactivity/impulsivity (d = .53)

(continued)

TABLE 1 (continued)

Study	Number of studies included	ADHD psychosocial treatment	Measures
Chimiklis et al. (2018)	11	Yoga, mindfulness, mediation	Parent-rated inattention (d = .35), teacher-rated inattention (d = .31), parent-rated hyperactivity/impulsivity (d = .39), teacher-rated hyperactivity/impulsivity (d = .22), observations of on-task behavior (d = 1.22), teacher-reported executive function (d = .31, .67 depending on measure), child report of parent-child relationship (d = .50), parent-reported stress (d = .44)
Hodgson et al. (2014)	14	Nonpharmacological	See primary paper; organized by modality and outcome
Purdie et al. (2002)	N/A—All designs aggregated	Nonpharmacological	School-based/education (d = .39); behavioral training (d = .50); parent training (d = .31)
Bikic et al. (2017)	12	Organizational skills training	Teacher-rated organizational skills (d = .54); Parent-rated organizational skills (d = .83); Parent-rated inattention (d = .26); Teacher-rated inattention (d = .56); Teacher-rated academic performance (d = .33); Grade point average (d = .29)
Zwi et al. (2011)	5	Parent training	Externalizing behavior (d = −.32); internalizing behavior (d = −.48)
Charach et al. (2013)	14	Parent training	ADHD symptoms (d = .77); Disruptive behavior (d = .75); Parenting skills (d = .55)
Rimestad et al. (2019)	16	Parent training	Parent-rated ADHD symptoms (d = .51); Parent-rated conduct problems (d = .44); Parent-rated negative parenting (d = .63); Independently assessed ADHD symptoms (d = .12); Independently assessed conduct problems (d = .31); Independently assessed negative parenting (d = .33)
Lee et al. (2012)	40	Parent training	(r = .34)
Mulqueen et al. (2015)	8	Parental interventions	Overall effect size (d = .61)

(continued)

TABLE 1 (continued)

Study	Number of studies included	ADHD psychosocial treatment	Measures
Coates et al. (2015)	11	Parenting interventions	Parent-rated ADHD symptoms (d = .68), parent-rated conduct problems (d = .59), parent-rated self-esteem (d = .93), parenting stress (d = .50); parental well-being (d = .23), parental behavior (d = .34)
Corcoran & Dattalo (2006)	16	Parents included in the intervention	Teacher (d = .75); parent (d = .43); child (d = .11); child academic performance (d = 8.20); child family functioning (d = .67); child internalizing (d = .64); child ADHD (d = .39); child externalizing (d = .36); child social competence (d = .07); child self-control (d = −1.67)
Klassen et al. (1999)	2	Psychological/ behavioral	Teacher (d = .40); Parent (d = .49)
Chan et al. (2016)	10	Psychosocial treatments for adolescents	Parent-rated symptoms and impairment (d = .30–.69); Academic and organizational skills (d = .51–5.15)
Richardson et al. (2015)	36	School-based interventions	Child assessment of inattention (d = .44); Child assessment of hyperactivity/impulsivity (d = .33); Observer-rated inattention (d = 1.30); Academic achievement (d = .19–.50); Teacher ratings of inattention (d = .60); Teacher ratings of hyperactivity/impulsivity (d = .23); Teacher ratings of externalizing (d = .28); Teacher ratings of child school adjustment (d = .26)
DuPaul et al. (2012)	7	School-based treatment for ADHD	Academic outcome (d = .43); Behavioral outcome (d = .18)
DuPaul & Eckert (1997)	8	School-based treatment for ADHD	Academic outcome (d = .31); Behavioral outcome (d = .45)
Storebø et al. (2019)	11	Social skills training	Social skills (d = .16), teacher-rated general behavior (d = 0.00), teacher-rated ADHD symptoms (d = −.02)

Note. ADHD = attention-deficit/hyperactivity disorder; ODD = oppositional defiant disorder. *d/g/r* = effect size estimate; note effect size calculations may vary based on individual meta-analysis procedures. Values are provided for heuristic information in the table.

[a]Some included studies were for individuals older than 18 years of age.

treatment literature. In addition to the potential lack of comprehensiveness, there are also substantive differences in the manner in which effect sizes are calculated and presented. For instance, there are some meta-analyses that collapse measures together (Fabiano et al., 2009; Mulqueen et al., 2015), some that make distinctions about the quality of the measure (e.g., probably masked vs. probably unmasked; Daley et al., 2014; Sonuga-Barke et al., 2013), and some that report effect sizes for specific types of measures related to ADHD (e.g., Storebø et al., 2019). These differences in reporting also make it difficult to generate conclusions about the overall efficacy of psychosocial treatments for ADHD, and there is a risk that recommendations from any one meta-analysis will not appropriately represent the treatment literature. Thus, there is an urgent need for a comprehensive meta-analysis of psychosocial ADHD treatments.

Summary

Given the inconsistency in findings across meta-analyses of psychosocial interventions and treatments for ADHD (Fabiano et al., 2015; Table 1), there is therefore a need to conduct a comprehensive meta-analysis that reviews the entire population of primary studies related to interventions for ADHD. The ADHD psychosocial treatment literature includes hundreds of studies of nonpharmacological intervention effects, combined in some manner, in over a dozen disparate meta-analyses (none of which include close to the entire population of studies; see Fabiano et al., 2015). Due to the pervasive and chronic impairment associated with ADHD, multiple treatments have been evaluated, using a diverse array of outcome measures. As the field has evolved to address the many potential treatment targets for ADHD, the variety of treatments and interventions has increased. Thus, there is a need for a comprehensive meta-analysis that simultaneously reports the effect of different treatment types, singly. The report also needs to distinguish effects for these varied treatment types across the array of measures and raters that generate information on the magnitude of the effect both proximally and distally. A comprehensive meta-analysis that synthesizes, interprets, and succinctly presents these results would significantly help the field in decision-making regarding the efficacy of psychosocial ADHD treatment. To achieve this aim, a comprehensive meta-analysis of between-group design studies was conducted. This article will report on the results of the meta-analysis, with companion papers addressing the current topography of the research literature (Schatz et al., 2020), meta-analyses of alternative research designs (e.g., pre-post assessments of efficacy; single-subject design studies), and alternative analyses (e.g., network meta-analysis) to follow in independent reports.

In addition, a comprehensive meta-analysis can explore the role of moderators of the effect size magnitude at the study level. One potential moderator that can be explored is study year, which would indicate whether effect sizes increased or decreased across time. This is an important moderator to explore as one reason for the lack of comprehensive meta-analyses within the ADHD literature has been a focus on a restricted time period (see Fabiano et al., 2015). If there is no impact of study year, scholars should be inclusive of all years in systematic reviews and meta-analyses. Other moderators of interest relate to study characteristics, such as whether participants were randomly assigned to group, and whether there was

equivalence in groups at baseline. Overall meta-analytic results will be also disentangled, and reported by treatment type, and across outcome measures and raters.

Method

Search and Retrieval Process

Multiple methods were used to conduct a comprehensive literature search of the psychosocial treatment literature for ADHD. The 416 studies already identified in the systematic review of ADHD psychosocial treatment meta-analyses (Fabiano et al., 2015) were directly included. Additional studies included in this meta-analysis were identified using five main techniques. First, literature searches using major search engines including PsycINFO, ERIC, and Medline were conducted with the electronic search completed on August 31, 2016 (see search terms and results in the Supplementary Materials, available in the online version of this article). Search criteria entered into each database are available from the first author. Based on the results of the computerized search, articles were identified that meet the inclusion criteria described below. Each identified article's reference section was then also systematically analyzed, and additional studies were added to the review in this way. Dissertations were identified using the same search terms as those used in the online databases within the ProQuest Dissertation Database. To facilitate the collection of preprints, emails were sent to listserves that included child and adolescent psychologists and psychiatrists. Thus, every effort was made to include both published and unpublished studies, given that the standard for research syntheses is now to include the entire literature appropriate for a review, not simply published studies (Albaracin, 2015; McAuley et al., 2000; Rosenthal, 1995). The meta-analysis protocol was documented a priori in an Institute of Education Sciences grant application.

Eligibility Criteria

Eligibility criteria for the meta-analysis were as follows: (1) The participants were diagnosed with ADHD or significantly well-described to suggest the characteristic behaviors of ADHD (e.g., "hyperactive," "off-task"). Note, in studies that focused on treatment for children with externalizing behavior problems (e.g., oppositional defiant disorder/conduct disorder, aggressive behavior, emotional/behavioral disturbance), over 50% of the participants must have been diagnosed with ADHD or characterized as such. (2) The participants did not have an IQ reported to be below 70. (3) The participants were under 18 years of age. (4) The participants did not have their condition better explained by a documented organic cause (e.g., brain trauma). (5) The study includes information that would permit the calculation of effect sizes (e.g., means/standard deviations, correlation coefficients, beta weights from regression) or included a mechanism to obtain the needed information by contacting the study's primary authors. (6) There was some psychosocial/educational, school-based interventions or treatment, broadly defined, that aims to improve academic/social functioning or outcomes. Medication-only studies were excluded. (7) The study was primarily a treatment-outcome study—laboratory investigations of psychosocial or

combined treatments were not considered in this meta-analysis. (8) Publication was in English.

Following the search and retrieval process, identified articles were reviewed to determine inclusion in the meta-analysis. A team of reviewers including the first two authors and graduate students trained by the first two authors reviewed the titles and abstracts of the initial studies identified via the review procedures (3593 papers). At this stage, reviewers were instructed to remove obviously ineligible papers, but retain any papers that may be eligible for a more extensive full-text review. Then, all studies that passed an initial abstract review received at least two full-text reviews. Any disagreements on eligibility were resolved through discussion among the first three authors. In total, 3575 records were screened, and once duplicates and records that did not apply based on title and abstract screening were removed; 968 articles were assessed through a full text review. Of these, 537 papers included a psychosocial treatment for ADHD and were included in the comprehensive meta-analysis. Of these, 226 employed a between-group design, and of these, there were 123 independent studies represented that included a treatment versus control group comparison, the basis of the present meta-analysis (see PRISMA diagram in Figure 1).

Study Coding

The coding of the primary studies occurred in two stages. First, once a primary study was identified for inclusion, the content expert team coded the majority of the domains for each article and identified the outcome(s) reported. These coders also entered all descriptive information (e.g., means and standard deviations) used to calculate effect sizes. This information was used in the second coding stage in which more details about the design and all available statistics related to the identified outcome(s) were coded by the methodology team.

Each intervention included in the study was rated with respect to multiple attributes (e.g., treatment type, duration, provider, setting, attendees, fidelity measures, etc.). Study design was categorized by design type, number of assessment points, number of groups, number and duration of phases, random assignment, sample size, and attrition. Each study's sample was rated in terms of demographics (e.g., age, gender, race, ethnicity), presence of comorbid conditions, inclusion/exclusion criteria, manner in which diagnoses were established, and so on. For each dependent measure, coders indicated the construct targeted by the measure (e.g., ADHD symptoms, impairment, parenting, etc.) as well as the person being rated and the informant. Finally, all information necessary to compute effect sizes was extracted from tables or graphs. Each study was coded by one of 17 raters (advanced graduate students or PhD-level investigators) and discrepant scores were resolved by discussion among the investigators. Assessment of risk of bias was informed by the Cochrane guidelines for assessing risk of bias in randomized trials (Higgins et al., 2018). From the Cochrane guidelines, we selected criteria based on information that is both relevant to psychosocial treatment for ADHD as well as commonly reported in empirical articles (e.g., random assignment to treatment, similarity of groups at baseline, attrition, assessment of treatment fidelity, etc.). Specific codes that were used to organize the results of the present meta-analysis are described below.

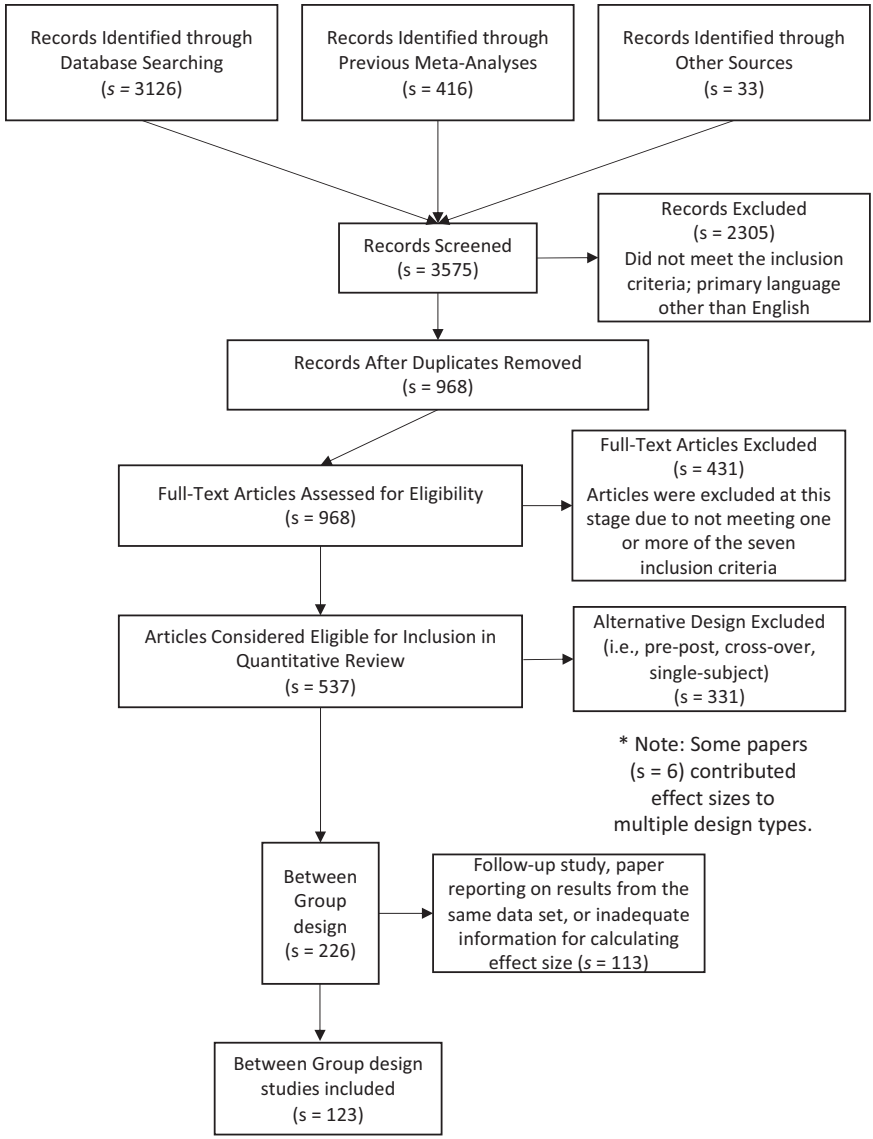

FIGURE 1. *PRISMA diagram for search and retrieval process.*

Study Design

The present meta-analysis includes between group design studies. These were defined as a study that includes assignment to an identifiable treatment and one or more comparison conditions.

Treatment Type

Treatments were categorized within the broad categories of behavioral interventions, training interventions, or a category reflecting additional interventions that either occurred frequently in the literature or in practice (combination of behavioral and training intervention, neurofeedback/biofeedback alone, academic accommodations, academic modifications, and self-monitoring).

Behavioral intervention. Multiple approaches were categorized within the behavioral intervention group. Behavioral parent training was defined as a group or individual approach to teach parents strategies to improve child behavior using social learning theory and/or operant theory. This could include self-directed bibliotherapy or web-based interventions. Behavioral Classroom Management was defined as a group or individual approach to teach teachers strategies to improve child behavior using social learning theory and/or operant theory. These could be classroom-wide or individual student interventions. Behavioral Peer Intervention was defined as an approach using operant or social learning principles to encourage appropriate peer interactions. This is distinct from social skills training, which is described below. Behavioral Family Problem-Solving Intervention was defined as an approach that utilized discussion and negotiation of parent-child, parent-teen, or family problems. This approach typically includes training for each family member on effective communication strategies, perspective taking, and compromising. There was also a category of general behavioral intervention that could be coded when the intervention is clearly behavioral in nature, but could not be readily classified as one of the other behavioral treatment options, often because it included multiple components.

Training intervention. Treatment approaches that involved teaching the child skills that were presumed to be deficient were coded as a training intervention. A treatment that targeted training of a neuropsychological process including training of working memory, self-control, sustained attention, or other executive function processes (e.g., child-training interventions to promote these specific skills) was coded as cognitive training. Organizational skills training was defined as an intervention approach that teaches the child or adolescent organizational strategies. This included teaching strategies to be more effective with study time, homework, and time management. Social skills training was defined as instruction in appropriate social behaviors (e.g., conversation skills, taking turns). The target is to reduce social skills knowledge deficits and contingencies are not tied to the use of social skills. If contingencies (i.e., rewards, punishment) are tied to the use of appropriate social skills, this was coded as a behavioral peer intervention. Emotional regulation training was classified as a treatment that teaches the child/adolescent how to moderate emotions such as anger, sadness, or anxiety or mindfulness interventions designed to promote a mental state of awareness in the present moment and acceptance of one's thoughts, emotions, and bodily feelings.

Additional interventions. An additional intervention group was created by combining all studies that included behavioral and training interventions. Harrison

et al. (2013) also noted academic supports can be utilized with children with ADHD; in addition to the interventions already coded above, academic accommodations and modifications were coded as distinct treatment types. Academic accommodations were defined as changes to practices in schools that hold students to the same standards as those without disabilities, but provide a differential boost to mediate the impact of the disability (e.g., reading instructions out loud, providing extra time, preferential seating, extra textbooks, pull out services to boost academic performance). Academic modifications were defined as changes to practices that alter, lower, or reduce expectations to compensate for disability (e.g., reduced homework, modified assignment length, reduced time spent on academic tasks). Self-monitoring was coded as an intervention in which the active treatment component is teaching/training the child to monitor his/her own performance. This includes self-instruction, self-control, and other self-management strategies.

Study Raters

Multiple sources of data were possible within the studies reviewed. For the purposes of organizing the meta-analytic results, study raters could be classified as a parent, as a teacher, as an observer (independent observations or the collection of archival records such as discipline referrals or grades), or child (most often child generated outcomes such as seatwork items completed within a prescribed amount of time; note this category *does not* typically reflect child self-report of symptoms).

Study Outcomes

Studies typically contained multiple dependent measures. Study measures also assessed varied constructs. Measured outcomes included ADHD symptoms, impairment across a number of domains, comorbid conditions such as externalizing disruptive behavior disorders, and internalizing symptoms such as anxiety or depression, treatment satisfaction, side effects, and cost. As many measures were outside of the typical scope of an ADHD treatment study, or occurred infrequently, the present meta-analysis focused on the proximal outcomes of treatment. Thus, study measures were combined into a set of general categories related to the typical proximal outcomes of ADHD treatment.

ADHD symptoms. Any measure of the presence, frequency, or severity of ADHD symptoms as defined by the *DSM* was coded in this category. This code included inattentive symptoms, hyperactive-impulsive symptoms, and combined symptoms.

Impairment. Measures that collected information on child social impairment (e.g., with peers, parents, teachers, siblings); academic impairment related to classroom productivity, accuracy, achievement, and behavior; or general impairment in the social, academic, or global domain were coded. These categories were collapsed into an overall category representing impairment related to ADHD.

Comorbid externalizing behavior. Any measure of the presence, frequency, or severity of externalizing behaviors in general. This included observations of general disruptive behavior or rule violations. Dependent variables that clearly included only ADHD symptoms (e.g., observations of the percent of time on-task) were classified under the ADHD Symptoms category.

Parenting behaviors and parenting effectiveness/stress. For studies that worked with parents, a typical outcome included the proximal improvement in parenting behavior. For these studies, this category was a more frequently studied indicator of impairment than the general Impairment category. Any measure of the type/frequency of parenting behaviors used by parents including self-reports or observations of parenting strategies were coded as parenting behaviors. In many behavioral parent training studies, measurements of parents' functioning within their role of parents was measured as an outcome. Stress experienced by parents or caregivers specific to their role as parents/caregivers, or an assessment of parents' perception of their own ability to parent effectively or to parent well was coded within this category. Thus, for the studies that included behavioral parent training these categories were also coded and reported.

Study Moderators

Study moderators were coded for variables that occurred at the study level. The study year of publication was coded for all studies. For studies that were preprints or under review at the time of the search, they were assigned a study year of 2016. Each study was coded for whether random assignment to group was used, or not.

Risk of bias. To evaluate the risk of bias influencing the magnitude of study effect sizes, five study characteristics were coded. These variables were coded for indicating low risk of bias, high risk of bias, or unclear risk of bias based on the information included within the study.

Baseline Equivalence of Means and Variance Bias

Effect sizes that had 10% or more difference between treatment and control groups at baseline were categorized as high risk of bias, when the difference was smaller than 10% the study was categorized as low risk of bias, and if the difference at baseline could not be determined, the effect sizes were categorized as unclear risk of bias

Selection Bias

For selection bias, studies that implemented and described their random allocation process were categorized as low risk of bias, and studies that did not implement random allocation were categorized as high risk of bias.

Reporting Bias

For reporting bias, studies that reported outcomes that were lower than the reported number of measures collected were categorized as high risk of bias, studies where it was unclear whether all collected outcomes were reported were

categorized as unclear risk of bias, and studies that reported on the same number of relevant outcomes as effect sizes were estimated as low risk of bias.

Attrition Bias

For attrition bias, studies that reported differential attrition between groups at a rate larger than 10% were categorized at high risk of bias, those that reported lower than 10% differential attrition were categorized as low risk of bias, and when it was not possible to determine the difference in attrition, the study was categorized as unclear risk of bias.

Implementation Bias

For implementation bias, studies that described their approach to assessing treatment fidelity were categorized as low risk of bias, studies where it appeared that treatment fidelity was assessed but the procedures were not directly described were coded as unclear, and studies that that did not report on fidelity assessment of the treatment implementation were categorized as high risk of bias.

Data Quality

The study team reviewed 968 articles for eligibility, and all articles screened in or out were reviewed to ensure accurate inclusion and exclusion of primary research articles. Then, the first and second authors met with the primary coders weekly to review coding process, discuss and answer questions, and update the codebook via an iterative process based on any decisions made regarding the study coding. The study team also reviewed all design, treatment type, and assessment label codes within the dataset to ensure accurate coding, and any discrepancies were resolved through discussion. Prior to the meta-analysis, all coded studies that had no data included for the means and standard deviations were individually reviewed to ensure the data were truly missing, and in cases where it was possible, the third author calculated effect sizes through inferential statistics included in the primary study. Finally, when data used to calculate effect sizes were initially verified, any unusual values (e.g., large negative or positive effect sizes, effect sizes of zero) were verified by the study team by reviewing the primary source. Study coders evidenced acceptable reliability as 10% of articles were double-coded and the median level of agreement was 85%.

Data Analysis

Effect sizes were calculated for each measure included in the identified studies. Measures that were unrelated to typical targets of ADHD treatment were not included (e.g., cognitive assessment of intelligence; symptoms of depression). For the purposes of this meta-analysis, a positive effect size will indicate an improvement in functioning and a negative effect size will represent deterioration in functioning. For calculating the effect sizes of treatments using between-group designs, standardized mean difference effect sizes will be used (e.g., Hedges & Olkin, 1985). The posttreatment mean of the control group was subtracted from the posttreatment mean of the treatment group, and the difference was divided by the pooled standard deviation. For studies that reported on dichotomous outcomes, transformations were applied to effect sizes as outlined by Sánchez-Meca

et al. (2003). When we examine the effect size distribution, there were effect sizes that appeared too extreme. To prevent these extreme effect sizes from distorting results, extreme values were winsorized to less extreme values using Tukey's inner fences. The analysis also corrected effect sizes and respective variances for small sample bias using formulas from Hedges (1981).

Most standard meta-analyses assume independence of the effects (see Becker, 2000). In our meta-analysis, there were typically several sources of dependence among the effects. Some studies reported on results of multiple treatment groups against the same control group. For this type of dependence, the covariance between groups was computed and modelled by multivariate meta-analysis. The second source of dependence arises because studies reported on multiple outcomes. Because most of the studies did not report on the correlation between outcomes, which is necessary to estimate the covariance between effect sizes reporting results from the same sample but different outcomes, we conducted robust variance estimation to account for this type of dependence (Hedges et al., 2010). Thus, our overall results report a model which combines multivariate meta-analysis and robust variance estimation. Similarly, our subgroup analyses specified which one of the models were fitted to the data (see Tables 2–4). All of our analyses were conducted in the R environment (R Core Team, 2018) using the metafor package (Viechtbauer, 2010). The analyses utilized a random-effects model, where both within- and between-sample uncertainty were incorporated in our weights and mixed-effects models, which included both predictor variables and additional between-studies uncertainty in the effect variances.

Presentation of Meta-Analytic Results

Initial meta-analytic results combined all studies together, but as outlined above, this was only a preliminary step as a goal of this meta-analysis was to disentangle the effects across parameters of the studies. Given the large number of studies included in the meta-analysis, multiple measures within each study, and diverse treatment types, presentation of results were organized within the larger framework of ADHD treatment reviews. Specifically, ADHD treatments have been previously reviewed narratively using the Lonigan et al. (1998) criteria by Pelham et al. (1998) and Pelham and Fabiano (2008) and subsequently updated by Evans et al. (2014) and Evans et al. (2018). As a result of these reviews, behavioral parent training, contingency management implemented in classrooms, and behavioral peer interventions met criteria for well-established, evidence-based treatment (Pelham et al., 1998; Pelham & Fabiano, 2008). Evans et al. (2014) and Evans et al. (2018) concurred with the findings in the prior reviews and also added some training interventions to the list of well-established, evidence-based treatment.

Thus, we organize our results based on these well-established treatments and also report on results for other treatments that have been evaluated within the psychosocial treatment literature (e.g., cognitive training). Each weighted average standardized mean difference (*SMD*) and respective standard error (*SE*) is presented within this framework, along with the number of studies (*s*) that contributed to the *SMD* and the number of effect sizes from these studies (*k*). For each *SMD* an I^2 index is reported as well, and this index represents the percentage of

TABLE 2

Results of meta-analysis for behavioral treatments combined with one another, behavioral parent training, behavioral classroom management, behavioral peer interventions, behavioral family problem-solving, and behavioral treatments combined with any other treatment

	Parent rater				Teacher rater				Observer				Child source			
Outcome	*k/s*	*SMD*	*SE*	I^2	*k/s*	*SMD*	*SE*	I^2	*k/s*	*SMD*	*SE*	I^2	*k/s*	*SMD*	*SE*	I^2
Behavioral Parent Training or Behavioral Classroom Management or Behavioral Peer Intervention or Behavioral Family Problem-Solving or Behavioral Intervention General or combination among them																
ADHD symptoms	58/24[a]	0.39	0.08	81.97	34/18[a]	0.23	0.09	54.61	7/3[b]	−0.02	0.09	37.65	3/3[c]	0.69	0.37	72.69
Impairment	49/17[a]	0.26	0.09	81.77	39/15[a]	0.30	0.12	90.67	28/11[a]	0.41	0.16	80.61	20/7[b]	0.27	0.08	49.50
Comorbid externalizing	68/23[a]	0.49	0.09	84.90	23/13[a]	0.03	0.06	0.23	40/15[a]	0.05	0.09	77.87	2/1[b]	0.06	0.24	33.09
Parenting behaviors	30/9[a]	0.59	0.14	80.22					51/11[a]	0.38	0.12	75.98				
Parenting effectiveness/ stress	61/18[a]	0.45	0.12	77.69												
Behavioral Parent Training																
ADHD symptoms	28/14[b]	0.32	0.10	79.13	8/6[b]	−0.12	0.15	71.72	6/2[b]	0.01	0.08	36.41				
Impairment	13/6[b]	0.00	0.08	61.04	12/4[b]	0.02	0.15	89.79	5/3[b]	0.41	0.29	88.83	6/2[b]	0.12	0.01	0.00
Comorbid externalizing	42/14[a]	0.49	0.13	84.30	6/4[b]	−0.18	0.07	0.00	14/8[b]	0.04	0.14	73.77				
Parenting behaviors	15/6[b]	0.70	0.13	81.29					23/6[b]	0.41	0.11	76.21				
Parenting effectiveness/ stress	42/12[b]	0.51	0.08	75.71												
Behavioral Classroom Management																
ADHD symptoms	5/3[b]	0.35	0.18	39.61	7/3[b]	0.66	0.16	30.34					2/2[c]	1.03	0.09	0.00
Impairment	4/1[b]	0.15	0.06	0.00	2/2[c]	0.72	0.42	81.78	2/1[b]	0.18	0.94	94.42	5/1[b]	0.44	0.14	16.29
Comorbid externalizing					2/1[b]	0.26	0.00	0.00	1/1	1.12	0.32		2/1[b]	0.06	0.24	33.09

(continued)

TABLE 2 (continued)

Outcome	Parent rater				Teacher rater				Observer				Child source			
	k/s	*SMD*	*SE*	I^2	*k/s*	*SMD*	*SE*	I^2	*k/s*	*SMD*	*SE*	I^2	*k/s*	*SMD*	*SE*	I^2
Behavioral Peer Intervention																
ADHD symptoms																
Impairment	4/1[b]	0.15	0.06	0.00	2/2[c]	0.72	0.42	81.78								
Comorbid externalizing																
Behavioral Family Problem-Solving																
ADHD symptoms	3/1[b]	0.50	0.62	90.52					1/1	−0.49	0.32					
Impairment	2/1[b]	0.64	0.35	58.16					1/1	−0.46	0.32					
Comorbid externalizing																
Parenting behaviors	3/1[b]	0.53	0.58	89.26					1/1	−0.28	0.31					
Parenting effectiveness/ stress																
Behavioral Parent Training or Behavioral Classroom Management or Behavioral Peer Intervention or Behavioral Family Problem-Solving or Behavioral Intervention General combined with any other treatment																
ADHD symptoms	113/45[a]	0.36	0.06	97.05	82/36[a]	0.13	0.06	99.82	21/5[a]	−0.12	0.05	97.41	5/4[a]	0.41	0.38	85.88
Impairment	145/35[a]	0.30	0.08	98.41	112/30[a]	0.26	0.07	99.90	92/22[a]	0.21	0.10	80.36	76/21[a]	0.16	0.08	99.97
Comorbid externalizing	134/41[a]	0.44	0.09	98.33	61/25[a]	0.09	0.06	96.38	81/21[a]	0.19	0.12	99.69	4/3[a]	0.43	0.29	60.42
Parenting behaviors	84/22[a]	0.46	0.09	99.89					101/17[a]	0.26	0.09	87.80	2/1[a]	0.00	0.00	0.00
Parenting effectiveness/ stress	129/29[a]	0.30	0.10	79.12												

Note. k = number of effect sizes; s = number of studies; *SMD* = standardized mean difference; *SE* = standard error; I^2 = test of heterogeneity of the estimate.
[a]Multivariate meta-analysis + Robust standard errors meta-analysis. [b]Robust standard errors meta-analysis. [c]Univariate meta-analysis.

TABLE 3

Results of meta-analysis for training-focused treatments combined with one another, cognitive training, organizational skills training, social skills training, emotion regulation training, and training-focused treatments combined with any other treatment

	Parent rater				Teacher rater				Observer				Child source			
Outcome	*k/s*	*SMD*	*SE*	I^2	*k/s*	*SMD*	*SE*	I^2	*k/s*	*SMD*	*SE*	I^2	*k/s*	*SMD*	*SE*	I^2
Cognitive Training or Organizational Skills Training or Social Skills Training or Mindfulness Training or Emotion Regulation Training or combination among them																
ADHD symptoms	17/7[a]	0.37	0.16	80.13	15/4[a]	−0.22	0.11	78.34					2/1[b]	0.73	0.37	84.57
Impairment	12/4[a]	0.47	0.15	90.81	4/2[b]	0.06	0.46	83.16	3/1[b]	0.35	0.06	0.00	18/6[a]	0.27	0.09	87.85
Comorbid externalizing	10/3[a]	0.33	0.24	86.82	8/4[a]	0.07	0.15	93.15	2/1[b]	0.17	0.94	87.45	1/1	0.06	0.27	
Cognitive Training																
ADHD symptoms	15/6[a]	0.27	0.18	81.43	15/4[a]	−0.22	0.11	78.34					2/1[b]	0.73	0.37	84.57
Impairment	3/2[a]	0.04	0.41	96.92	1/1	−0.76	0.33		3/1[b]	0.35	0.06	0.00	7/3[a]	0.09	0.13	0.00
Comorbid externalizing	9/2[a]	0.16	0.05	56.70	7/3[a]	−0.06	0.11	94.72	2/1[b]	0.17	0.94	87.45	1/1	0.06	0.27	
Organizational Skills Training																
ADHD symptoms																
Impairment																
Comorbid externalizing																

(continued)

TABLE 3 (continued)

	Parent rater				Teacher rater				Observer				Child source			
Outcome	*k/s*	*SMD*	*SE*	I^2	*k/s*	*SMD*	*SE*	I^2	*k/s*	*SMD*	*SE*	I^2	*k/s*	*SMD*	*SE*	I^2
Social Skills Training																
ADHD symptoms	9/2[b]	0.54	0.23	84.37	3/1[b]	0.36	0.52	80.36					8/3[b]	0.32	0.20	84.48
Impairment	1/1	1.12	0.41		1/1	0.69	0.40									
Comorbid externalizing	1/1	0.25	0.39		1/1	0.88	0.40						3/1[b]	0.52	0.15	28.18
Parenting behaviors																
Parenting effectiveness/stress	9/2[b]	0.54	0.23	84.37	3/1[b]	0.36	0.52	80.36					8/3[b]	0.32	0.20	84.48
Emotion Regulation Training																
ADHD symptoms																
Impairment													3/1[b]	0.43	0.07	0.00
Comorbid externalizing																
Cognitive Training or Organizational Skills Training or Social Skills Training or Mindfulness Training or Emotion Regulation Training combined together and with any other treatment																
ADHD symptoms	61/27[a]	0.38	0.09	94.09	75/22[a]	0.07	0.07	99.91	10/1[a]	−0.11	0.07	89.99	6/4[a]	0.27	0.30	98.00
Impairment	86/19[a]	0.40	0.12	96.08	68/15[a]	0.32	0.09	96.52	59/14[a]	0.10	0.07	73.13	87/22[a]	0.21	0.08	98.18
Comorbid externalizing	48/15[a]	0.31	0.11	94.49	35/13[a]	0.40	0.12	94.58	25/6[a]	0.41	0.26	97.20	3/3[c]	0.60	0.35	56.18
Parenting behaviors	35/10[a]	0.25	0.10	89.75					43/6[a]	0.04	0.03	77.18				
Parenting effectiveness/stress	39/8[a]	0.13	0.14	88.22												

Note. k = number of effect sizes; s = number of studies; *SMD* = standardized mean difference; *SE* = standard error; I^2 = test of heterogeneity of the estimate.
[a]Multivariate meta-analysis + Robust standard errors meta-analysis. [b]Robust standard errors meta-analysis. [c]Univariate meta-analysis.

TABLE 4

Results of meta-analysis for all behavioral and training-focused treatments combined with one another, neurofeedback/biofeedback, academic accommodations, academic modifications, and self-monitoring

	Parent rater				Teacher rater				Observer				Child source			
Outcome	*k/s*	*SMD*	*SE*	I^2	*k/s*	*SMD*	*SE*	I^2	*k/s*	*SMD*	*SE*	I^2	*k/s*	*SMD*	*SE*	I^2
Behavioral Parent Training, Behavioral Classroom Management, Behavioral Peer Interventions, Behavioral Family Problem-Solving, Behavioral Intervention General, Organizational Skills Training, Social Skills Training, Emotion Regulation Training, in any combination (i.e., all treatments from Table 1 and Table 2, combined)																
ADHD symptoms	116/46[a]	0.37	0.06	97.20	97/37[a]	0.15	0.07	99.93	19/4[a]	0.01	0.16	99.84	6/5[a]	0.56	0.36	98.81
Impairment	155/37[a]	0.29	0.08	98.28	117/31[a]	0.30	0.07	99.91	89/22[a]	0.19	0.09	80.33	107/25[a]	0.22	0.07	99.95
Comorbid externalizing	134/40[a]	0.44	0.09	98.38	64/26[a]	0.10	0.06	95.95	73/20[a]	0.20	0.13	99.69	4/3[b]	0.43	0.29	60.42
Parenting behaviors	84/22[a]	0.46	0.09	99.89					101/17[a]	0.26	0.09	87.80	2/1[a]	0.00	0.00	0.00
Parenting effectiveness/ stress	113/28[a]	0.34	0.11	77.98												
Academic Accommodations																
ADHD symptoms					1/1	−0.12	0.41									
Impairment					4/1[b]	0.17	0.32	54.09					6/1[b]	−0.46	0.06	0.00
Comorbid externalizing					1/1	0.11	0.41									
Academic Modifications																
ADHD symptoms																
Impairment																
Comorbid externalizing																
Self-Monitoring																
ADHD symptoms					1/1	0.21	0.41									
Impairment					4/1[b]	0.53	0.23	15.75					13/2[b]	−0.39	0.11	0.00
Comorbid externalizing					1/1	0.46	0.41		4/1[b]	−0.11	0.11	0.00				

Note. k = number of effect sizes; s = number of studies; *SMD* = standardized mean difference; *SE* = standard error; I^2 = test of heterogeneity of the estimate.
[a]Multivariate meta-analysis + Robust standard errors meta-analysis. [b]Robust standard errors meta-analysis. [c]Univariate meta-analysis.

true, real dispersion; larger values of I^2 represent larger between-studies variability with respect to the total variability.

As noted in the introduction, it is also necessary to consider the domain assessed and the source of the information on each outcome measure. Results are therefore organized first by treatment type, then by source of the measure (i.e., parent, teacher, observation, child product), and finally by domain assessed. Thus, we conduct a subgroup analysis of the meta-analyzed literature by presenting results by treatment type, rater, and outcome measure.

In addition to the subgroup analyses in Tables 2 to 4, we also conducted moderator analyses on the effect size estimates to explore if any of the risk of bias assessment variables were a potential source of heterogeneity. Thus, moderator analyses examined if the studies categorized as having low, high, or unclear risk on study parameters related to potential bias in reporting moderated effect size magnitude.

Results

There were 226 eligible between-group studies. After removing follow-up studies, combining results from multiple papers reporting on the same dataset, and articles that did not include sufficient information to calculate effect sizes, there were 123 between-group studies included in this meta-analysis, and these studies provided a total of 2312 standardized mean differences. (See list of studies in the online appendix; the online appendix includes 185 separate manuscripts, as some studies had multiple manuscripts. In these cases, outcome data were integrated across manuscripts to yield a single study.) A boxplot of the 123 studies' *SMD*s is presented in Figure 2. The *SMD* ranged from −0.76 to 1.12 with a median of 0.18, and a slightly positive skewed distribution; most of the distribution includes values larger than zero, indicating that most studies to some degree reported positive effect of ADHD interventions. Next, we performed an overall analysis combining multivariate meta-analysis and robust standard errors. The overall weighted average *SMD* for the effect of ADHD interventions was 0.26 ($SE = 0.027, z = 9.67, p < .001$), with a 95% confidence interval [*CI*] [0.21, 0.32], under the random-effects model. In addition, the assessment of homogeneity suggested a large degree of heterogeneity across studies ($I^2 = 93.20\%$, $\hat{\tau}^2 = 0.19$). This suggests a positive and statistically significant effect of ADHD interventions in between-group studies, but there was considerable variability between study effect sizes. In short, the overall effect of ADHD interventions was about 0.25 standard deviations.

In the data set, 18% of studies ($s = 22$) did not allocate students to conditions randomly. These 22 studies contributed 298 effect sizes, representing 13% of our data set. Thus, before proceeding with other analyses, a meta-regression was performed to explore the relationship between the magnitude of the effect size and the type of allocation. Results of a mixed-effects model indicated there were not significant differences between the type of allocation ($b = -0.03$, $SE = 0.04$, $z = -0.81$, $p = 0.42$), 95% *CI* [−0.11, 0.04]). The weighted average *SMD* for the studies that allocated participants at random was 0.26 ($SE = 0.02$), and the weighted average *SMD* was 0.29 ($SE = 0.04$) for the non–random allocation studies. Thus,

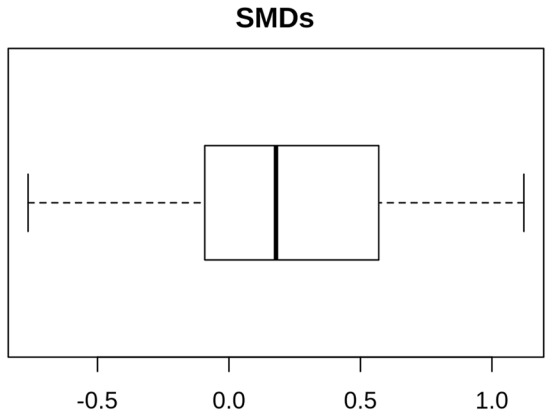

FIGURE 2. *Boxplot of overall standardized mean differences.*

all effect sizes were retained in a single data set, regardless of allocation. Next, year of study was explored as a moderator of effect size. The results of a mixed-effects model indicated that study year did not relate significantly to the size of the effect size; the coefficient and standard errors to the second decimal point were all zero.

Next, analyses were conducted to explore if at least some variation in the overall effect of ADHD interventions can be explained by the type of informant or target assessment. To do so, a multivariate mixed model with robust standard errors were fitted to the data. Figure 3 illustrates the average weighted results for each one of these moderator variables (i.e., effect modifier). Each figure includes the number of effect sizes (*k*), the weighted estimate (*SMD*), and the confidence interval for each category (to be comprehensive, all categories of measures are included in Figure 3; however, Tables 2–4 illustrate the effect sizes for the outcomes of proximal interest). Results indicate that for both of these moderators, there is still unexplained variability beyond that explained by both moderators (see Figure 3). For the moderator related to type of informant, $Q_E(2302) = 32916.02$, $p < .001$ ($I^2 = 93.31\%$, and $\hat{\tau}^2 = 0.20$). For the moderator related to target assessment, $Q_E(2276) = 33237.36$, $p < .001$ ($I^2 = 93.07\%$, $\hat{\tau}^2 = 0.19$). The large I^2 values and the statistically significant Q_E suggest that significant amount of variation remains, even after accounting for either of those moderators.

Consequently, subgroup analyses were explored in which the effect of the different interventions, type of informant, and target assessment were parsed out, given the considerable variability within these parameters illustrated by Figure 3. Outcomes were organized by treatment type, and effect sizes for specific outcomes and raters are presented in Tables 2 to 4. In Tables 2 and 3, the first rows present the combination of all treatments within each category (e.g., behavioral, training) with one another. Effect sizes for each treatment are then presented singly. Then, the effect sizes for the treatments alone or in combination with any other treatment within the meta-analysis are presented in the final row, when appropriate.

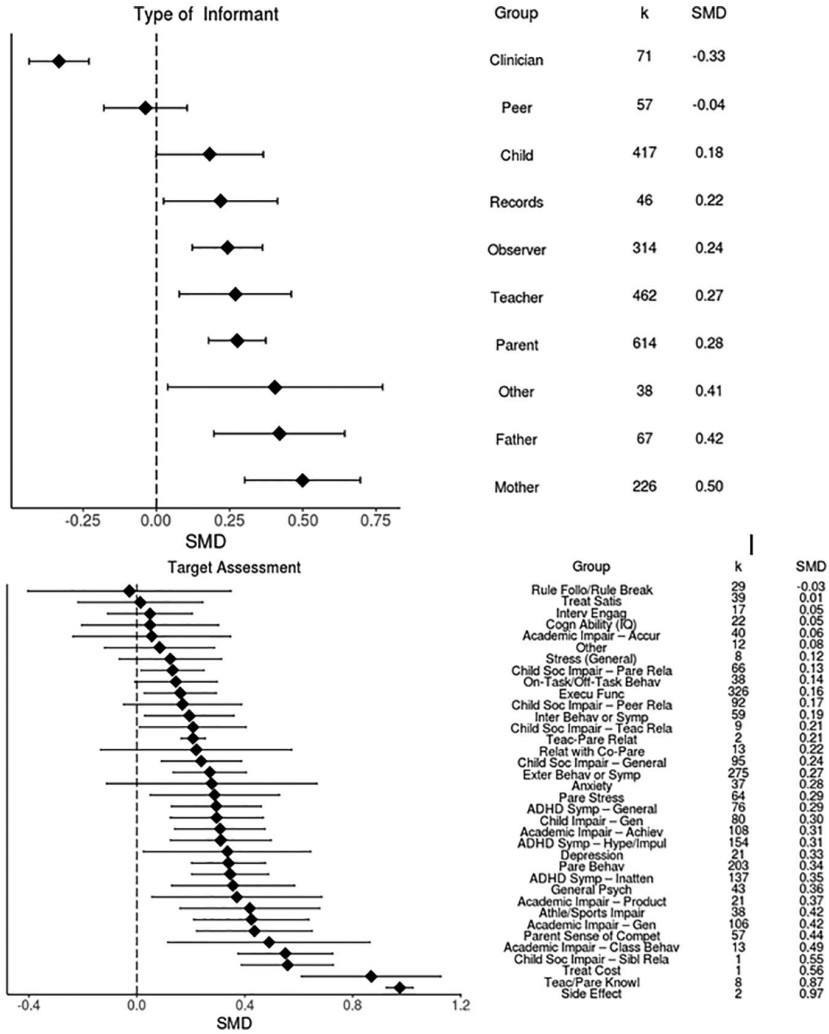

FIGURE 3. *Results of the moderator analyses for type of informant (top panel) and target assessment (bottom panel).*
SMD = standardized mean difference; k = number of effect sizes.

Behavioral Treatment

The results of the behavioral intervention effect size calculations are presented in Table 2. The overall effect of behavioral interventions combined together varied based on the rater and measure. Parent-rated ADHD symptoms (*SMD* = 0.39) and impairment (*SMD* = 0.26) evidenced small to moderate effects, whereas

comorbid externalizing (*SMD* = 0.49) and parenting behaviors (*SMD* = 0.59)/parenting effectiveness and stress (*SMD* = 0.45) were moderate in magnitude. Ratings provided by teachers resulted in a smaller magnitude of effect (*SMD* ranged from 0.03 to 0.30), though approximately half to a third as many studies included this rater. Observer ratings yielded different information, with impairment (*SMD* = 0.41) and parenting behaviors (*SMD* = 0.38) evidencing a moderate effect. When child sources were assessed, there was a large effect on ADHD symptoms (*SMD* = 0.69) and a small effect on impairment (*SMD* = 0.27).

Focusing on specific treatment types, it is apparent that the proximal outcome effect sizes for particular interventions evidence treatment efficacy, and distal or unrelated measures yield less evidence of efficacy. For instance, behavioral parent training resulted in strong treatment effects for parent-rated parenting (*SMD* = 0.70) and parent effectiveness/stress ratings (*SMD* = 0.51), and moderate effects for observations of parenting behaviors (*SMD* = 0.41). For behavioral parent training studies, teacher ratings from typically untreated settings yielded a negligible effect size (*SMD* = −0.18 to 0.02). *Note, the effect size for parent ratings of impairment (SMD = 0.00) is misleading, as the parenting stress and effectiveness effect sizes are not included in this estimate.* In contrast, teacher ratings for classroom behavior management effect sizes are large for ADHD symptoms (*SMD* = 0.66) and impairment (*SMD* = 0.72). There were only two studies for behavioral peer intervention and one for behavioral family problem solving alone, making interpretations of the meta-analytic effect across studies untenable at present. The final rows of the table illustrate that when behavioral interventions were combined with any other intervention, effect size magnitudes were attenuated, likely due to a mixing of outcomes related to proximal and distal targets as well as combining behavioral interventions with less established treatment approaches.

Training Interventions

The results of the training intervention effect size calculations are presented in Table 3. It should be noted that there are fewer studies and effect sizes within the categories listed in Table 3, relative to Table 2, making these findings more tentative. The overall effect of training interventions when combined together varied based on the rater and measure. Parent-rated ADHD symptoms (*SMD* = 0.37), comorbid externalizing (*SMD* = 0.33), and impairment (*SMD* = 0.47) evidenced moderate effects. Teacher raters indicated no evidence of effectiveness on ADHD-related behaviors (*SMD* ranged from −0.22 to 0.07). Observer ratings were only included in a single study, with comorbid externalizing behaviors (*SMD* = 0.17) evidencing a small effect and impairment a moderate effect (*SMD* = 0.35). When child sources were assessed, there was a large effect on ADHD symptoms (*SMD* = 0.73) and a small effect on impairment (*SMD* = 0.27).

Focusing on specific treatment types, there is variability in the magnitude of effect sizes. For instance, cognitive training results in small effect sizes for parent-rated symptoms (*SMD* = 0.27), but no impact on parent-rated impairment (*SMD* = 0.04). Child sources yielded a large effect size in the single study (*SMD* = 0.73) that assessed it. However, all teacher ratings yield a negative effect

size (*SMD* = −0.76 to −0.06). It is notable that there were no studies of organizational skills training alone that did not include any additional intervention components (e.g., parent training; contingency management). There were few studies of social skills (*s* = 3) and emotion regulation training (*s* = 1) alone yielding overall positive effects, but they were few in number making these findings in need of replication. The final rows of the table illustrate that when training interventions were combined with any other intervention within the sample of papers, effect size magnitudes were attenuated for parent, observer, and child production ratings. Results improved for teacher ratings when all treatments were combined together.

Additional Treatments

A current unanswered question in the research literature is the efficacy of identified evidence-based treatments (i.e., behavioral and training interventions; Evans et al., 2014; Evans et al., 2018; Pelham et al., 1998; Pelham & Fabiano, 2008) when combined with one another. Results do not suggest any additive or synergistic effect from the current studies within the literature when these interventions are combined. Indeed, similar to the treatment combinations in the final rows of Tables 2 and 3, effect sizes appear to be attenuated when combined. Table 4 lists the effect size estimates for these additional treatment types reviewed.

Academic accommodations and modifications are commonly employed for children with ADHD in school settings (Spiel et al., 2014), so it is surprising that there was only a single study of an academic accommodation administered alone, and this study yielded modest to ineffective impacts on outcome measures. There was no unimodal study of academic modification in the searched literature. Standardized mean differences for cognitive training treatment yielded negligible effects for the majority of the measures and raters. Another commonly employed intervention in practice, self-monitoring, was also rarely implemented as a standalone treatment, as the meta-analysis yielded only two studies of this treatment alone.

Risk of Bias

Risk of bias was also investigated. Figure 4 indicates that overall the highest risk of bias appears to occur for implementation bias and variance at baseline. To assess if there are any systematic differences between effect sizes categorized as high, low, or unclear risk of bias, we conducted moderator analyses using those classifications (see Table 5). All of these models produced I^2 values larger than 90% suggesting that difference across effect sizes cannot be attributed solely to the risk of bias classification. Selection bias was the only moderator that did not have any explanatory power (i.e., the group means did not differ significantly). The effect sizes classified as unclear risk of bias for baseline mean (*SMD* = 0.08) produced on average smaller weighted mean than those classified as high (*SMD* = 0.32) or low (*SMD* = 0.31) risk of bias. Similarly, the effect sizes classified as unclear risk of bias for baseline variance (*SMD* = 0.06) produced on average smaller weighted mean than those classified as high (*SMD* = 0.31) or low (*SMD* = 0.34) risk of bias.

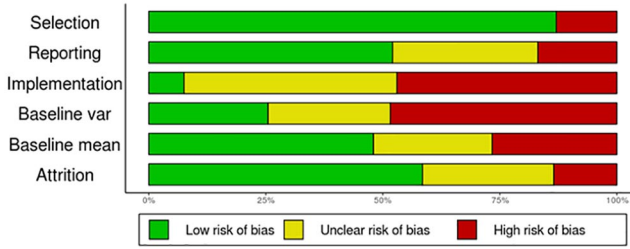

FIGURE 4. *Risk of bias estimates.*

Publication Bias

The current literature in meta-analysis lacks methods and clear recommendations to assess the presence of publication bias for dependent effect sizes. All of the often-used methods were developed assuming independence of the effect sizes. Thus, multiple methods were used to descriptively explore potential publication bias. The trim and fill method (Duval & Tweedie, 2000) indicates that zero studies are missing on the left side, suggesting that publication bias is not a major concern in our data set. On the other hand, the Egger's test assuming independence ($z = 2.08$, $p = .04$), the adapted Egger's test with robust variance estimation ($z = 3.76$, $p < .001$), and the rank correlation test for funnel plot asymmetry (Kendall's $tau = .06$, $p < .001$), all suggest the presence of publication bias in our data set. Thus, it is recommended that the results be interpreted with some caution as the positive effect of the treatments identified in this meta-analysis could be overestimated.

Discussion

The present meta-analysis represents the most comprehensive summary of psychosocial treatment studies for ADHD, to date. This comprehensive approach to research retrieval and synthesis was necessary given the considerable variability in the meta-analytic literature for ADHD psychosocial treatments (Table 1). With this comprehensive approach, reliable estimates of effect size were generated, and these estimated effects were investigated across treatment types, raters, and outcomes. Together, the meta-analysis provides an overview of psychosocial treatment effects for ADHD, and it also spotlights areas in need of additional study. Across the studies reviewed and synthesized, there is clear evidence for the efficacy of behavioral interventions for children with ADHD as a key component of school-based intervention. The overall meta-analytic results, impact of subgroup analyses and moderator analyses, limitations, and future directions are all addressed in the discussion that follows, in turn.

Overall Effect of Psychosocial Treatment for ADHD

The overall effect size for between-group studies across the psychosocial ADHD literature was small, and positive ($SMD = 0.26$). However, this effect size is a poor indicator of the effect of psychosocial treatment as it combines a varied

TABLE 5

Analysis of risk of bias moderators

Study-level moderator	*SMD*	*SE*	Q_E	Q_M	I^2
Baseline mean difference			*17673.66***	*69.11***	90.56
High	0.32	0.04			
Low	0.31	0.03			
Unclear	0.08	0.04			
Baseline variance difference			17752.22**	84.90**	90.60
High	0.31	0.03			
Low	0.34	0.04			
Unclear	0.06	0.03			
Selection			18038.53**	0.01	91.17
High	0.27	0.06			
Low	0.27	0.03			
Unclear	—				
Implementation			18016.52**	10.85*	91.14
High	0.28	0.04			
Low	0.23	0.05			
Unclear	0.25	0.03			
Reporting			17966.76**	7.48*	91.10
High	0.29	0.06			
Low	0.22	0.04			
Unclear	0.30	0.04			

Note. SMD = standardized mean difference; *SE* = standard error; Q_E = test of residual heterogeneity; Q_M = test of the difference among group means; I^2 = remaining percentage of real observed dispersion after accounting for the moderator.
$^{**}p < .001$. $^{*}p < .05$.

collection of measures, treatment types, and information sources. Statistical analyses indicated considerable heterogeneity in effect size estimates when the type of informant and outcome assessment were varied. Had the meta-analysis been concluded by the authors following the calculation of the overall effect, this poor indicator of treatment efficacy could have led to incorrect conclusions regarding the efficacy of psychosocial treatments (see also Fabiano et al., 2015). It is more precise to interpret the overall effects of the ADHD literature once effect sizes are grouped by particular treatment types, as is commonly done for pharmacological ADHD treatments (e.g., Conners, 2002; Faraone, 2009).

The overall effect of psychosocial treatments, when considered by specific treatment types, largely corresponded to systematic reviews of ADHD psychosocial treatment that concluded behavioral parent training, contingency management in school settings, behavioral peer interventions, and training interventions were evidence-based treatments. On proximal outcomes of impairment in parenting, behavioral parent training had a strong effect. Child behavior was

significantly improved in classroom settings with contingency management approaches. Behavioral peer interventions and organizational skills training did not occur frequently in the literature as stand-alone interventions. Though the effect sizes for these treatments were positive, the results are tentative given the need for additional replication of the findings.

This meta-analysis also provides a follow-up of a recent meta-analysis of "probably masked" versus "unmasked" measures. Sonuga-Barke et al. (2013) reported positive effect sizes for outcomes completed by individuals closest to the treatment type (e.g., parent ratings completed by parents who were in a study of behavioral parent training), categorized as unblinded measures. Results for ADHD symptoms ratings were not significant for measures completed by raters who were hypothesized to be unaware of the treatment condition (e.g., teacher ratings completed in a behavioral parent training study). In the present meta-analysis, outcomes largely corresponded to the Sonuga-Barke findings, but they were conceptualized differently—as proximal versus distal outcomes (see also Pfiffner, 2014). It is difficult to mask psychosocial treatment effects in the ADHD area, as parents and teachers are key treatment implementers in most cases. Follow-up analyses from the same investigatory team have indicated that a broader range of outcomes, beyond ADHD symptoms, were significantly impacted by behavioral interventions, even on probably masked measures (Daley et al., 2014), and these follow-up results of the initial Sonuga-Barke et al. (2013) meta-analysis (that had focused solely on ADHD symptoms), largely correspond to the pattern of results reported herein.

Differences in Effectiveness Across Grouping Variables

Relative to the overall meta-analytic analysis results, a more accurate, nuanced representation of the psychosocial treatment effects for ADHD are presented in Tables 2 to 4. Here a number of conclusions are apparent, including (1) treatment type and outcome measures used influence the magnitude of the effect size; (2) there is variability in the density of the literature across psychosocial treatments; (3) some treatments have not been routinely evaluated as stand-alone interventions; and (4) combining effect sizes across treatment types attenuates effects. Each of these major results will be briefly discussed.

It is clear from the results of this meta-analysis that not all treatments and measures are created equal. The most common measures within the meta-analysis were ratings of ADHD symptoms, impairment, and comorbid externalizing behaviors. Treatment effects were typically apparent on these measures for behavioral treatments when completed within settings that included active treatment. The magnitude of treatment effects for behavioral treatments was generally consistent with prior meta-analyses (see Table 1). The present meta-analysis indicated there is variability in the number of studies that have been conducted as stand-alone interventions on particular treatment types. In the present coding scheme, if additional treatment components were combined (e.g., organizational skills training + behavioral parent training), these results are not presented independently. This was a decision made by the coding team to permit a nuanced view of the single effects of psychosocial treatment. This decision may have some consequences as the combination of stand-alone interventions represented in the first

row of Tables 2, 3, and 4 do not necessarily represent planned combinations of treatment in multimodal interventions. Indeed, another meta-analysis has indicated greater effect size magnitudes for planned combinations of treatments (Moore et al., 2018), and combined treatment is widely recommended for ADHD (Barbaresi et al., 2020). Planned companion papers will further investigate the role of these psychosocial combinations in a network meta-analysis (Schatz et al., 2021).

The results of this review indicate differences in treatment-type density within the larger, scholarly literature (Schatz et al., 2020) with behavioral parent training having the greatest density of study and other treatments having minimal study of stand-alone effects (e.g., organizational skills training; behavioral peer interventions). Contingency management in schools was also not frequently studied in between-group studies as a stand-alone intervention (i.e., fewer than 10 independent research studies), but it is important to note that companion papers investigating pre-post, crossover, and single-case design studies will include many more investigations of this approach (see also DuPaul & Eckert, 1997; DuPaul et al., 2013; Fabiano et al., 2009; Pelham & Fabiano, 2008; Pelham et al., 1998). It is important to note that the majority of the studies in the comprehensive literature search are from these alternative research designs. This illustrates that a consequence of a decision by the task force on evidence-based treatments of Division 53 in the American Psychological Association (Southam-Gerow & Prinstein, 2014) to focus solely on between group designs will omit a large proportion of the ADHD treatment literature, particularly for school-based interventions.

Some of the interesting findings from the meta-analytic review relate to what has not been extensively studied in the research literature. There were no studies of organizational skills training alone (i.e., with no concomitant parent training, contingency management, or additional psychosocial support). This approach is considered a well-established treatment using alternative review criteria (Evans et al., 2014; Evans et al., 2018), so our review does not indicate that there is a lack of evidence for this approach. Rather, it indicates that this has not been extensively studied as a stand-alone intervention in between-group design studies. Similarly, there were almost no studies of academic accommodations or modifications in between-group design studies (see Table 4), replicating similar reviews (Harrison et al., 2013) in this area (though there are additional studies using single-subject or crossover designs). This is in spite of academic interventions, accommodations, and modifications being widely deployed in schools through individualized education programs and Section 504 accommodation plans. In contrast to the broad use, there appears to be little systematic research of these interventions and their efficacy, perhaps contributing to the high rate of office of civil rights complaints related to ADHD supports in schools (U.S. Department of Education, Office of Civil Rights, 2016). In both cases, the results of the meta-analysis suggest additional controlled trials are needed to buttress the literature base. Finally, although more studies of cognitive training were identified, this treatment generally did not yield clinically meaningful standardized mean differences (see also Moore et al., 2018, for a similar finding).

Finally, the combinations of effect sizes in Tables 2, 3, and 4 suggest that aggregating different treatment types, outcomes, and raters together can mask

differences in the magnitude and variability of effects. Moreover, disentangling the potential sources of variability among effect sizes is not an easy task given the current reporting practices. Figure 3 indicated that the type of measure and outcome assessed can influence the magnitude of the effect size, and this is a likely contributor to the large I^2 values obtained in the meta-analysis (see also Moore et al., 2018). Together these findings indicate there is a need for greater precision in defining treatments, and planning for measurement of specific outcomes, both in primary studies and meta-analytic reviews to enhance the conclusions that can be generated.

Limitations

This meta-analysis has limitations. Although considerable effort was used to obtain a comprehensive collection of ADHD psychosocial treatment studies, there is the possibility that relevant primary studies were missed during the literature search. Additionally, there were studies that reported on the results of a between-group, psychosocial treatment study, but did not report sufficient information to contribute to the present meta-analysis. Another limitation of these results is that they only include between group design studies. Additional, companion reviews will report the results of pretest-posttest designs and single-subject designs. In order to appropriately evaluate the entire treatment literature, a consideration of the results of all designs, together, is necessary. Finally, by limiting the search to publications in English, studies reported in other languages were not included.

The meta-analysis is also limited by the choices made in conceptualizing the approach for combining data from studies. For example, in an effort to provide increased precision in effect size estimates, studies were reported in Tables 2 to 4 if they were evaluated as stand-alone interventions. This resulted in some treatments (e.g., organizational skills training) being underrepresented in the table as it was commonly combined with another intervention type. The lack of effect sizes in the table do not necessarily indicate a lack of evidence for the intervention, which other narrative reviews have identified as an evidence-based treatment for ADHD (Evans et al., 2018). It is also important to note that the moderate to large I^2 values indicate that effect sizes in Tables 2 to 4 do not indicate homogeneous estimates, even after grouped by rater, outcome, and treatment type. This indicates that there are other factors contributing to heterogeneity within the combined studies, and additional moderator analyses, additional studies, or both, are needed to ascertain reliable effect size estimates. For example, these effect sizes combine primary study results across age, race/ethnicity, and sex—individual differences due to these demographic factors would not be apparent within the current approach to data synthesis. A related limitation to the varied ways that studies reported, or did not report, demographic characteristics including racial and/or ethnic characteristics, age or grade, and socioeconomic status, which made it difficult to explore the relationship between these variables and *SMD* estimates. Similarly, the present studies reported information on dose and frequency/duration of treatment inconsistently, precluding the analysis of these factors as potential moderators of effect size magnitude. This diversity in study characteristics,

which was unexplored in the present meta-analysis, also likely contributes to the significant I^2 statistics.

It is also important to note that the coding scheme for defining stand-alone interventions and categorizing outcomes was based on decisions made by the meta-analysis team, grounded within the larger literature of evidence-based ADHD treatment reviews (e.g., Evans et al., 2014; Evans et al., 2018; Pelham et al., 1998; Pelham & Fabiano, 2008). This resulted in continuity across these reports, but also introduces limitations. For example, quantifying parent training as a stand-alone intervention does not provide information on the content of any particular parent training program. There is evidence that the results of a parent training intervention may vary based on the approach of the therapist or the content introduced (e.g., Prinz & Miller, 1994). An additional limitation related to the combinations of various measures, as impairment indices from diverse sources were collapsed into a single category to reduce the number of effect sizes reported. Furthermore, the results are limited to immediate results of treatment; the impact of treatment on the maintenance of effects was outside the scope of this analysis.

A final limitation of note within this meta-analysis is the role of medication in the treatment of ADHD in the included studies. Stimulant medication is by far the most common treatment for ADHD (Danielson et al., 2018). Medication use within the studies included in this meta-analysis was not evaluated in the calculation of effect sizes, thus it is not possible to comment on the role of combined medication and psychosocial treatment. Furthermore, medication was not evaluated as a moderator in these analyses given the lack of reporting related to dose, schedule, and adherence in the majority of the reviewed studies. Future meta-analyses of single and combined treatments for ADHD remain an area in need of future study.

Future Directions for Research

ADHD is now widely conceptualized as a life-course persistent disorder, requiring intervention and treatment throughout the lifespan and during developmental transitions (DuPaul et al., 2019). Missing from this meta-analysis is any information on the results of ADHD psychosocial treatment over time, or during important developmental transitions as the results reported were direct between group comparisons. A future meta-analysis from this data set will investigate pre-post change with length of treatment investigated as a moderator, to begin to address the impact of treatment intensity over time for any treatment effort. Additional studies should also investigate the timing and sequencing of treatment, as this might be an important influencer of treatment uptake and effectiveness. For example, Barkley et al. (1992) reported considerable drop-out for an adolescent-focused family intervention administered in an outpatient clinic. However, Fabiano et al. (2016), using the same intervention but linked to the transition to driving, reported almost no drop-out or missed sessions across the entire sample. As another example, Pelham, Fabiano et al. (2016) illustrated that the sequencing of ADHD treatment had a significant impact on treatment adherence. Specifically, when behavioral interventions were offered first, parents attended the majority of behavioral parent training sessions. However, when medication was used first,

and behavioral parent training was added later, the attendance at behavioral parent training was modest, at best. The different rates of adherence are a likely candidate contributing to the superiority of implementing behavioral treatment first on measures of classroom functioning at the end of the school year in this study. These comparisons begin to move the field from questions of only efficacy to questions that begin to relate to parameters of implementation the influence outcome as well (see Landes et al., 2019), which is an area in need of considerably more study in the field of ADHD treatment research. Furthermore, whereas medication treatments for ADHD improve academic productivity, there is little evidence that this results in improvements in academic achievement (Kortekaas-Rijlaarsdam et al., 2019; MTA Cooperative Group, 1999; Pelham, Altszuler et al., 2020). There were also few randomized controlled trials of academic interventions ($s = 1$ for academic accommodations and $s = 0$ for academic modifications) within the literature identified in the present meta-analysis, indicating that the study of academic supports and interventions is a needed area of future research.

Implications for ADHD Treatment

A major goal of this meta-analysis was to add to the current knowledge base on effective treatment for ADHD. The present findings align with professional practice guidelines that emphasize the use of behavioral supports as a key component of ADHD treatment (Barbaresi et al., 2020; Wolraich et al., 2019). It is also important to emphasize that although the methodological approach in the present meta-analysis generally investigated single, psychosocial intervention, when in practice, it would be typical that multiple psychosocial treatments would be combined together to address impairment across settings (e.g., behavioral parent training combined with contingency management in the classroom). A companion paper is addressing the network of effect sizes across treatment combinations (Schatz et al., 2021). Depending on the measure, the findings approach the efficacy of stimulant medication (e.g., Faraone, 2009), and of note, the range of raters and outcomes assessed for efficacy are more diverse than typical stimulant medication trials. Behavioral interventions such as parent training had the largest density of studies contributing to the meta-analysis, and combined with contingency management in schools, evidenced strong effects for proximal measures of outcome. The meta-analysis also indicated that more study of stand-alone psychosocial interventions such as organizational skills training, behavioral family therapy, behavioral peer intervention, and academic accommodations/interventions in randomized, controlled trial designs is needed. As a whole, there is clear evidence for the efficacy of behavioral interventions for children with ADHD as a key component of treatment.

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Note

The research reported here was supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R324A160133 to University at Buffalo. The opinions expressed are those of the authors and do not represent views of the Institute or the U.S. Department of Education.

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