



Intervention Research for Students with Co-occurring Reading Difficulties and Inattention: A Systematic Review of Single-Case Design Studies

Garrett J. Roberts¹ · Esther R. Lindström² · Zaira Jimenez³ · Ekta Ghosh¹ · Senaida Mehmedovic¹ · Kimberly A. McFadden² · Mohammad Bahadori Fallah²

Accepted: 4 April 2023

© The Author(s), under exclusive licence to Springer Science+Business Media, LLC, part of Springer Nature 2023

Abstract

This systematic review and synthesis summarizes intervention research for Grade K-12 students with a reading difficulty and co-occurring inattention to identify (a) the relevant intervention literature base, (b) the student, study, and intervention characteristics of these studies, (c) the effects of these interventions on reading and behavior outcomes, and (d) the collateral impact of reading interventions and behavior interventions on behavior outcomes and reading outcomes, respectively. Our search process yielded 14 eligible studies. Findings suggest that word reading instruction is associated with improved word reading outcomes and self-monitoring and function-based interventions are associated with improved student behavior. No study measured a collateral effect for reading or behavior interventions. Future reading intervention research is needed to better understand how to improve the reading and behavior outcomes for Grade K-12 students with a reading difficulty and co-occurring inattention. A PRISMA-compliant abstract can be found at https://osf.io/5v8ke/?view_only=d78b4cdc7eb946ae997df91e08fe2809.

Keywords Special education · ADHD · Learning disability · Reading · Behavior

Introduction

The relationship between attention-deficit hyperactivity disorder (ADHD) and co-occurring reading difficulties (RD) as well as other behavior disorders (e.g., oppositional defiant disorder; conduct disorder) is well cited in the literature. Currently co-occurrence rate estimates between ADHD and RD range from 15 to 40% (Goldston et al., 2007; Sexton et al., 2012; Willcutt & Pennington,

✉ Garrett J. Roberts
garrett.roberts@du.edu

Extended author information available on the last page of the article

2000; Willcutt et al., 2005) and ADHD and behavior disorders range from 20 to 65% (Kadesjo et al., 2003; Pliska, 1998; Posner et al., 2007; Wilens et al., 2002). When students have co-occurring RD and ADHD (RD + ADHD), they are likely to experience greater difficulty in reading than students with only RD and more inattention and social impairments than students identified with only ADHD (Lyon, 1996; Mayes & Calhoun, 2007a, b). Therefore, it is not surprising that students with RD + ADHD are at increased risk of challenges in long-term educational, social (e.g., ability to make friends), behavioral, and emotional functioning (Carroll et al., 2005; Karande et al., 2009; Wei et al., 2014).

Compared with hyperactivity, the inattentive subtype of ADHD (e.g., lack focus; engage in off-task behavior) is more common and has a stronger negative association with reading outcomes (e.g., Lin et al., 2013; MacDonald et al., 2021; McGrath et al., 2011; Willcutt, 2012; Willcutt et al., 2012). When students with or at risk for co-occurring RD and inattention (RD + Inattention) receive reading interventions designed for students without behavior difficulties, they are at a greater risk of “treatment resistance,” characterized by reading difficulties continuing despite receiving a reading intervention (e.g., Macdonald et al., 2021; Roberts et al., 2021). Unfortunately, school-based intervention research provides little guidance on how to best support students with RD + Inattention during reading instruction to improve reading and behavioral outcomes. Additionally, many schools address reading and behavior difficulties in isolation (Briesch et al., 2020; Burns et al., 2012; Freeman et al., 2015), despite evidence suggesting greater efficacy of combined programs. To increase the likelihood that students with co-occurring RD and challenging behaviors (including inattention) will respond to reading instruction, interventions could address both reading and behavioral outcomes *simultaneously* (e.g., Macdonald et al., 2021; Roberts et al., 2020; Tamm et al., 2017). Currently, there is a lack of evidence to suggest that reading-only interventions without behavior support are associated with improvements in behavior (i.e., collateral effect of reading-only intervention on behavior outcomes), or that behavior interventions without reading support are associated with improvements in reading outcomes (i.e., collateral effect of behavior-only intervention on reading outcomes). Overall, research in this area is limited (Cook et al., 2012; Roberts et al., 2015, 2020; Tamm et al., 2017), and schools need guidance in identifying effective interventions to improve both reading and behavior outcomes for students with RD + Inattention (e.g., Macdonald et al., 2021; National Center on Intensive Intervention, 2013; Roberts et al., 2020, 2021). Synthesizing interventions for this population can provide valuable insight regarding effective instructional practices.

Reviews for School-Based Interventions for Students with Inattention

To date, no systematic review has been conducted on interventions for students with inattention or only the inattentive subtype of ADHD, although several reviews have focused on academic interventions for students with ADHD in school settings using a single-case design (SCD) methodology (Harrison et al., 2019), group design (Roberts et al., 2020), or a combination of methodologies

(Stewart & Austin, 2020). First, Roberts et al. (2020) reviewed group design reading or behavior interventions for Grade K-12 students with co-occurring RD and behavior difficulties (e.g., externalizing behaviors, internalizing behaviors, ADHD). Roberts et al. (2020) identified four intervention studies that included students with RD+ADHD. Two of these studies examined validated reading curricula with and without behavior support for elementary students, the third investigated effects of game-based instruction with and without reading instruction for sixth graders, and the fourth study taught students in Grade 7–10 with co-occurring reading, ADHD, and behavioral disorders how to summarize science text with no behavior support added. Each of the three studies implementing a behavior support used a different intervention (e.g., game-based instruction, daily report cards), which is not surprising given the lack of consensus in the field on how to best support student behavior during academic instruction. Across these four studies, reading interventions led to improvements in reading, and behavior interventions led to improvements in behavior. The authors found no evidence of collateral impacts (i.e., reading interventions improving behavior and behavior interventions improving reading).

Harrison et al. (2019) conducted a meta-analysis with 27 classroom-based SCD interventions for students with ADHD. This review did not require students to have a co-occurring academic difficulty (e.g., RD) and did not report the co-occurrence of other disabilities (e.g., behavioral disorders, learning disabilities). Characteristics of these interventions were as follows: ten self-management (i.e., self-assessing and self-recording one's behavior or academic performance; $ES=0.93$), nine instructional (i.e., teach a skill; $ES=0.87$), seven consequence-based ($ES=0.67$), and one antecedent-based ($ES=0.97$). Similar to Roberts et al. (2020), Harrison et al. (2019) found the impact of the behavior support interventions to be positive (mean effect size of 0.87), with a range of intervention categories (e.g., instructional, self-management) and intervention descriptions within each intervention category (e.g., Six different self-management interventions [e.g., technology-based self-monitoring, classwide self-management, self-management with peer monitoring]). Disaggregated reading outcomes were not available in this review.

Finally, Stewart and Austin (2020) conducted a synthesis of reading interventions for students in Grade 4–12 with or at risk for ADHD, although students were not required to demonstrate an RD. Of the 16 studies they synthesized, 14 used SCD, and two used group design. This synthesis was focused on reading outcomes from reading interventions and did not investigate or report behavior outcomes. Findings indicated that effect sizes ranged from -0.06 to 2.63 across interventions featuring computer-based instruction ($k=2$), self-regulated strategy development with additional components ($k=5$), self-monitoring or goal setting ($k=3$), and other strategies ($k=4$; e.g., different colored ink during reading, graphic organizers). The authors reported frequent use of self-regulated strategy development and main idea and summarization techniques. They also noted a lack of vocabulary interventions for this population. Furthermore, the authors noted that many students had ADHD with a co-occurring behavior disorder or learning disability but did not report the percentage of students that had the co-occurring disabilities. As in the other reviews,

the authors highlighted the need for more intervention research to support the reading outcomes of students with ADHD.

Findings from these reviews (Harrison et al., 2019; Roberts et al., 2020; Stewart & Austin, 2020) extend those of earlier reviews (e.g., Chronis et al., 2006; DuPaul et al., 2012; Jitendra et al., 2008; Reid et al., 2005) that demonstrated the potential benefits of academic and self-management interventions on improved students' academic outcomes. Furthermore, these findings support the value of antecedent- and consequence-based behavior interventions and self-management interventions in improving behavior outcomes (e.g., DuPaul et al., 2012; Harrison et al., 2019), although given the range of reading (e.g., SRSD, main idea and summarization) and behavior support (e.g., antecedent-based, self-management) interventions, the process for choosing the appropriate intervention for a given student with ADHD was unclear. Of these reviews, only Roberts et al. (2020) and Stewart and Austin (2020) reported or described reading interventions or reading outcomes. The other reviews presented academic interventions and outcomes as an aggregate and did not disaggregate based on content area (e.g., reading, mathematics). Furthermore, even though many school-based interventions for students with ADHD use SCD methodology, there has yet to be a systematic review of SCD research for students with RD + ADHD.

Single-Case Design Studies

As summarized by Horner et al. (2005), SCDs are an experimental design, whose characteristics are well-aligned with special education research. First, the focus of SCDs on individual students allows for analysis at the individual level. This level of analysis facilitates detection of those who do and do not adequately respond to an intervention or independent variable (e.g., treatment resistance). Next, SCDs have practical benefits such as small samples of students, potential for multiple replications, and use in real-world settings (e.g., classrooms). Finally, SCDs can be a cost-effective approach to produce reliable evidence for identifying effective interventions; these findings can then be instrumental in justifying costlier randomized controlled trials. However, the benefits of SCDs diminish when studies lack methodological rigor.

Fortunately, the overall quality of SCD studies has improved over time (Harrison et al., 2019). To assist researchers in determining adequate research quality, the What Works Clearinghouse (WWC; Institute of Education Sciences [IES], 2020), has established methodological and design guidelines. Through these guidelines (IES, 2020), studies can receive one of the following designations: *Meets WWC SCD Standards without Reservations*, *Meets WWC SCD Standards with Reservations*, or *Does Not Meet WWC SCD Standards*. Researchers and practitioners may use these guidelines to evaluate individual SCDs for methodological rigor and thus, interpretability of findings. These WWC guidelines are widely used in systematic reviews to evaluate individual study quality (e.g., Cho Blair et al., 2021; Harrison et al., 2019; Roberts et al., 2020),

and applying these criteria can provide valuable context to interpret intervention findings and areas for further investigation.

Purpose and Research Questions

Researchers have stated a need to better understand and identify effective practices to support reading and behavior outcomes for students with RD+Inattention (Macdonald et al., 2021; Roberts et al., 2015, 2020; Tamm et al., 2017). Therefore, the present study will extend previous recent reviews in the following ways. First, this study builds on Roberts et al.' (2020) synthesis by investigating SCD studies, a particularly useful design for special education intervention research. Second, this study builds on Stewart and Austin's (2020) synthesis by including younger students in Grades K-3, who may benefit from specific supports in learning foundational reading skills. Third, this study builds on Harrison et al. (2019) by specifically investigating reading outcomes. Finally, this study extends both Stewart and Austin (2020) and Harrison et al. (2019) by including students who are inattentive, but not hyperactive, as neither of these two reviews included students who only demonstrated the inattentive subtype of ADHD. Together, these extended inclusion parameters will provide a comprehensive scope of intervention research for school-age students with co-occurring reading and attention difficulties.

To do so, we first conducted a systematic review to identify relevant studies for this sample of students. From the identified studies, we sought to answer the following research questions: (1) what are the student (e.g., grade, disability), study (e.g., sample size, study design), and intervention (e.g., group size, implementer) characteristics?, (2) what are the effects of reading interventions on reading outcomes, behavioral interventions on behavioral outcomes, and combined reading and behavioral interventions on reading or behavioral outcomes?, and (3) what are the collateral effects of reading interventions on behavior outcomes and behavior interventions on reading outcomes?

Method

Search Procedures

The search process had three steps: electronic database search, ancestral review, and hand search. Each step was independently completed by two graduate students in a college of education. The first author trained the two graduate students to reliably conduct an electronic database search, ancestral review, and hand search. In this training, the first author described each step of all search procedures to the graduate students. Graduate students needed to achieve 90% reliability with the first author on identified articles in each step of the following search processes (i.e., electronic database search, ancestral review, hand search). Reliability was

calculated by dividing the number of correctly identified articles by the total number of correct articles possible. After meeting the 90% reliability standard, the first author and two trained graduate students independently completed each step of the search process.

Inclusion Criteria

We included studies in our analysis that met all the following criteria in the area of participants, intervention characteristics, and study design.

Participant Characteristics The participants needed to be identified as Grade K-12 students with RD + Inattention. Various labels of with or at risk for a co-occurring RD and inattention were accepted. To identify students with RD, students could be identified through school (e.g., teacher nomination, school identified RD) or researcher (e.g., systematic reading screening process) eligibility processes. Additionally, students met the RD criteria if baseline reading data indicated RD (e.g., below benchmark on a norm referenced measure). Students did not meet the RD criteria if the study reported participants having a learning difficulty or disability not specific to reading (e.g., Whitford et al., 2013). To identify students with inattention, labels were accepted that conveyed that a student had inattention, with or without a co-occurring behavioral disorder (e.g., conduct disorder, EBD). We did not require that students have a clinical diagnosis of the inattention subtype of ADHD, because students with subclinical levels of inattention are also at an elevated risk of academic deficits (Kirova et al., 2019). Students with co-occurring intellectual disabilities, autism, or pervasive developmental disorder – not otherwise specified were excluded from analyses.

Intervention Characteristics The intervention needed to be delivered in English and include either reading instruction (e.g., word reading, fluency, comprehension) or a behavior intervention (e.g., social skills, self-monitoring) as an independent variable. The study also needed to measure either a reading (word reading, comprehension) or behavior (e.g., on-task behavior, disruptive behavior) outcome. Finally, the intervention needed to occur in a school (e.g., normal school hours, after school, summer school, juvenile justice facility), home, or clinical setting.

Study Characteristics The study needed to use a SCD, meet or meet with reservations the WWC determinants of study quality standards (IES, 2020), and have a minimum of three opportunities to demonstrate an effect with K-12 students with RD + Inattention participants on reading or behavior outcomes. For example, Shimabukuro et al. (1999) used a multiple baseline across reading, writing, and math content areas and measured reading in the reading setting, but not in math or writing settings. In this example, there was only one opportunity for a demonstration of effect in reading, so the reading outcome from this study was not included in our analyses. However, in this same study, Shimabukuro et al. (1999) also measured behavior (i.e., engagement) across the three content areas, resulting in three

opportunities for a demonstration of effect in behavior, and thus this outcome was included in our analyses. In another example, we excluded Ennis's (2016) multiple baseline across participants study, as there was only one K-12 students with RD + ADHD participant, and therefore, only one opportunity for a demonstration of effect. Finally, all studies were published in peer-reviewed journals from January 1, 1975, through January 31, 2022, to reflect the time period since the Education for All Handicapped Children Act (later reauthorized as Individuals with Disabilities Education Act) was signed into law.

Electronic Database Search

An electronic search of the databases ERIC and psycINFO used the following combination of search terms: (*read OR reading OR phonics OR "phonological awareness" OR "phonemic awareness"*) AND (*"behav* disorder" OR "behav* disturbance" OR "behav* disability" OR "behav* difficulty" OR "problem behav*" OR attention* OR hyperactive OR hyperactivity OR ADHD OR "internaliz* behav*" OR "externaliz* behav*" OR "emotional disturbance" OR "emotional disorder" OR "emotional and behav*" OR "social skills" OR "behav* concern"*) AND (*instruction OR intervention OR treatment OR medicat**) AND (*student* OR child OR adolescent*). The electronic database search identified 4105 articles. After reviewing all identified article abstracts for characteristics that could exclude a given study (e.g., research design other than SCD, participants were not in grades K-12), 4,011 studies were excluded. We reviewed the full text of 94 studies and excluded 86 studies for the following reasons: the study did not include K-12 students with RD + Inattention; an insufficient number of students to establish three determinations of effect (IES, 2020; $k=56$); a research design other than SCD was used ($k=7$); the study did not meet SCD standards with or without reservations (IES, 2020; $k=22$); or instruction was delivered in a language other than English ($k=1$). This process resulted in eight studies from the electronic database search meeting inclusion criteria (Bouck et al., 2021; Bruhn et al., 2016; Carroll et al., 2015; Cho & Blair, 2017; Flores & Ganz, 2007; Hook & DuPaul, 1999; Idler et al., 2017; Shimabukuro et al., 1999). Figure 1 outlines the screening process and summarizes reasons for exclusion.

Ancestral Review and Hand Search

To identify additional articles for inclusion, the reference sections of related syntheses were reviewed (DuPaul et al., 2012; Fabiano et al., 2009; Harrison et al., 2019; Pyle & Fabiano, 2017; Stewart & Austin, 2020). This process generated four additional studies (Cullen et al., 2013; McCain & Kelley, 1994; Schmitt et al., 2009; Stahr et al., 2006). Next, we reviewed journals frequently publishing SCD studies with students with academic or behavioral difficulties and journals that included at least two studies already identified for this synthesis. We reviewed published articles within the date range of the electronic search (i.e., January 1, 1975–January

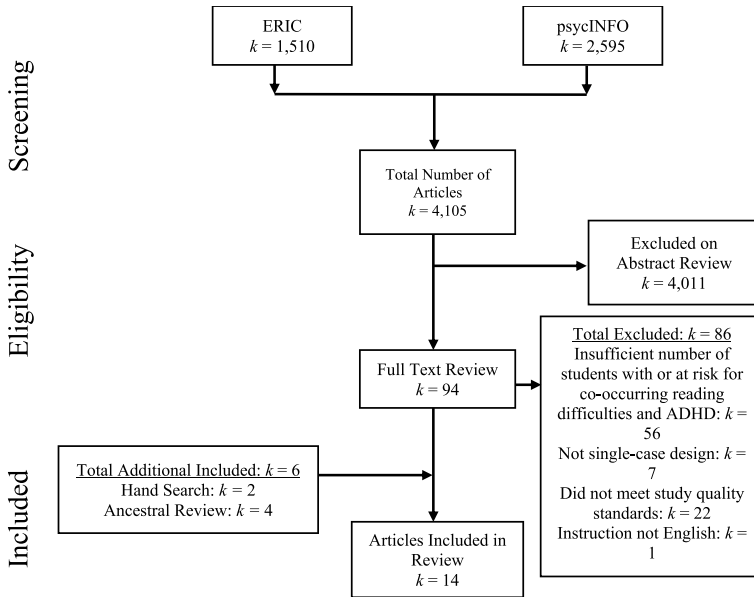


Fig. 1 Screening and eligibility flowchart

31, 2022) in the following journals: *Behavioral Disorders*, *Behavior Modification*, *Education and Treatment of Children*, *Exceptional Children*, *Journal of Attention Disorders*, *Journal of Emotional and Behavioral Disorders*, *Journal of Learning Disabilities*, *Journal of Positive Behavior Intervention*, *Learning Disabilities Research and Practice*, *Remedial and Special Education*, *School Psychology Review*, and *The Journal of Special Education*. This process generated two additional studies (Bruhn & Watt, 2012; Janney et al., 2013).

Coding Procedures

The first and second authors as well as two graduate students in a college of education coded the articles. The graduate students received training from the first author prior to coding. In this training, the first author described each component of the code sheet and then the first author and all coders coded an article together. As a final step, the coders independently coded an article. Coders needed to meet or exceed 90% exact agreement (sum of agreements were divided by the sum of agreements and disagreements) with the first author on each dimension (e.g., effect size calculation, student characteristics) prior to independent coding; all coders met this threshold on the first attempt. Following the training, coders independently double coded all articles for study and participant characteristics, study design, study outcomes, social validity, and WWC determinants of study quality rating (IES, 2020). Coding discrepancies were rare, but when they did occur, they were reviewed and discussed until a consensus was reached.

WWC Study Quality Determination

We evaluated study quality using the WWC determinants of study quality rating for SCD studies (IES, 2020). Studies received evaluations of *Meets WWC SCD Standards without Reservations* or *Meets WWC SCD Standards with Reservations* when they met the following five criteria: (a) displayed data graphically or in a tabular format, (b) systematically manipulated an independent variable, (c) reported interassessor agreement for each outcome and each phase on 20% of the available data and the interassessor agreement average was equal to or exceed 80% for the entire study, (d) ensured that residual effects were not present, and (e) demonstrated a minimum of three demonstrations of effect over time. In addition to these criteria, reversal designs require a minimum of four phases, and multiple baseline and multiple probe designs require at least six phases. As a final review step, withdrawal, multiple baseline, and multiple probe designs needed five or more data points per phase to *Meet WWC SCD Standards without Reservations* or three to four data points per phase to *Meet WWC Standards with Reservations*. Alternating treatments designs required one to two points per phase and five or more data points per condition to *Meet WWC SCD Standards without Reservations* or four data points per condition to *Meet WWC SCD Standards with Reservations*. A more detailed description of the WWC determinants of study quality rating for SCD studies (IES, 2020) can be found at <https://ies.ed.gov/ncee/wwc/Docs/referenceresources/WWC-Standards-Handbook-v4-1-508.pdf>

Effect Size

We calculated Tau-*U* (Parker et al., 2011b) effect sizes for each qualifying case within each identified study. We chose Tau-*U* to measure the extent to which data overlapped across phases at the individual level because it is a robust, recommended, and frequently used effect size in systematic reviews (e.g., Harrison et al., 2019; Stewart & Austin, 2020; Parker et al., 2011a). More specifically, Tau-*U* (Parker et al., 2011b) is a nonparametric technique that compares each data point in the baseline phase to each data point in the intervention phase and adjusts for trends in data (Vannest & Ninci, 2015). Commonly used Tau-*U* effect size benchmarks are small (≤ 0.2), moderate (0.21–0.59), and large (≥ 0.6 ; Vannest & Ninci, 2015). However, given the fact that Tau-*U* is commonly used in systematic reviews, a more meaningful benchmark may be from Harrison et al.' (2019) meta-analysis on classroom-based SCD interventions for students with ADHD. This contextually relevant meta-analysis found effect sizes for antecedent-based, instructional (i.e., teaching a skill), consequence-based, and self-management interventions ranging from 0.67 to 0.97 ($M = 0.87$, $SE = 0.02$).

To calculate Tau-*U* effect sizes, we first extracted raw data from relevant graphs using WebPlotDigitizer (Rohatgi, 2022). Next, we entered the extracted baseline and intervention data points into the single-case effect size calculator (Pustejovsky et al., 2021). The results section provides a study-level description of the baseline and intervention phase data points that were compared to calculate Tau-*U*. In our reporting of behavioral data effect sizes, positive effects represent an increase in

engagement (e.g., on-task behavior, attention) or a decrease in disruptive behavior (i.e., disruptive behavior was reverse-coded).

Throughout our search and reporting processes, we followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) framework. A completed PRISMA checklist is available at https://bit.ly/swrdadhd_osf.

Results

Table 1 reports the study characteristics for the 14 SCD studies in this synthesis, including 76 individual effect sizes across 29 total participants. Table 2 reports the study Tau-*U* effect sizes by participant and outcome. Of the 76 effect sizes, there were 52 reading effect sizes and 23 behavior (i.e., direct measures of engagement and disruptive behavior, attention/stress survey) effect sizes. Interventions focused on reading ($k=5$) with 40 reading effect sizes, behavior support ($k=7$) with 19 behavior effect sizes and reading with behavior support ($k=2$) with 12 and four reading and behavior effect sizes, respectively. The reading interventions reported only reading effect sizes, and behavior-focused interventions reported only behavior effect sizes. Of the two studies that examined combined reading and behavior interventions, Hook and DuPaul (1999) included only reading outcomes, whereas Idler et al. (2017) included both a reading outcome and an attention/stress survey completed after each session (i.e., student rated themselves from 0 to 100 on their ability to pay attention and their stress level).

All participants included in this synthesis had an RD. Co-occurring disabilities included inattention-only ($n=7$), ADHD ($n=15$), ADHD and a behavior disorder (e.g., emotional/behavior disorder, oppositional defiant disorder; $n=6$), and co-occurring ADHD, a behavior disorder, and a speech and language impairment ($n=1$). Eight studies included students in the elementary grades. The remaining studies included students in middle school (i.e., Grades 6–8; $k=5$) or a combination of middle and high school ($k=1$).

The group sizes of the intervention were 1:1 ($k=4$), whole-class ($k=3$), small group (i.e., 2–8 students; $k=1$), computer-based (i.e., independent; $k=2$), or a combination of group sizes ($k=4$). Intervention implementers were similarly varied; implementers included researcher-only ($k=3$), teacher-only ($k=3$), parent-only ($k=1$), or a combination of the student (i.e., self-monitoring), therapist, teacher, parent, computer, and/or researcher ($k=7$). Finally, six studies met the WWC quality indicators without reservations, six studies met the WWC quality indicators with reservations, and two studies had outcomes within the study that met the WWC quality indicators without and with reservations.

Reading Interventions

Five studies described reading interventions for a total of ten participants. Four of the studies had an intervention targeting word reading or passage reading, and one

Table 1 Study characteristics

Study	Study design	n	Grade	Participant disability	Group size	Implementer	Social validity	WWC study rating
<i>Reading Interventions</i>								
Bouck et al. (2021)	AT	2	8	P1/P2-RD, ADHD	1:1	Teacher, Researcher	Yes	M
Carroll et al. (2015)	AT	2	1 ^a	P1/P2-RD, ADHD	1:1	Teacher	No	M/MWR
Cullen et al. (2013)	MP across word sets	1	4	P1-RD, ADHD	Computer	Researcher, Computer	Yes	MWR
Flores and Ganz (2007)	MP across behaviors	1	5	P1-RD, ADHD	SG	Researcher	No	M
Schmitt et al. (2009)	AT	4	8-10 ^a	P1-4-RD, ADHD, BD	Computer	Researcher, Computer	Yes	M
<i>Behavior Interventions</i>								
Bruhns and Watt (2012)	W	1	7	P1-RD, ADHD, BD	WC, SG, Ind, Computer	Student, Teacher	Yes	MWR
Bruhns et al. (2016)	W	2	7	P1-RD, ADHD, BD	WC, SG, 1:1, Ind, Computer	Student, Teacher	Yes	MWR
Cho and Blair (2017)	MBL across content	1	6	P1-RD, ADHD, BD	WC, 1:1, Ind	Teacher	Yes	M
Janney et al. (2013)	W	2	1-2	P1-RD, inattention; P2-RD, ADHD	WC	Teacher	Yes	MWR
McCain and Kelley (1994)	AT	2	4	P1/P2-RD, Inattention, BD	WC	Teacher, Parent	No	M
Shimabukuro et al. (1999)	MBL across content	3	6-7	P1-3-RD, ADHD	WC, Ind	Student, Teacher	No	MWR
Stahr et al. (2006)	W	1	4	P1-RD, ADHD, BD, SLI	WC	Student, Therapist	Yes	MWR
<i>Reading + Behavior Interventions</i>								
Hook and DuPaul (1999)	MBL across students	4	2-3	P1-4-RD, ADHD	1:1	Parent	Yes	M/MWR
Idler et al. (2017)	AT	4	3-5	P1-4-RD, Inattention	1:1	Researcher	No	M

WWC What Works Clearinghouse, AT alternating treatment, P participant, RD Reading difficulty with or without a learning disability, ADHD attention-deficit/hyperactivity disorder, M meets, MWR meets with reservations, MP multiple probe, SG small group, BD behavior disorder (e.g., emotional/behavior disorder, oppositional defiant disorder), W withdrawal, WC whole class, Ind independent, MBL multiple baseline

^aGrade level not reported, grade estimated on age

Table 2 Study effects

Study	Condition components		Tau-U				Outcome					
	Intervention	Baseline ^a	Outcome		Tau-U		Outcome		Tau-U			
			P1	P2	P3	P4	P1	P2	P3	P4		
<i>Reading Interventions</i>												
Boucek et al. (2021)	I1: R I2: R I3: R	R R R	RC RC RC	RC	-0.60 0.18 0.52	-0.12 0.72 0.68	1.00	RC rate ^b RC rate ^b RC rate ^b	-1.08 -0.77 -1.08	-1.16 -0.04 -1.20		
Carroll et al. (2015)	I1: R I2: R I3: R I4: R	None None None None	WR WR WR WR	WR	0.88 1.00 1.00 1.00	1.00 1.00 1.00 1.00	1.00					
Cullen et al. (2013)	R	None	WR	WR	1.04							
Flores and Ganz (2007)	I1: R I2: R I3: R	R R R	RC RC Vocab	RC	0.92 1.00 0.87							
Schmitt et al. (2009)	I1: R I2: R	R R	RC RC	RC	0.50 0.69	0.33 0.56	-0.42 0.36	RC rate ^b RC rate ^b	0.25 0.28	-0.32 -0.20	0.81 1.01	
<i>Behavior Interventions</i>												
Bruhn and Watt (2012)	B	None	Engage	Engage	0.98			DB	0.64			
Bruhn et al. (2016)	B	None	Engage	Engage	0.86	0.62		DB	0.67	0.73		
Cho and Blair (2017)	B	None	Engage	Engage	1.05			DB	1.14			
Janney et al. (2013)	B	None	Engage	Engage	0.96	0.97						
McCain and Kelley (1994)	B	B	Engage	Engage	0.80	0.87		DB	0.66	0.84		
Shimabukuro et al. (1999)	B	None	Engage	Engage	0.99	1.03	0.78					
Stahr et al. (2006)	B	None	Engage (ELA)	Engage (ELA)	0.96			Engage (Math)	1.01			
<i>Reading + Behavior Interventions</i>												
Hook and DuPaul (1999)	R + B	None	PRF (School)	PRF (Home)	0.96	0.58	0.93	0.81	0.95	0.92	0.87	0.91

Table 2 (continued)

Study	Condition components		Outcome		Tau-U		Outcome				Tau-U		
	Intervention	Baseline ^a	P1	P2	P1	P2	P3	P4	P1	P2	P3	P4	
Idler et al. (2017)	R+B	R	PRF	PRF	0.61	0.03	0.08	0.11	Attention/stress	-0.33	0.08	0.39	1.06

P participant, *I* Intervention Condition Number, *RC* reading comprehension, *WR* word reading, *Vocab* vocabulary, *B* behavior, *Engage* engagement, *DB* disruptive behavior, *ELA* English language arts setting, *Math* mathematics setting, *PRF* passage reading fluency, *School* school setting, *Home* home setting

^aBaseline references a no treatment or weaker treatment that each intervention was compared against to determine the effect size

^bRC Rate is the number of correct responses divided by completion time, as compared to RC which is the number of correct responses

study had an intervention addressing reading comprehension and vocabulary. These five studies only reported reading outcomes. Three studies reported reading interventions for elementary students, and two studies reported reading interventions for secondary students.

Two studies (Carroll et al., 2015; Cullen et al., 2013) investigated the impact of a word reading intervention on word reading outcomes for elementary students. Carroll et al. (2015) targeted sight word learning with three different error correction procedures relative to a control condition (i.e., student read words without error correction procedures). Participants were Grade 1 students who received intervention in a 1:1 setting. Cullen et al. (2013) tested the effects of an interactive computer program with audio corrective feedback for Grade 4 students learning and practicing targeted sight words. This condition was compared to students reading words from PowerPoint slides with no feedback.

Two studies had an intervention which tested variations of passage reading interventions prior to answering reading comprehension questions for secondary students. Bouck et al. (2021) tested the effects of repeated reading interventions on reading comprehension outcomes of Grade 8 students in a 1:1 setting. In this study, there was a baseline condition of students reading a passage silently to themselves one time, and three intervention conditions: (a) students reading a novel passage to themselves two times (1), (b) students reading a novel passage aloud with a teacher (2), and (c) students reading a novel passage aloud with a teacher two times (3). In the second study, Schmitt et al. (2009) tested two computer-based intervention conditions with Grade 4 students: (a) listening to a passage being read by the computer (students were unable to read the passage) and (b) reading a passage aloud while the passage was being read by the computer. These conditions were compared to a baseline condition of independent silent reading without a computer.

Finally, Flores and Ganz (2007) included a reading comprehension and vocabulary intervention titled *Corrective Reading Thinking Basics: Comprehension Level A* (Engelmann et al., 2002). The intervention condition instruction included statement inferences (1), story facts (2), and analogies (3), which were added to the baseline phase of the Direct Instruction reading curriculum. This intervention was delivered to Grade 5 students in a small group setting.

Behavior Interventions

Seven studies included a behavior intervention with a total of 12 participants. Three studies delivered a self-monitoring intervention, three delivered an individualized function-based intervention, and one delivered a school-home note system. Three studies included participants in elementary school, and four studies included participants in middle school. These seven studies only included behavior outcomes.

Two of the studies (Bruhn & Watt, 2012; Bruhn et al., 2016) tested effects of a self-monitoring intervention conducted in a Grade 7 general education setting during reading instruction, with students rotating to various reading stations (e.g., whole class, small group, computer). In both studies, self-monitoring forms addressed student behavior (e.g., be respectful) rather than academic outcomes (e.g.,

reading accuracy) on paper (Bruhn & Watt, 2012) or an iPad (Bruhn et al., 2016). Shimabukuro et al. (1999) also used a self-monitoring intervention. Unlike Bruhn and Watt (2012) and Bruhn et al. (2016) who taught students to self-monitor their behavior, Shimabukuro et al. (1999) taught students to self-monitor their academic performance. They conducted this intervention with Grade 6 and 7 students across reading, writing, and math settings and used paper forms.

Three studies delivered an individualized function-based intervention (Cho & Blair, 2017; Janney et al., 2013; Stahr et al., 2006) based on a functional behavior assessment completed on each participant; interventions varied by content and setting. Two studies (Cho & Blair, 2017; Stahr et al., 2006) included a function-based intervention with one student in multiple content areas (i.e., reading, writing, math). The participant in Cho and Blair's (2017) study was in Grade 6, whereas the participant in Stahr et al.' (2006) study was in Grade 4. By contrast, Janney et al. (2013) delivered the function-based intervention to two students (Grade 1 and 2) in the general education setting.

Finally, McCain and Kelley's (1994) behavior intervention for Grade 4 students tested two conditions: take-home notes with and without a response cost. In the without response cost condition, students took home a notecard stating how well they met their behavioral goals during reading and English language arts (based on the number of smiley faces earned). When students met a specified daily criterion, they earned a reward at home. The take-home note with response cost condition was identical to the without response cost condition, except students could lose smiley faces for inappropriate behavior.

Reading Intervention with Behavioral Supports

Two studies included a reading intervention with behavior supports; these studies yielded a total of 16 eligible effect sizes. In Hook and DuPaul's (1999) study, students in Grade 2 and 3 read a book aloud to their parents in the home setting. Parents received training and coaching in error correction procedures in reading, the use of praise for accurate reading, and the use of positive reinforcement, time outs, and a token economy to support student behavior. The study by Idler et al. (2017) tested the effects of a reading fluency intervention for students in Grade 3–5 across two conditions: reading with and without mindfulness breathing. When students were in the reading fluency condition, they read and reread passages with feedback, retold the passage, listened to an adult read the passage, and graphed the number of words they read after the final read. When students were in the mindfulness breathing exercise, they practiced breathing and focusing on their breath prior to the reading fluency routine.

Reading Interventions on Reading Outcomes

The five reading intervention studies yielded 40 eligible reading effect sizes and no behavior effect sizes. Two studies investigated the effects of a word reading

intervention on word reading outcomes. First, Carroll et al.' (2015) study had three conditions with a Tau- U mean word reading effect size: (a) single-response repetition was 0.94 ($SD=0.08$, range: 0.88–1.00), (b) remove and re-present was 1.00 ($SD=0.00$, range: 1.00–1.00), and (c) re-present until independent 1.00 ($SD=0.00$, range: 1.00–1.00). Second, Cullen et al. (2013) had one student with a Tau- U effect size on one word reading measure of 1.04.

Additionally, two studies tested variations of passage reading prior to completing a reading comprehension measure. Bouck et al. (2021) compared effects of three conditions using two reading comprehension measures. Across both reading comprehension measures, the Tau- U mean effect size was -0.61 for intervention 1 ($SD=0.60$, range: -1.16 to -0.06), 0.03 for intervention 2 ($SD=0.62$, range: -0.77 to 0.72), and -0.27 for intervention 3 ($SD=1.01$, range: -1.20 to 0.68). In Schmitt et al. (2009), across two reading comprehension measures, the Tau- U mean effect size was 0.29 ($SD=0.67$, range: -0.42 to 0.69) and 0.04 ($SD=0.67$, range: -0.87 to 1.01) for the first and second intervention, respectively.

Finally, Flores and Ganz's (2007) study was the only combined reading comprehension and vocabulary intervention. Of the four students included in the study, only one student met the inclusion criteria for the present synthesis. Tau- U effect size values for the first and second reading comprehension measure, following intervention 1 and 2, were 0.92 and 1.00 , respectively. The Tau- U effect size for vocabulary during the third intervention was 0.87 . Across the reading interventions, the reading comprehension effect sizes ranged from -1.20 to 1.04 . The word reading Tau- U effect sizes were all positive and had less variability (range: 0.88 – 1.04).

Behavioral Interventions on Behavioral Outcomes

The seven behavior intervention studies yielded 19 eligible behavior effect sizes and no reading effect sizes. Three studies examined effects of self-monitoring interventions. For the eligible student in Bruhn and Watt's (2012) study, Tau- U effect size values were 0.98 for engagement and 0.64 for disruptive behavior. For Bruhn et al. (2016), the Tau- U mean effect size U was 0.74 ($SD=0.17$, range: 0.62 – 0.86) on engagement and 0.70 ($SD=0.04$, range: 0.67 – 0.73) on disruptive behavior. Finally, Shimabukuro et al. (1999) had a Tau- U mean engagement effect size of 1.01 ($SD=0.03$, range: 0.78 – 1.03).

Three studies focused on individualized function-based interventions. Cho and Blair (2017) had one student with a Tau- U effect size of 1.05 on engagement and 1.14 on disruptive behavior. Stahr et al. (2006) also had one student with an engagement Tau- U effect size of 0.96 in the English language arts setting and 1.01 in the mathematics setting. Finally, Janney et al. (2013) had a Tau- U mean effect size of 0.97 ($SD=0.01$, range: 0.96 – 0.97) on engagement.

The final behavior intervention was McCain and Kelley (1994). In this study, take-home notes with response cost outperformed take-home notes without response

cost with a Tau-*U* mean effect size of 0.84 ($SD=0.05$, range: 0.80–0.87) on engagement and 0.75 ($SD=0.13$, range: 0.66–0.84) on disruptive behavior. Across the behavior interventions, all Tau-*U* effect sizes for engagement (range: 0.62–1.05) and disruptive behavior (range: 0.64–1.14) were positive.

Combined Reading and Behavioral Interventions on Reading or Behavioral Outcomes

Two studies delivered combined reading and behavior interventions with a total of 16 eligible effect sizes. Hook and DuPaul (1999) measured reading fluency at school and home. Across both settings, the Tau-*U* mean effect size was 0.87 ($SD=0.13$, range: 0.58–0.96). This study did not include a behavior outcome. Idler et al. (2017) reported a Tau-*U* mean effect size of 0.21 ($SD=0.27$, range: 0.03–0.61) on passage reading fluency and 0.21 ($SD=0.27$, range: 0.30–0.59) on a student survey of attention and stress delivered prior to the reading activities. Idler et al.' (2017) was the only study to measure both reading and behavior. Additionally, Idler et al. (2017) was the only study to measure behavior with a survey (i.e., delivered each session; student rated themselves from 0 to 100 on their ability to pay attention and their stress level). Across all the combined reading and behavior interventions, effect sizes for reading fluency were positive and ranged from 0.08 to 0.96.

Collateral Impact of Interventions

In our planned analyses, we had intended to investigate the collateral effects of reading and behavior interventions. In other words, we aimed to determine the effects of reading interventions on behavior outcomes and behavior interventions on reading outcomes. However, we were unable to evaluate this final question because no identified reading intervention reported behavior outcomes, and no identified behavior intervention reported reading outcomes.

Social Validity

Finally, we coded studies for whether researchers reported collecting data about social validity. Of the 14 included studies, we found that a majority ($k=9$) collected social validity data. Two studies (22%) reported teacher data, one study (11%) reported student data, five studies (56%) reported teacher and student data, and one study (11%) reported parent, teacher, and student data. Only Cullen et al. (2013) conducted social validity interviews, with the other eight studies delivering social validity questionnaires. We coded social validity reporting across all three intervention domains: reading, behavior, and combined. Of the reading interventions, three (60%) reported social validity; of the behavior interventions, five (71%) reported social validity; and one of the two combined interventions (50%) reported social validity. In general, student-directed questions about social

validity focused on their enjoyment of the intervention, the ease of procedures, their perceived “fairness” of the intervention (especially regarding behavior components), and the degree to which they felt that the intervention had helped to improve their reading and/or behavior. Teacher- and parent-directed questions addressed appropriateness, effectiveness, and feasibility of the interventions.

Discussion

This synthesis includes 14 SCD studies that include K-12 students with RD + Inattention and met the inclusion criteria. Our findings suggest that reading interventions can lead to improved word reading and reading comprehension outcomes for students with RD + Inattention. Only Flores and Ganz (2007) implemented a research-based, validated reading curriculum as part of their intervention. All other reading interventions were focused on a single strategy of teaching sight words (Carroll et al., 2015; Cullen et al., 2013) or reading a passage prior to answering reading comprehension questions (Bouck et al., 2021; Schmitt et al., 2009). Findings from studies focusing on word reading skills through repeated practice and error corrections were promising. However, findings were also mixed on the extent to which supporting student passage reading can lead to improved reading comprehension outcomes. Therefore, embedding reading comprehension strategies into reading instruction, similar to Flores and Ganz (2007), may be a more beneficial strategy to improve reading comprehension outcomes. Furthermore, no studies in our sample investigated the effect of a reading intervention on behavior outcomes. Even though previous reviews (Roberts et al., 2015, 2020) identified reading-focused interventions as associated with positive effects on reading but little to no effect on behavior, the studies in our sample did not report sufficient data to address our research question on the collateral impact of reading interventions on behavior outcomes. Therefore, the extent to which a reading intervention alone can improve student behavior was unable to be determined through this synthesis.

Regarding the behavior interventions, findings suggested that these interventions can lead to improved engagement outcomes and reductions in disruptive behavior for students with RD + Inattention. Three of the studies investigated the effects of self-monitoring. This synthesis adds further evidence to previous studies that self-monitoring can support student behavior (e.g., DuPaul et al., 2012; Harrison et al., 2019). This synthesis also identified three function-based intervention studies and found positive effects on behavior. Given the time requirement to collect data and develop individualized interventions, such function-based interventions should only be used when less intensive interventions are unable to produce the desired behavioral improvement. One study, McCain and Kelley (1994) used take-home notes in which teachers rated student behavior on a card that was sent home to parents. Based on the study design and number of students with RD + Inattention in this study, we were only able to compare two versions of take-home notes (i.e., with and without response cost) to each other, and we were unable to compare either version of the take-home notes to a

baseline condition. Therefore, recommendations on the use of take-home notes based on this single study are limited. However, daily report cards, a variation of take-home notes, have a strong research base in regard to improving behavioral outcomes for students with ADHD (Pyle & Fabiano, 2017). As with the reading interventions, we were unable to identify a behavior intervention that measured reading outcomes. Even though we were unable to measure the collateral impact of behavior interventions on reading outcomes, this finding of minimal behavior interventions for students with RD+Inattention that report reading outcomes may highlight a need for further research in this area. If a distal goal of behavior support is to facilitate students' academic learning, researchers may choose to include academic outcomes when designing behavior interventions.

Finally, two studies included interventions with a reading and behavior component. Hook and DuPaul (1999) implemented a family-based intervention with parents delivering the reading intervention with behavior support and found an improvement on reading fluency outcomes. They did not, however, report a behavior outcome. Idler et al. (2017) taught students a mindfulness breathing exercise prior to the reading intervention. Because the intervention was delivered after the mindfulness breathing exercise and prior to the reading intervention, findings were not conclusive as to whether the intervention improved attention during reading instruction. Idler et al.' (2017) study was the only study to measure both reading and behavior outcomes. Based on these two identified studies, the extent to which combined reading and behavior interventions impacts reading and behavior outcomes concurrently was unable to be answered in this synthesis.

Limitations

This synthesis yields several findings that can support research and practice, and these findings should be considered in the context of certain limitations. First, the synthesis includes a limited number of identified studies, in part due to studies needing to meet or meet with reservations the WWC SCD study design standards (IES, 2020), have a minimum of three opportunities to demonstrate an effect with K-12 students with RD+Inattention, be peer-reviewed, and be published. By design, these inclusion criteria excluded some studies relevant for students with RD+Inattention; however, given that all included studies were conducted in a rigorous manner and peer-reviewed, there can be an added confidence in this synthesis' findings, as compared to if we had included studies based on less rigorous standards or designs. Future syntheses may address the potential role of publication bias in reading and behavior interventions for students with RD+Inattention.

A second limitation of the study is owed to a lack of clear agreement in the field on how to best measure SCD outcomes. In particular, the *WWC Standards and Procedures Guide* (IES, 2020) does not recommend reporting visual analysis in systematic reviews. This decision has prompted several commentaries on the importance of visual analysis in interpreting findings (e.g., Kratochwill et al., 2021; Maggin et al., 2021). Given the lack of consensus in the field on measuring SCD study effects, we followed the WWC recommendations and did not report visual

analysis findings and instead calculated Tau-*U*, an effect size measure used in previous syntheses (e.g., Stewart & Austin, 2020) and meta-analyses (e.g., Harrison et al., 2019) published in leading special education research journals.

The next limitation of this synthesis was the limited number of identified studies that implemented a reading with behavior support intervention. Therefore, it was unclear the extent to which such an intervention was able to improve reading and behavior outcomes concurrently. Similarly, we were unable to answer our final research question on the collateral impact of reading interventions on behavior outcomes and behavior interventions on reading outcomes, due to a lack of eligible studies that investigated either effects of reading intervention on behavior outcomes or behavior intervention on reading outcomes.

Future Research and Implications for Practice

Findings from this synthesis align with those of previous syntheses (e.g., Roberts et al., 2015, 2020; Stewart & Austin, 2020) in emphasizing a need to better understand how to best support students with RD+Inattention's reading and behavior outcomes. Based on the reading and behavior interventions identified in this review as well as other reviews (e.g., Harrison et al., 2019; Roberts et al., 2020; Stewart & Austin, 2020), findings suggest that researchers have implemented a range of interventions that are generally effective, although there remains a need to better understand and provide guidance on which interventions should be implemented with a given student with RD+Inattention. In other words, even though there are a range of effective interventions available, research questions related to for whom and under what conditions remain an area of future research.

Furthermore, given that many students with RD+Inattention also have co-occurring behavior disorders and students with RD+Inattention are likely to have more severe reading challenges than students with only RD, more research is needed on how to best support reading *and* behavior needs of students with RD+Inattention. Even though we were unable to answer the research questions related to the association between reading interventions with behavior improvements and behavior interventions with reading improvements, we join other researchers who have called for interventions to integrate reading and behavior components to address both reading and behavior, simultaneously as a potentially worthwhile avenue for future research (e.g., Macdonald et al., 2021; Roberts et al., 2020; Tamm et al., 2017). Research in integrating behavior supports could take the form of a standardized approach (e.g., self-monitoring, token economy), or a more intensive and individualized approach, such as a function-based intervention. We also highlight the need for reading-only, behavior-only, and combined reading and behavior interventions to report both reading and behavior outcomes for students with RD+ADHD. As a final note, we recommend that future studies examining behavior and reading interventions for students with RD+Inattention continue to report social validity data to ensure that such interventions are developmentally appropriate, result in meaningful growth, matched to student goals, and feasible to implement. Our findings suggest that such reporting is more common in behavior

interventions than those targeting reading, and the data from such efforts may help to inform development of interventions that are more effective and feasible.

There are several implications for practice. First, for students with RD+Inattention, student word reading can be supported with repeated practice and corrective feedback. Second, Flores and Ganz (2007) found that embedding specific reading comprehension strategies into a research-based curriculum can support specific reading comprehension outcomes aligned to the strategies. In terms of behavior, our findings indicate that self-monitoring is an effective tool to improve student engagement and reduce challenging behavior, even in larger group settings. Finally, students with RD+Inattention with more intensive behavioral challenges may benefit from individualized, function-based interventions to support their behavior goals. As more effective interventions are developed to address the reading and behavior needs of students with RD+Inattention in Grade K-12, these practices need to be addressed in teacher preparation and professional development.

Conclusion

In summary, students with RD+Inattention often require more intensive reading interventions than students with only RD and more intensive behavior interventions than students who are inattentive without RD. This synthesis identified strategies to support students with RD+Inattention's word reading, although research was limited on how to best support reading comprehension. This synthesis also found evidence that self-monitoring and function-based interventions may be effective for improving student behavior. Future research is needed on how to support students with RD+Inattention's reading and behavior needs, simultaneously. Ultimately, for students with RD+Inattention, there remains a need to better understand, through high-quality intervention studies, the conditions required to produce meaningful reading and behavior gains.

Funding The research reported here was supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R324B190010 to the University of Denver and Grant R324B210020 to Lehigh University. The opinions expressed are those of the authors and do not represent views of the Institute or the U.S. Department of Education.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

References

References marked with an asterisk (*) indicate studies included in the synthesis.

- *Bouck, E. C., Truckenmiller, A., Bone, E., & Flanagan, S. (2021). Comparing the effectiveness of reading modifications on comprehension accuracy and reading comprehension rate. *Preventing School Failure: Alternative Education for Children and Youth*, 65(3), 194–205.

- Briesch, A. M., Chafouleas, S. M., Nissen, K., & Long, S. (2020). A review of state-level procedural guidance for implementing multitiered systems of support for behavior (MTSS-B). *Journal of Positive Behavior Interventions*, 22(3), 131–144.
- *Bruhn, A., & Watt, S. (2012). Improving behavior by using multicomponent self-monitoring within a targeted reading intervention. *Behavioral Disorders*, 38(1), 3–17.
- *Bruhn, A. L., Vogelgesang, K., Fernando, J., & Lugo, W. (2016). Using data to individualize a multicomponent, technology-based self-monitoring intervention. *Journal of Special Education Technology*, 31(2), 64–76.
- Burns, M. K., Riley-Tillman, T. C., & VanDerHeyden, A. M. (2012). *RTI applications: Academic and behavioral interventions* (Vol. 1). Guilford Press.
- Carroll, J. M., Maughan, B., Goodman, R., & Meltzer, H. (2005). Literacy difficulties and psychiatric disorders: Evidence for comorbidity. *Journal of Child Psychology and Psychiatry*, 46(5), 524–532.
- *Carroll, R. A., Joachim, B. T., St. Peter, C. C., & Robinson, N. (2015). A comparison of error-correction procedures on skill acquisition during discrete-trial instruction. *Journal of Applied Behavior Analysis*, 48(2), 257–273.
- *Cho, S. J., & Blair, K. S. C. (2017). Using a multicomponent function-based intervention to support students with attention deficit hyperactivity disorder. *The Journal of Special Education*, 50(4), 227–238.
- Cho Blair, K. S., Park, E. Y., & Kim, W. H. (2021). A meta-analysis of Tier 2 interventions implemented within school-wide positive behavioral interventions and supports. *Psychology in the Schools*, 58(1), 141–161. <https://doi.org/10.1002/pits.22443>
- Chronis, A. M., Jones, H. A., & Raggi, V. L. (2006). Evidence-based psychosocial treatments for children and adolescents with attention-deficit/hyperactivity disorder. *Clinical Psychology Review*, 26(4), 486–502.
- Cook, C. R., Dart, E., Collins, T., Restori, A., Daikos, C., & Delpont, J. (2012). Preliminary study of the confined, collateral, and combined effects of reading and behavioral interventions: Evidence for a transactional relationship. *Behavioral Disorders*, 38(1), 38–56.
- *Cullen, J., Keesey, S., & Alber-Morgan, S. R. (2013). The effects of computer-assisted instruction using Kurzweil 3000 on sight word acquisition for students with mild disabilities. *Education and Treatment of Children*, 36(2), 87–103.
- DuPaul, G. J., Eckert, T. L., & Vilaro, B. (2012). The effects of school-based interventions for attention deficit hyperactivity disorder: A meta-analysis 1996–2010. *School Psychology Review*, 41(4), 387–412.
- Engelmann, S., Haddox, P., Hanner, S., & Osborn, J. (2002). *Corrective reading thinking basics*. Science Research Associates/McGraw-Hill.
- Ennis, R. P. (2016). Using self-regulated strategy development to help high school students with EBD summarize informational text in social studies. *Education and Treatment of Children*, 39(4), 545–568.
- Fabiano, G. A., Pelham, W. E., Jr., Coles, E. K., Gnagy, E. M., Chronis-Tuscano, A., & O'Connor, B. C. (2009). A meta-analysis of behavioral treatments for attention-deficit/hyperactivity disorder. *Clinical Psychology Review*, 29(2), 129–140.
- *Flores, M. M., & Ganz, J. B. (2007). Effectiveness of direct instruction for teaching statement inference, use of facts, and analogies to students with developmental disabilities and reading delays. *Focus on Autism and Other Developmental Disabilities*, 22(4), 244–251.
- Freeman, R., Miller, D., & Newcomer, L. (2015). Integration of academic and behavioral MTSS at the district level using implementation science. *Learning Disabilities: A Contemporary Journal*, 13(1), 59–72.
- Goldston, D. B., Walsh, A., Mayfield Arnold, E., Reboussin, B., Sergent Daniel, S., Erkanli, A., Nutter, D., Hickman, E., Palmes, G., Snider, E., & Wood, F. B. (2007). Reading problems, psychiatric disorders, and functional impairment from mid-to late adolescence. *Journal of the American Academy of Child & Adolescent Psychiatry*, 46(1), 25–32. <https://doi.org/10.1097/01.chi.0000242241.77302.f4>
- Harrison, J. R., Soares, D. A., Rudzinski, S., & Johnson, R. (2019). Attention deficit hyperactivity disorders and classroom-based interventions: Evidence-based status, effectiveness, and moderators of effects in single-case design research. *Review of Educational Research*, 89(4), 569–611.
- *Hook, C. L., & DuPaul, G. J. (1999). Parent tutoring for students with attention-deficit/hyperactivity disorder: Effects on reading performance at home and school. *School Psychology Review*, 28(1), 60–75.

- 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*(2), 165–179.
- *Idler, A. M., Mercer, S. H., Starosta, L., & Bartfai, J. M. (2017). Effects of a mindful breathing exercise during reading fluency intervention for students with attentional difficulties. *Contemporary School Psychology, 21*(4), 323–334.
- Institute of Education Sciences. (2020). *What works clearinghouse standards handbook* (Version 4.1). <https://ies.ed.gov/ncee/wwc/Docs/referenceresources/WWC-Standards-Handbook-v4-1-508.pdf>
- *Janney, D. M., Umbreit, J., Ferro, J. B., Liaupsin, C. J., & Lane, K. L. (2013). The effect of the extinction procedure in function-based intervention. *Journal of Positive Behavior Interventions, 15*(2), 113–123.
- Jitendra, A. K., DuPaul, G. J., Someki, F., & Tresco, K. E. (2008). Enhancing academic achievement for children with attention deficit hyperactivity disorder: Evidence from school-based intervention research. *Developmental Disabilities Research Reviews, 14*, 325–330.
- Kadesjo, C., Hagglof, B., Kadesjo, B., & Gillberg, C. (2003). Attention-deficit-hyperactivity disorder with and without oppositional defiant disorder in 3- to 7-year-old children. *Developmental Medicine and Child Neurology, 45*, 693–699. <https://doi.org/10.1017/S0012162203001282>
- Karande, S., Bhosrekar, K., Kulkarni, M., & Thakker, A. (2009). Health-related quality of life of children with newly diagnosed specific learning disability. *Journal of Tropical Pediatrics, 55*(3), 160–169. <https://doi.org/10.1093/tropej/fmn099>
- Kratochwill, T. R., Horner, R. H., Levin, J. R., Machalicek, W., Ferron, J., & Johnson, A. (2021). Single-case design standards: An update and proposed upgrades. *Journal of School Psychology, 89*, 91–105.
- Lin, Y. C., Morgan, P. L., Farkas, G., Hillemeier, M., & Cook, M. (2013). Reading, mathematics, and behavioral difficulties interrelate: Evidence from a cross-lagged panel design and population-based sample of US upper elementary students. *Behavioral Disorders, 38*(4), 212–227. <https://doi.org/10.1177/019874291303800404>
- Lyon, G. R. (1996). The state of research. In S. Cramer & W. Ellis (Eds.), *Learning disabilities: Lifelong issues* (pp. 3–61). Paul H. Brooks.
- Macdonald, K. T., Barnes, M. A., Miciak, J., Roberts, G., Halverson, K. K., Vaughn, S., & Cirino, P. T. (2021). Sustained attention and behavioral ratings of attention in struggling readers. *Scientific Studies of Reading, 25*(5), 436–451.
- Maggin, D. M., Barton, E., Reichow, B., Lane, K., & Shogren, K. A. (2021). Commentary on the what works clearinghouse standards and procedures handbook (v. 4.1) for the Review of Single-Case Research. *Remedial and Special Education*. Advance online publication
- Mayes, S. D., & Calhoun, S. L. (2007a). Learning, attention, writing, and processing speed in typical children and children with ADHD, autism, anxiety, depression, and oppositional-defiant disorder. *Child Neuropsychology, 13*, 469–493. <https://doi.org/10.1080/09297040601112773>
- Mayes, S. D., & Calhoun, S. L. (2007b). Learning, attention, writing, and processing speed in typical children and children with ADHD, autism, anxiety, depression, and oppositional-defiant disorder. *Child Neuropsychology, 13*(6), 469–493.
- *McCain, A. P., & Kelley, M. L. (1994). Improving classroom performance in underachieving preadolescents: The additive effects of response cost to a school-home note system. *Child & Family Behavior Therapy, 16*(2), 27–41.
- McGrath, L. M., Pennington, B. F., Shanahan, M. A., Santerre-Lemmon, L. E., Barnard, H. D., Willcutt, E. G., DeFries, J. C., & Olson, R. K. (2011). A multiple deficit model of reading disability and attention-deficit/hyperactivity disorder: Searching for shared cognitive deficits. *Journal of Child Psychology and Psychiatry, 52*(5), 547–557. <https://doi.org/10.1111/j.1469-7610.2010.02346.x>
- National Center on Intensive Intervention. (2013). *Implementing intensive intervention: Lessons learned from the field*. U.S. Department of Education, Office of Special Education Programs.
- Parker, R. I., Vannest, K. J., & Davis, J. L. (2011a). Effect size in single-case research: A review of nine nonoverlap techniques. *Behavior Modification, 35*, 303–322.
- Parker, R. I., Vannest, K. J., Davis, J. L., & Sauber, S. B. (2011b). Combining nonoverlap and trend for single-case research: Tau-U. *Behavior Therapy, 42*(2), 284–299.
- Pliszka, S. R. (1998). Comorbidity of attention-deficit/hyperactivity disorder with psychiatric disorder: An overview. *Journal of Clinical Psychiatry, 59*(Suppl. 7), 50–58.
- Posner, K., Melvin, G. A., Murray, D. W., Gugga, S. S., Fisher, P., Skrobala, A., & Cunningham-VitielloAbikoffGhumanKollins, C. B. H. B. J. K. S. (2007). Clinical presentation of attention-deficit/hyperactivity disorder in preschool children: The Preschoolers with Attention-Deficit/

- Hyperactivity Disorder Treatment Study (PATS). *Journal of Child and Adolescent Psychopharmacology*, 17, 547–562. <https://doi.org/10.1089/cap.2007.0075>
- Pustejovsky, J. E., Chen, M., & Swan, D. M. (2021). Single-case effect size calculator (Version 0.5.2) [Web application]. Retrieved from <https://jepusto.shinyapps.io/SCD-effect-sizes/>
- Pyle, K., & Fabiano, G. A. (2017). Daily report card intervention and attention deficit hyperactivity disorder: A meta-analysis of single-case studies. *Exceptional Children*, 83(4), 378–395.
- Reid, R., Trout, A., & Schartz, M. (2005). Self-regulation interventions for children with attention deficit/hyperactivity disorder. *Exceptional Children*, 7(4), 361–377.
- Rohatgi, A. (2022). WebPlotDigitizer (Version 4.6) [Computer software]. Retrieved from <http://aroha.tgi.info/WebPlotDigitizer>
- Roberts, G., Rane, S., Fall, A.-M., Denton, C. A., Fletcher, J. M., & Vaughn, S. (2015). The impact of intensive reading intervention on level of attention in middle school students. *Journal of Clinical Child & Adolescent Psychology*, 44(6), 942–953.
- Roberts, G. J., Cho, E., Garwood, J. D., Goble, G. H., Robertson, T., & Hodges, A. (2020). Reading interventions for students with reading and behavioral difficulties: A meta-analysis and evaluation of co-occurring difficulties. *Educational Psychology Review*, 32, 17–47.
- Roberts, G. J., Vaughn, S., Roberts, G., & Miciak, J. (2021). Problem behaviors and response to reading intervention for upper elementary students with reading difficulties. *Remedial and Special Education*, 42, 169–181.
- Sexton, C. C., Gelhorn, H., Bell, J., & Classi, P. (2012). The co-occurrence of reading disorder and ADHD: Epidemiology, treatment, psychosocial impact, and economic burden. *Journal of Learning Disabilities*, 45(6), 538–564. <https://doi.org/10.1177/0022219411407772>
- *Schmitt, A. J., McCallum, E., Hale, A. D., Obeldobel, E., & Dingus, K. (2009). Can text-to-speech assistive technology improve the reading comprehension of students with severe reading and emotional disabilities? *Journal of Evidence-Based Practices for Schools*, 10(2), 95–115.
- *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 and Treatment of Children*, 22(4), 397–414.
- *Stahr, B., Cushing, D., Lane, K., & Fox, J. (2006). Efficacy of a function-based intervention in decreasing off-task behavior exhibited by a student with ADHD. *Journal of Positive Behavior Interventions*, 8(4), 201–211.
- Stewart, A. A., & Austin, C. R. (2020). Reading interventions for students with or at risk of attention-deficit/hyperactivity disorder: A systematic review. *Remedial and Special Education*, 41(6), 352–367.
- Tamm, L., Denton, C. A., Epstein, J. N., Schatschneider, C., Taylor, H., Arnold, L. E., Bukstein, O., Anixt, J., Koshy, A., Newman, N. C., Maltinsky, J., Brinson, P., Loren, R. E. A., Prasad, M. R., Ewing-Cobbs, L., & Vaughn, A. (2017). Comparing treatments for children with ADHD and word reading difficulties: A randomized clinical trial. *Journal of Consulting and Clinical Psychology*, 85(5), 434–446.
- Vannest, K. J., & Ninci, J. (2015). Evaluating intervention effects in single-case research designs. *Journal of Counseling & Development*, 93(4), 403–411.
- Wei, X., Yu, J. W., & Shaver, D. (2014). Longitudinal effects of ADHD in children with learning disabilities or emotional disturbances. *Exceptional Children*, 80(2), 205–219.
- 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 and Treatment of Children*, 36, 147–167.
- Wilens, T. E., Biederman, J., Brown, S., Tanguay, S., Monuteaux, M. C., Blake, C., & Spencer, T. J. (2002). Psychiatric comorbidity and functioning in clinically referred preschool children and school-age youths with ADHD. *Journal of the American Academy of Child & Adolescent Psychiatry*, 41(3), 262–268.
- Willcutt, E. G. (2012). The prevalence of DSM-IV attention-deficit/hyperactivity disorder: A meta-analytic review. *Neurotherapeutics*, 9(3), 490–499. <https://doi.org/10.1007/s13311-012-0135-8>
- Willcutt, E. G., Nigg, J. T., Pennington, B. F., Solanto, M. V., Rohde, L. A., Tannock, R., Loo, S. K., Carlson, C. L., McBurnett, K., & Lahey, B. B. (2012). Validity of DSM-IV attention deficit/hyperactivity disorder symptom dimensions and subtypes. *Journal of Abnormal Psychology*, 121(4), 991–1010. <https://doi.org/10.1037/a0027347>
- Willcutt, E. G., & Pennington, B. F. (2000). Psychiatric comorbidity in children and adolescents with reading disability. *The Journal of Child Psychology and Psychiatry and Allied Disciplines*, 41(8), 1039–1048.

Willcutt, E. G., Pennington, B. F., Olson, R. K., Chhabildas, N., & Hulslander, J. (2005). Neuropsychological analyses of comorbidity between reading disability and attention deficit hyperactivity disorder: In search of the common deficit (Comparative Study Research Support, U.S. Gov't, P.H.S.). *Developmental Neuropsychology*, 27(1), 35–78.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.

Authors and Affiliations

Garrett J. Roberts¹  · Esther R. Lindström² · Zaira Jimenez³ · Ekta Ghosh¹ · Senaida Mehmedovic¹ · Kimberly A. McFadden² · Mohammad Bahadori Fallah²

Esther R. Lindström
esther.lindstrom@lehigh.edu

Zaira Jimenez
zjime001@ucr.edu

Ekta Ghosh
ekta.ghosh@du.edu

Senaida Mehmedovic
Senaida.Mehmedovic@du.edu

Kimberly A. McFadden
kam421@lehigh.edu

Mohammad Bahadori Fallah
mob321@lehigh.edu

¹ Department of Teaching and Learning Sciences, Morgridge College of Education, The University of Denver, 1999 E. Evans Ave, Denver, CO 80210, USA

² Department of Education and Human Services, College of Education, Lehigh University, 111 Research Drive, Bethlehem, PA 18015, USA

³ School of Education, University of California Riverside, 1207 Sproul Hall, Riverside, CA 92521, USA