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A META-ANALYSIS OF ANTECEDENT EXERCISE ON CHILDREN'S CLASSROOM BEHAVIORS

by

Chelsea Johnson

A Thesis
Submitted to the Graduate School,
the College of Education and Human Sciences
and the School of Psychology
at The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Master of Arts

Approved by:

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December 2022

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2022

Published by the Graduate School

ABSTRACT

The purpose of the current study was to systematically review the literature investigating the effects of antecedent aerobic exercise on students with emotional and behavioral disorders. Eighteen studies met inclusion criteria, which included single case design studies and group studies, participant age, and an exercise intervention. Tau U was used as the procedure to calculate an effect size for A-B contrasts for single case design studies and effect size ranged from small to moderate for multiple variables such as disruptive behavior and academically engaged behavior. Hedges *g* was used to calculate an omnibus effect size for all single case design studies as well as group design studies and indicated a large, significant effect for AAE on student behavior. A moderator analysis was conducted for student age and length of exercise period, and neither was found to significantly moderate treatment effects. Limitations and future directions are provided.

ACKNOWLEDGMENTS

I would like to thank my committee chair, Dr. Brad Dufrene, for your supervision, assurance, and guidance throughout this project. Thank you to my committee members, Dr. Stephanie McCoy and Dr. Joe Olmi for your assistance and flexibility throughout this project. Thank you to Dr. Emily DeFouw for providing me with additional guidance. I would like to express my deepest gratitude to Caitlyn Weaver. I appreciate you more than you know for the time and effort you put in while guiding me through this entire project. I know that this endeavor would have not been possible without you. My gratitude is also expressed to Terreca Cato, Rebecca Lovelace, Abby Lawson, and Jordan Etherington for assistance with data collection. Finally, a special thanks to Terreca Cato and Rebecca Lovelace for the continued support and keeping my motivation high as well as our dedicated work times and meetings; we are forever locked in.

DEDICATION

I would like to dedicate this project to family and friends with whom I would have not made it to this point in life without your consistent support and confidence in me. Specifically, to my Dad, Barry Johnson, I know you are so proud. I know you are not physically here to see it, but I am finally close to "taking a break on my homework" as you would always tell me to do. I will be Dr. Johnson one day, as you always called me. Thank you for the long and consistent phone calls, keep watching over me.

To my mother, Heather Johnson, and brothers, Dylan and Ethan Johnson, thank you for always being there for me throughout all my years of life consumed by school. Thank you for always telling me that it will pay off. Thank you to all my family for always believing in me and pushing me to the finish line. You all may not understand, but you always listen. A big thank you to all my dearest friends, Clea, Madison, Terreca, Kameron, Mina, and Rebecca. You all are the best support system I could ever have. In addition, the hugest thank you to Terreca Cato for being by my side since our first year in the program. I could not have done it without you as my sidekick. Thank you all for your continued support and dedication to ensure I make it to the finish line.

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LIST OF ABBREVIATIONS

AAE	Antecedent Aerobic Exercise
ADHD	Attention-Deficit/Hyperactivity Disorder
AO	Abolishing Operation
ASD	Autism Spectrum Disorder
CDC	Center for Disease Control and Prevention
EO	Establishing Operation
IOA	Interobserver Agreement
ODD	Oppositional Defiant Disorder
USM	The University of Southern Mississippi
WWC	What Works Clearinghouse

CHAPTER I - INTRODUCTION

The prevalence of child mental health concerns is steadily increasing and rose even more between 2010 and 2020 (American Academy of Pediatrics, 2021; CDC, 2020; Ghandour et al., 2020). Likewise, 13-20% of children experience a mental health disorder per year (Perou et al., 2013). Common emotional and behavioral disorders include attention-deficit/hyperactivity disorder (ADHD), conduct disorder, and oppositional defiant disorder (ODD). Disruptive behaviors, which are a characteristic of individuals with emotional and behavioral disorders, can be expressed as aggression, stealing, fighting, off-task behavior, and defiance toward peers and adults, as well as internalizing disorders (e.g., anxiety and depression) (Basile, 1993; Kazdin, 1987). Disruptive behaviors in youth are certainly concerning. There are many systemic factors that can contribute to youth exhibiting disruptive behaviors such as poverty, neglect, and drug use (Walker et al., 1998). Many students from low socioeconomic areas are also subject to violence which may be reflected in their behavior (Centers for Disease Control and Prevention, 2016). If these behaviors are not intervened with early, it can lead to more severe concerns such as school suspension and criminal activity (Sheehy-Skeffington, 2020). Additionally, there are a plethora of factors that can influence disruptive behaviors such as adverse childhood experiences (e.g., low socioeconomic status, poverty, abuse, harsh parenting) (Ibberson, 2017).

Disruptive behaviors in school settings can be challenging and frustrating for teachers as those behaviors impede student achievement while taxing administrators (Allday & Pakurar, 2007). Teacher frustration then leads to reactive and punitive measures. School personnel become inclined to implement office discipline referrals,

suspensions, and expulsions. Out of school suspension is the most widely used and growing reactive procedure in public schools (Hatten, 2020; Stevenson, 2020;); these punitive actions increase the risk of dropping out of school, incarceration, and unemployment in the future (Rosenbaum, 2020; Venus, 2020). Although many students with emotional and behavioral disorders engage in disruptive behavior due to systemic factors in their schools and communities, there are more environmental factors that may play a role in students with emotional and behavioral disorders exhibiting disruptive behaviors in schools.

Some children with emotional and behavioral disorders may experience physiological under-arousal. Under-arousal can be defined as a state of physiological deprivation (Folino et al., 2014) in which a student's physiological arousal is low. Individuals who engage in disruptive behavior could possibly do so as a means of increasing their arousal to a more preferred level (Folino et al., 2014). Individuals can increase their physiological arousal through a variety of activities such as heart rate which is a way in which physiological arousal can be measured. Thus, physiological under-arousal may provide the motivation for students to engage in disruptive behaviors. Consequently, antecedent interventions that increase physiological arousal may prevent disruptive behaviors.

From an applied behavioral analytic perspective, motivating operations are antecedent events that alter the value of stimuli that function as reinforcers, and thereby alter the current probability of behavior (Cooper, Heron, & Heward, 2020). There are two types of motivating operations, establishing operations, and abolishing operations. Establishing operations increase the value of a reinforcer and increase the current

probability of a response associated with that reinforcer. If an individual is food deprived, food is more reinforcing. So, food seeking behaviors are more likely to occur in that instance. Abolishing operations decrease the value of a reinforcer and decrease the current probability of a response associated with that reinforcer. If an individual has recently indulged in consuming a large amount of food, food is less reinforcing. Thus, food seeking behaviors would be less likely to occur (Cooper et al., 2020).

For a student that is physiologically under-roused, physiological under-arousal can be an establishing operation. Therefore, the student may engage in disruptive behaviors to obtain physiological arousal because arousal is more reinforcing at that moment. If exercise (e.g., an arousal activity) is implemented into a physiological under-aroused student's daily schedule, then physiological arousal is obtained via a more appropriate means; then, satiation for arousal may follow and disruptive behaviors will be less likely to occur. Per the theory of motivating operations, a low resting heart rate is a way to measure under-arousal and correlates with physiological under-arousal and is a characteristic of individuals who exhibit disruptive behaviors (Stadler et. al, 2008). Therefore, if an individual engages in activity that raises their heart rate (e.g., makes them aroused), they may be less likely to indulge in physiological arousal seeking behaviors.

Motivating operations can be directly linked to antecedent-based interventions. For example, if a student is attention deprived and motivated to access attention, then an antecedent intervention could include delivering attention on a fixed schedule so that the student is satiated for attention and thus less likely to engage in attention-seeking behaviors. Antecedent interventions may be preferred relative to consequent interventions for a variety of reasons such as they reduce the probability of the aberrant behavior from

occurring. Unfortunately, interventions that are consequence-based are commonly implemented to reduce the presence of disruptive behaviors in children with emotional and behavioral disorders such as ADHD and ODD. However, consequent-based interventions may require considerable effort in that educators must observe students engage in behavior and then deliver the appropriate consequence (Axelrod, 2017). In the instance of a positive reinforcement procedure, a teacher must observe a student engage in an appropriate behavior and then deliver the reinforcer; moreover, the reinforcer must be delivered on a schedule that will support sustained engagement in the behavior. For punishment, educators must observe the occurrence of the disruptive behavior and then deliver the punisher on an appropriate schedule to sufficiently suppress the behavior. Additionally, many punishment procedures are either illegal or not feasible in many settings such as schools which can also result in unintended outcomes (e.g., emotional, social, and motivational concerns) (Clarke et al., 1971).

An alternative to incorporating consequence-based interventions is exploring antecedent-based interventions (Axelrod, 2017; Luiselli, 2006). Antecedent-based interventions are an evidence-based practice used to address problem behaviors by modifying the environment (e.g., preferential seating, praise, time-in, and effective commands) to prevent or decrease the occurrence of maladaptive behaviors (Axelrod, 2017; Cooper et al., 2020). Antecedent-based interventions are thought to promote generalization of learned behaviors because they are not response dependent, and there are common stimuli across settings that can acquire discriminative properties (Axelrod, 2017; Cooper et al., 2020; Neitzel, 2009; Stokes & Baer, 1977). Antecedent-based interventions are more desirable because they have been shown to require less response

effort, appear less obtrusive, prevent disruptive behaviors, reduce office discipline referrals, and have higher acceptability with consumers (e.g., parents, teachers, and clients) when compared to consequence-based strategies (e.g., time-out, extinction, reprimands) (Allday & Pakurar, 2007; Allison et al., 1995; Axelrod, 2017; Cooper et al., 2020). A variety of antecedent-based strategies have been used in schools. Pre-corrections, or pre-teaching behavioral expectations, have been found to effectively prevent disruptive behavior (De Pry & Sugai, 2022; LeGray, Dufrene, Mercer, Olmi, & Sterling, 2013; Stormont, Smith, & Lewis, 2007). Picture schedules have been demonstrated effective for preventing disruptive behaviors by students with ASD during transitions (Reis, 2018; Schreibman, Whalen, & Stahmer, 2000). Finally, altering academic tasks by interspersing known and unknown items has been found to reduce disruptive behavior and increase on-task behavior (Calderhead, Filter, & Albin, 2006; Hulac & Benson, 2011).

Previous Meta-Analyses and Reviews of AAE

Researchers have conducted a variety of individual studies testing AAE interventions for improving students' behavior. Haverkamp and colleagues (2020) conducted a meta-analysis of physical activity interventions on cognitive outcomes and academic performance in adolescents and young adults. The researchers investigated the impact of acute and chronic physical activity interventions. An acute physical activity intervention indicated a single bout of physical activity, whereas chronic physical activity referred to repeated bouts of physical activity (Haverkamp et al., 2020). Effect sizes for both acute and chronic physical activity studies were reported as Hedge's *g* and Cohen's *d*. The results indicated that acute physical activity had a moderate impact on participants

cognitive outcomes (g = .31, p = <.001) and similar effects for the core domains of cognitive outcomes (processing speed, attention, and executive functions); however, there were no effects on cognitive flexibility (g = .372, p = .050) and working memory (g = .140, p = .264) (Haverkamp et al., 2020). Chronic physical activity results indicated a moderate effect on cognitive outcomes (g = .36, p = <.001), a significant moderate effect for processing speed (g = .30, p = <.001), attention (g = .50, p = <.001), and executive functions (g = .35, p = <.001), and a large effect for working memory (g = .59, p = <.001) (Haverkamp et al., 2020). Moderator analyses were conducted for both acute and chronic physical activity intervention studies. Attention, cognitive flexibility, working memory, and inhibition were analyzed for acute physical activity, and only attention and working memory were analyzed for chronic physical activity. Moderators analyzed included age, gender, duration of physical activity, intensity of physical activity, and dosage (e.g., minutes per week). For acute physical activity, interventions of longer duration were inversely related to the impact on attention (β = -.021, p = .006) and cognitive flexibility (β = -.036, p = .012). Likewise, chronic physical activity impacted the outcome of attention whereas age, percentage of boys in the study, and intensity did not (Haverkamp et al., 2020). Regarding chronic physical activity interventions, the percentage of boys impacted the effects of attention and working memory whereas age, duration, and frequency did not impact attention. When analyzing the impact of moderators on working memory, moderators did not impact the results, or there was a low number of studies which did not allow for calculation (Haverkamp et al., 2020).

Haverkamp et al. (2020) found an overall positive effect of both acute and chronic physical activity on adolescents and young adults when assessing the cognitive and

academic performance outcomes. Additionally, when analyzing the impact on cognitive domain outcomes, acute interventions with shorter bouts of exercise were more effective than longer bouts of exercise. Although acute physical activity produced effects, Haverkamp et al. (2020) reported that chronic physical activity (e.g., repeated bouts of exercise) produced larger effect sizes on cognitive outcomes. The results of Haverkamp et al. (2020) indicated that the implementation of acute or chronic physical activity can influence specific components of adolescents and young adults' cognitive performance.

Although the current meta-analysis does not specifically analyze studies with participants diagnosed with an intellectual disability and only school-aged children, it is important to note the impact of exercise on individuals with intellectual disabilities. Ogg-Groenendaal, Hermans, and Claessens' (2014) systematic review analyzed the effects of exercise on challenging behavior in individuals with intellectual disabilities. Studies included were analyzed for the methodological quality, which included the following criteria: number of participants, presence of a control group, follow-up measurement after more than 1 week, and completeness of data presentation (Ogg-Groenendaal et al., 2014). Additionally, the impact of low and high intensity exercise interventions was analyzed which provided overall mean improvement scores in percentages. Using a bootstrapping method (e.g., statistical method for estimating quantities), the results of the study indicated that exercise led to a decrease in challenging behavior (M = 30.9%); however, there were no significant differences between high and low intensity exercise interventions (Ogg-Groenendaal et al., 2014). The review also assessed the effects of exercise on specific categories of challenging behavior which indicated a mean improvement score of 44.4% for total challenging behavior (M = 44.4), 40.6% for

stereotypical behavior (*M* = 40.6), 16.4% for aggressive and destructive behaviors (*M* = 16.4), 23.1% for self-injurious behavior (*M* = 23.1), 8.2% for hyperactivity (*M* = 8.2), and 55.9% for behaviors classified as other (*M* = 55.9) (Ogg-Groenendaal et al., 2014). While this review supports the use of exercise for decreasing challenging behaviors, Ogg-Groenendaal et al. (2014) state that results should be interpreted with caution due to low methodological quality of included studies. Taken together, Haverkamp et al. (2020) and Ogg-Groenendaal et a. (2014) demonstrated, via meta-analyses, that AAE can be effective for improving students' cognitive outcomes as well as reducing challenging behaviors. However, those meta-analyses did not include students with emotional and behavioral disorders in school settings.

Regarding the use of students with emotional and behavioral disorders in school settings, Allison, Faith, and Franklin (1995) conducted a meta-analysis of AAE studies that targeted students' disruptive behaviors. Effect sizes were reported for group and single-case design studies. Effect sizes for the group designs were reported as Cohen's *d* and converted to Hedges *g* and Olkin's *d* (Allison et al., 1995). Group studies included both within and between group designs. The effect sizes for single-case design studies were reported as *d*. The single-case design studies included a variety of designs such as a multiple baseline, extended ABA design, reversal design, and alternating treatment. The results of Allison et al. (1995) meta-analysis determined that in 26 of the single case design studies, 22 depicted positive results, 1 had no effect, and 3 produced negative results (*d* = 1.99, *SE* = 0.4). For group design studies, 12 indicated positive results, and 4 produced negative results (*d* = .33; *SE* = .08) (Allison et al., 1995). Additionally, a moderator analysis was conducted to determine the extent to which age, developmental

status, duration of exercise, type of exercise (aerobic or nonaerobic), type of measurement (direct behavioral observations and other methods), total number of sessions, total weeks of treatment, and the general methodological quality altered treatment effects. For the single case design studies, the moderator analysis did not detect any statistically significant moderators. The moderator analysis for group design studies indicated that studies incorporating direct observations, participants with hyperactive symptoms, and a nonaerobic exercise intervention (e.g., weightlifting, sprinting, jumping) moderated treatment effects and were associated with stronger effects. Moreover, Allison et al. found that studies with greater methodological rigor resulted in weaker effects.

Allison et al. (1995) found an overall strong effect for AAE interventions for reducing students' disruptive behaviors. Allison et al. (1995) recommended that future AAE studies increase the methodological rigor of AAE intervention studies by including additional observation data points, reliability checks on the dependent variable, regular treatment integrity checks on the independent variable, appropriate control groups or conditions incorporating attention placebos, assessment of the social validity of treatment outcomes, blinding as many persons as possible (e.g., data collectors, staff, parents, clients) to experimental conditions and hypotheses (Allison et al., 1995).

Although the Allison et al. (1995) study provides some important contributions to the literature, there were some limitations that should be addressed in future systematic reviews and meta-analyses. First, Cohens *d* was used as the effect size for the single case design studies, which is not appropriate for single case designs with repeated measurement due to autocorrelation and serial dependence. Second, Allison et al. included a review of methodological rigor based on a checklist that included the

following items: indication of blind raters, inter-reliability assessed for dependent variables, and a record of treatment integrity and social validity. Since that time, there is a greater consensus regarding a framework for systematically reviewing design rigor with the What Works Clearinghouse (WWC) standards being the most widely accepted standards for evaluating methodological rigor of single case design studies (Kratochwill et al., 2010). Overall, the previously discussed studies provide a review regarding the impact of exercise on individuals with emotional and behavioral disorders including those diagnosed with an intellectual disability. The studies exuded that implementing exercise can improve cognitive outcomes and reduce challenging and disruptive behaviors (Allison et al., 1995; Haverkamp et al., 2020; Ogg-Groenendaal et al., 2014).

Purpose of the Current Study

In regard to systematic reviews and meta-analyses of AAE studies with students with emotional and behavioral disorders, there is a paucity of research. To date, there was only one identified meta-analysis (Allison et al., 1995) of AAE for students with emotional and behavior disorders. Then, a review evaluating the effects of physical activity on challenging behaviors with individuals diagnosed with an intellectual disability (Ogg-Groenendaal et al., 2014) and another meta-analysis analyzing the effect of physical activity on cognitive and academic performance (Haverkamp et al., 2020). Moreover, the Allision et al. (1995) review was conducted in 1995, and there have been additional published studies since 1995 examining the effect of antecedent exercise on disruptive behaviors that have not been analyzed. Lastly, Allison et al. (1995) used Cohens *d* as an effect size for single case design studies, which is not appropriate for those designs (Hedges et al., 2012). Thus, the purpose of the current study is to conduct a

meta-analysis of the AAE literature base in order to address the aforementioned factors and determine the effect of AAE on children with emotional and behavioral disorders. The following research questions will be evaluated:

Research Question 1: What is the effect of AAE interventions on the disruptive and appropriate behaviors of students' with emotional and behavioral disorders?

Research Question 2: What are the characteristics of components of AAE interventions that have been tested with students with emotional and behavioral disorders?

Research Question 3: If social validity data were collected, how did participants' and other individuals perceive the antecedent exercise intervention?

Research Question 4: Do students' grade and length of AAE moderate treatment effects?

CHAPTER II - METHOD

Literature Search

Search Process

To locate articles for the study, a search was conducted using the APA PSYCHinfo, APA PsychArticles, and ERIC databases (last searched 5/18/2022). The following search terms were used in each database: the first line: “Antecedent exercis*”; “behavior*” on the second line. Then, the following terms were used in a second search: in the first line, “aerobic exercis*”; on the second line, “behavior*”; on the third line, “school”. The first, second, and third lines were connected by the “AND” Boolean operant.

Article Identification

Initial Literature Search. Appendix A illustrates the search process. The initial search generated 316 articles. After duplicates were removed, 293 articles remained.

Abstract & Title Review. The remaining 293 articles were screened via abstract and title review by the primary researcher. If it was clear that the articles did not include participants in grades K-12 or an exercise intervention, the article was excluded. After completing this review, 240 articles were removed with 53 articles included for the next review.

Full-Text Review. The remaining 53 articles were included in the full-text review. During the full-text review, the article needed to meet the following inclusion criteria: a) implemented an antecedent exercise intervention, b) participants were students in grades K-12, c) research included original data collection or archival data for a single study (i.e., not a book or systematic review/meta-analysis/literature review), d) study included an

experimental single case design or an experimental group design with a control group, and e) study must have evaluated student classroom behavior (e.g., appropriately engaged behavior, disruptive behavior). After this was completed, 18 articles were included (35 removed). Interobserver agreement (IOA) was completed for 16 of the 53 articles. Point by point agreement was used to calculate IOA (Cooper et al., 2020). Graduate student researchers served as additional data collectors for IOA. If researchers disagreed on a variable, the discrepancy was analyzed and brought to an agreement. IOA was 100% between both researchers after verbal discussion of variable discrepancies.

Duplicates removal and dissertation/review removal. Duplicate articles were removed. Additionally, if meta-analyses, systematic reviews, or books appeared, they were removed. A total of 23 duplicates were removed. A total of 7 articles were removed due to being systematic reviews, meta-analyses, or a book.

Excluded Articles. Multiple articles were excluded during specific phases of the study such as data extraction due to the inability to extract data paths, but were still included in additional coding. For instance, four articles were excluded for specific calculations due to not meeting inclusion rules of the calculation (e.g., fewer participants than required for analyses). See respective areas (e.g., Hedge's *g*) for excluded articles. Lastly, there were a total of 18 articles included in the coding process, and articles were excluded in previous steps due to not meeting previously mentioned inclusion criteria.

Article Coding

Each article included was coded for several specific variables. The primary researcher utilized Excel to code variables from each article that passed the full-text review. A unique coding key was created for each item. For example, for grade of

participants, the primary researcher coded "1" for Preschool, "2" for Elementary School (K-5th), "3" for Middle School (6-8th), "4" for High School, or "999" for not specified. IOA was calculated to determine accuracy in coding variables. If graduate researchers disagreed on a variable, the discrepancy was analyzed and brought to an agreement. IOA was 100% between both researchers after discussion and agreement of variable discrepancies.

Participant, Intervention, and Exercise Treatment Variables

Participant Variables

For each article, the primary researcher coded the number of participants. Additionally, the primary researcher coded the participants' reported grade (e.g., preschool, elementary, middle, and high school), disability status (e.g., no disability, at-risk, and identified disability), gender (e.g., male, female, and unspecified), race, and ethnicity.

Intervention Variables

For each article, the primary researcher coded variables pertaining to the exercise intervention implemented. The variables coded were the type of intervention (name of intervention), type of dependent variable (disruptive behavior, prosocial behavior, appropriate behavior, academically engaged behavior, academic performance, and other), dependent variable measurement, implementer of intervention, setting, type of exercise, instructional setting (class-wide, small group, individual), treatment integrity, social validity/treatment acceptability, interobserver agreement, target academic instruction, and time of day the intervention occurred.

Exercise Treatment Variables

The primary researcher coded variables pertaining to specific components of the exercise intervention. The variables coded were heart rate measurement, exercise session length (in minutes), session frequency (number of sessions per day), and length of the exercise intervention (in weeks). Additionally, if these variables were reported, the primary researcher specified additional information for the variable. For example, if the heart rate measurement was reported, the primary researcher coded it as "1" and then specified what type of device the heart rate was collected with (e.g., Apple Watch).

Moderator Variables

Specific moderator variables were coded and used to analyze the impact on AAE. The participant's grade level and AAE exercise length were used as moderators. Grade level consisted of the following: preschool, elementary, middle, and high school. Exercise length consisted of the following: Only two moderators were analyzed due to the limited information included articles provided.

Data Extraction

Data were extracted from the single-case design studies. Data were extracted to calculate the effect sizes for each study. The WebPlotDigitizer (4.5) software program was used to extract the y-values for each data point on the graphs in 9 studies. A second data collector extracted data for 3 (33.33%) of the 9 included studies. During this stage, three articles were excluded due to inability to extract data points (e.g., unclear graphs and bar graphs), or no graphs provided (Heemskerk et al., 2020; Lee et al., 2018; Morrison et al., 2011). Proportional agreement IOA was used to calculate IOA for data

extraction (Cooper et al., 2020). Data points below 80% were discussed and reviewed to reestablish accuracy. IOA was calculated for 27.2% of the articles.

Effect Sizes

Baseline-Corrected Tau

Baseline-corrected Tau is a non-parametric effect size calculation that is amenable to single-case design studies. Baseline-corrected Tau can be used to test for a significant baseline trend, and if a significant baseline trend is detected, then the baseline trend can be corrected. Baseline-corrected Tau was used to assess effect size (Tarlow, 2017) for all adjacent phases for each participant in each study. The effect size calculation integrates both overlap of data points between phases and any baseline trend. Effect sizes between zero and one are interpreted as a positive effect of the intervention on the participants behavior. Additionally, values that are closer to 1 will demonstrate a stronger effect relative to values closer to zero. A Tau value of less than 0.2 is a small effect, a moderate effect includes values between 0.2 and 0.6, a large effect includes values between 0.6 and 0.8, and values greater than 0.8 are very large (Vannest & Ninci, 2015). One limitation of Baseline-corrected Tau is that a weighted effect size, or omnibus effect, cannot be calculated.

Hedge's g

Hedge's *g* is an effect size measure that is amenable to single-case design studies, is part of the standardized mean difference family of effect sizes, and can be used to calculate an omnibus effect for a group of single-case design studies (Pustejovsky & Ferron, 2017). Pustejovsky and Ferron (2017) indicated that in order to calculate Hedge's *g*, studies need to have at least three participants. Based on this, data from 4 studies were

excluded from the Hedges *g* calculation (Celiberti et al., 1997; Chazin et al., 2018; Neely et al., 2015; Powers et al., 1992). Also, one study (Bachman & Fuqua, 1984) was excluded due to inability to extract the data paths due to the graph sequence being unclear. An additional three studies were excluded due to inability to extract data points from the provided bar graph (Heemskerk et al., 2020; Lee et al., 2018) and the absence of a graph with baseline to intervention data (Morrison et al., 2011). There were 4 out of 7 group design studies (Bowling et al., 2017; MacMahon & Gross, 1987; Pontifex et al., 2013; van den Berg et al., 2019) excluded in the effect size calculation due to the absence of a graph or a chart with mean and standard deviation data. Furthermore, Hedge's *g* values may be interpreted in a manner similar to Cohen's *d* in which a value of .2 is a small effect, 5 is considered a medium effect, and a value or .8 is considered a large effect (Cohen, 1992).

Data Analysis

Tarlow's (2016) online calculator (https://ktarlow.com/stats/tau/) was used to calculate baseline corrected Tau values. For each adjacent phase, an effect size was also calculated. In the R studio, Hedge's *g* was computed by downloading the *dmetar* package to the data base (Harrer, Caijpers, Furukawa, & Ebert, 2019). The mean and standard deviation were calculated in Excel for each phase with raw data.

CHAPTER III RESULTS

Eighteen studies with a total of 1,080 participants were included in the study. The studies were published in the following journals: Frontiers in Psychology (k=1), Behavioral Residential Treatment (k=1), The Journal of Pediatrics (k=1), Behavior Modification (k=1), Journal of Applied Behavior Analysis (k=2), Journal of Developmental and Behavioral Pediatrics (k=1), Behavioral Disorder (k=1), Journal of Developmental and Behavioral Disabilities (k=1), Journal of Abnormal Psychology (k=1), Journal of Science and Medicine in Sport (k=1), Early Childhood Education Journal (k=1), Journal of School Psychology (k=1), Remedial and Special Education (k=1), Research in Developmental Disabilities (k=1), Journal of Positive Behavior Interventions (k=1), Pediatrics (k=1), and Behavioral Interventions (k=1). Studies included in the present meta-analysis were published between 1982 and 2022. The articles included 11 different types of single case designs and included withdrawal designs (k=3), alternating treatment designs (k=7), and a multiple baseline design (k=1). Seven articles other studies were experimental group designs with a control condition.

Table 1 *Publication by Journal*

Journal	k
Frontiers in Psychology	1
Behavioral Residential Treatment	1
The Journal of Pediatrics	1
Behavior Modification	1
Journal of Applied Behavior Analysis	2
Journal of Developmental and Behavioral Pediatrics	1
Behavioral Disorder	1
Journal of Developmental and Behavioral Disabilities	1
Journal of Abnormal Psychology	1
Journal of Science and Medicine in Sport	1
Early Childhood Education Journal	1
Journal of School Psychology	1
Remedial and Special Education	1
Research in Developmental Disabilities	1
Journal of Positive Behavior Interventions	1
Pediatrics	1
Behavioral Interventions	1

Eight out of the 16 included studies reported race, and 47 participants identified as African American, 219 identified as Caucasian, 5 identified as Asian, and 9 identified as Multiracial. Zero studies included participants' ethnicity. Sixteen out of 18 studies included participant gender, 342 identified as male and 125 as female. One study included preschool participants, 15 studies included elementary participants, 5 studies included middle school students, and 3 studies included high school students. Some studies included a mixture of grades such as elementary, middle, and high school participants (Bachman & Fuqua, 1983; Bowling et al., 2017). The participants received the intervention in a variety of settings including general education classroom (n=720), gymnasium (n=208), playground (n=60), separate room (n=7), and other/variety (n=9). Likewise, participants received the intervention from a variety of implementers, including teachers (n=675), paraprofessionals (n=5), and researcher/investigators (n=276). The intervention was delivered in multiple formats. Five studies implemented the intervention

class wide. Five studies implemented the intervention in small groups. Eight studies implemented the intervention individually.

Table 2 *Demographic Information*

Demographic Variable		N
Race	African American	47
	Caucasian	219
	Asian	5
	Multiracial	9
	Other	0
Ethnicity	Latinx	0
	Not Latinx	0
	Not Specified	0
Gender	Female	125
	Male	342
	Other	0
Grade	Preschool	1
	Elementary (K-5th)	15
	Middle School (6th-8th)	5
	High School (9th–12th)	3

Social Validity

Across 18 studies, only 3 reported teacher social validity data. Losinski and colleagues (2017) reported that teachers and others associated with the antecedent exercise intervention rated the intervention as acceptable and effective for reducing stereotypical behaviors. Lee et al. (2016) reported that all teachers indicated that the physical activity intervention was a favorable, appropriate, and an effective way to target behaviors. Chazin and colleagues (2015) used blind raters to complete social validity questions pertaining to the participants behaviors. One participants rater indicated the participant was engaging in slightly more appropriate behavior when observing the exercise condition compared to the control condition. The second participants' raters

indicated no clear differences in behavior. Moreover, the small number of studies reporting social validity data (16.6%) indicates that it is imperative for future studies to assess acceptability and feasibility of the AAE intervention.

Effect Size Calculations

Tau was calculated for 115 A-B contrasts (e.g., baseline to intervention). Tests for a significant baseline trend were conducted for all A-B comparisons, and significant baseline trends were discovered for 3 of the 8 studies including single case designs. When there was a significant baseline trend, it was corrected using the Tarlow (2016) calculator. Tau U values ranged from -.452 to .812. Twenty-six phase contrasts resulted in small effects, 44 phase contrasts resulted in moderate effects, 43 phase contrasts resulted in large effects, and 2 phase contrasts resulted in extra-large effects. The Hedge's *g* value for all included studies was .7349, $p<.001$, indicating a large effect of AAE. See Appendix C.

Moderator Analysis

Moderator analyses were conducted to determine the moderating effects of grade level and length of AAE session on participants' outcomes (e.g., included at least three participants'). Hedge's *g* was used to evaluate if grade and length of AAE moderated the effect of AAE.

Table 3 *Effect Size Results for Moderator Variables*

Moderator	*k* (studies)	Hedge's *g*	95% Confidence Interval	
			Lower Limit	Upper Limit
Grade	4	1.0671	.2903	1.8439
Exercise Length	4	1.0672	.2911	1.8432

Grade

Out of 4 studies, two included elementary, one included middle school, and one included high school participants. There was no significant effect for grade as a moderator ($p = 0.4895$).

Exercise Length

Exercise length of AAE was used as a moderator to determine the impact of exercise length on the effects of AAE. There was no significant effect for exercise length on AAE outcomes ($p = 0.4868$).

CHAPTER IV DISCUSSION

To date, there has only been one systematic review of the AAE literature that included students with emotional and behavior disorders. Allison et al. (1995) conducted a meta-analysis of the AAE literature that included a wide range of participants with the majority of studies including children engaging in disruptive behaviors and those diagnosed with emotional and behavioral disorders. Other systematic reviews (Ogg-Groenendaal et al., 2014) have focused on research testing exercise on the behavior of individuals with developmental disabilities (e.g., Intellectual Disability, Autism Spectrum Disorder). This study extends the AAE literature by including a meta-analysis of AAE studies that have been conducted since the Alison et al. (1995) meta-analysis and includes more contemporary effect size calculations for single case design studies.

In regard to the first research question which addressed the effect of AAE on students with emotional and behavioral disorders disruptive and appropriate behaviors, results were statistically significant ($p = <.05$). Therefore, this indicates that behaviors potentially decreased (e.g., disruptive behaviors) or increased (e.g., on-task behavior) due to the implementation AAE. Likewise, an omnibus effect size was calculated for single case and group design studies which resulted in a value of .7349, showing that AAE is beneficial for decreasing problem behaviors. Eighty-seven phase contrasts resulted in a moderate to large effect (44 moderate and 43 large) showing that the implementation of AAE impacted student behavior.

The second research question addressed the characteristics of AAE interventions for students with emotional and behavioral disorders. Results from this study indicated that participants spent on average 16.93 minutes engaging in the AAE intervention. AAE intervention lengths ranged from 6 minute to 39.5 minutes. However, Cannella-Malone et al. (2011) implemented one 20-minute AAE session in the morning time and implemented eight 1–5-minute AAE breaks throughout the school day. Thus, it would be beneficial to conduct studies that have a variety of exercise length times to determine the needed amount to produce positive outcomes. Additional AAE intervention characteristics varied for each included study. Included studies implemented the AAE intervention in settings such as outdoors, resource rooms, and general education classrooms. The AAE intervention was implemented class-wide, individually, and in small group settings. The variety in implementation delivery is beneficial because it means that AAE intervention can be implemented in a flexible manner (e.g., class-wide, individually, and small groups). In regard to the time of day the intervention occurred, included studies reported that the AAE intervention was implemented in the morning, midday, and one study implemented the intervention multiple times during the day. Likewise, the frequency of the AAE intervention was consistent throughout the included studies (e.g., 1 time per day). However, Cannella-Malone et al. (2011) delivered the AAE intervention once in the morning and 7 additional times throughout the day.

The third research question addressed the social validity of AAE interventions for students with emotional and behavioral disorders. Results from this study indicated that 3 out of 18 studies collected social validity data. The AAE intervention was reported to be favorable, appropriate, effective (Chazin et al., 2015; Lee et al., 2016) and acceptable

(Losinski et al., 2017). Therefore, 15 out of the 18 studies did not include social validity data which was consistent with Allison et al. (1995) results.

The fourth research question addressed the moderating effects of students' grade and length of exercise period on students' outcomes. Results from this study indicated that both grade and length of exercise did not influence the effect of AAE. These findings are consistent with Allison and colleagues' (1995) meta-analysis, grade and exercise length moderators did not explain variance in AAE outcomes. Allison et al. (1995) meta-analysis used exercise length, and age as moderators and found no significant effects. Likewise, other moderators analyzed were developmental status, type of exercise, type of measurement, total number of sessions, total weeks of treatment, and general methodological quality and found no significant results (Allision et al., 1995). The impact of the length of exercise moderator could have not been significant due to the fact that studies were excluded from the moderator analysis. Thus, making the range for the length of exercise small. Moreover, in 2018, the Physical Activity Guidelines Advisory Committee published a systematic review providing details regarding physical activity recommendations for Americans. Specifically, the report signified that children and adolescents between the ages of 6-17 years should engage in at least 60-minutes or more of exercise per day, 3 days a week (e.g., moderate, or vigorous intensity) (Piercy et al., 2018). Likewise, the report stated that children and adolescents who engage in the recommended dose of exercise show improvements in executive function, processing speed, attention, and improved cognition (Piercy et al., 2018). The report also provided details on what type of physical activity movements children and adolescents should engage in. However, studies included in this review did not meet the recorded physical

activity guidelines and participants did not engage in the recommended activities. Thus, it is important to understand that the results could potentially improve if participants engaged in the recommended dose of physical activity. Likewise, the exercises participants completed were not engaging (e.g., fun). Future studies should incorporate exercises that peak child interest such as playing games that include throwing a ball, active games such as chasing, jumping rope, vigorous dancing, swimming, and other vigorous activities (Piercy et al., 2018).

In addition to findings related to research questions, there are other important findings from this study. First, many of the published studies do not provide detailed participant demographics which was consistent with Allison et al. (1995) meta-analysis results. Specifically, none of the included studies reported ethnicity for participants. Few to no studies reported detailed information regarding participants disability status. Although some studies indicated if the students were at-risk or were diagnosed with a disability, the disability was not specified. This is important because it does not allow researchers to specify who AAE is effective for when regarding ethnicity and disability status and type. Future research must provide complete demographic data for participants so researchers and applied professionals can better understand for AAE is effective. Moreover, the studies did not include detailed information regarding the setting studies were conducted in, which limits our understanding of the settings in which AAE can be expected to be effective.

Additionally, limited studies collected social validity data. The lack of social validity data does not allow researchers to determine feasibility, acceptability, and social importance of procedures and outcomes. Limited to no studies indicated or included

interobserver agreement data (IOA), as a result, methodological rigor is lacking, and results can be deemed questionable. Lastly, Folino et al. (2014) was the only study that investigated the temporal effects of the AAE intervention. The results of the study indicated that the positive effects (e.g., decrease in disruptive behavior) of the AAE intervention decreased after specific amounts of time (e.g., 60-minutes post intervention). The temporal effects are essential because it will allow researchers to establish how long the impact of AAE are maintained throughout the school day.

Limitations

This study includes some limitations that should be considered when evaluating findings. First, this meta-analysis included a relatively small number of studies, which can create problems for analyzing the findings and can limit the generality of findings. The smaller the number of studies and participants results in the less researchers are able to indicate who the AAE intervention benefits. Likewise, due to the small number of studies, less is known about the conditions under which AAE is effective.

Second, this study did not include grey literature, which can increase susceptibility to publication bias. Grey literature refers to studies that were not published, such as unpublished theses and dissertations. This is indicated as a limitation because if these studies were included, it could have altered the overall results of the current study. Therefore, since grey literature was not included it is possible that the benefits of the AAE intervention could have been over or overestimated. Hence, the susceptibility to publication bias. Another limitation is that not only did limited studies provide social validity data, but the measures and instruments used were not valid. The studies provided unknown methods and instruments for social validity that lacked technical adequacy.

Thus, this limits researchers on determining if consumers value the AAE intervention. Finally, though IOA was completed for multiple steps, it was not conducted for the search and identification process for the included process. As a result, there may be concerns about the comprehensiveness of studies included.

Summary and Future Directions

There are multiple areas of AAE that should be further investigated. First, there are few studies implementing AAE on emotional and behavioral disorders. Also, limited studies provided detailed participant and setting demographics. The inclusion of these variables will permit researchers to indicate and clarify which population the AAE intervention benefits. Also, the inclusion of the detailed setting demographics will allow researchers to indicate which setting the AAE intervention can be effective for. Future studies should also indicate if participants have a diagnoses disability to determine which individuals the AAE intervention is most successful with (e.g., children diagnosed with ADHD).

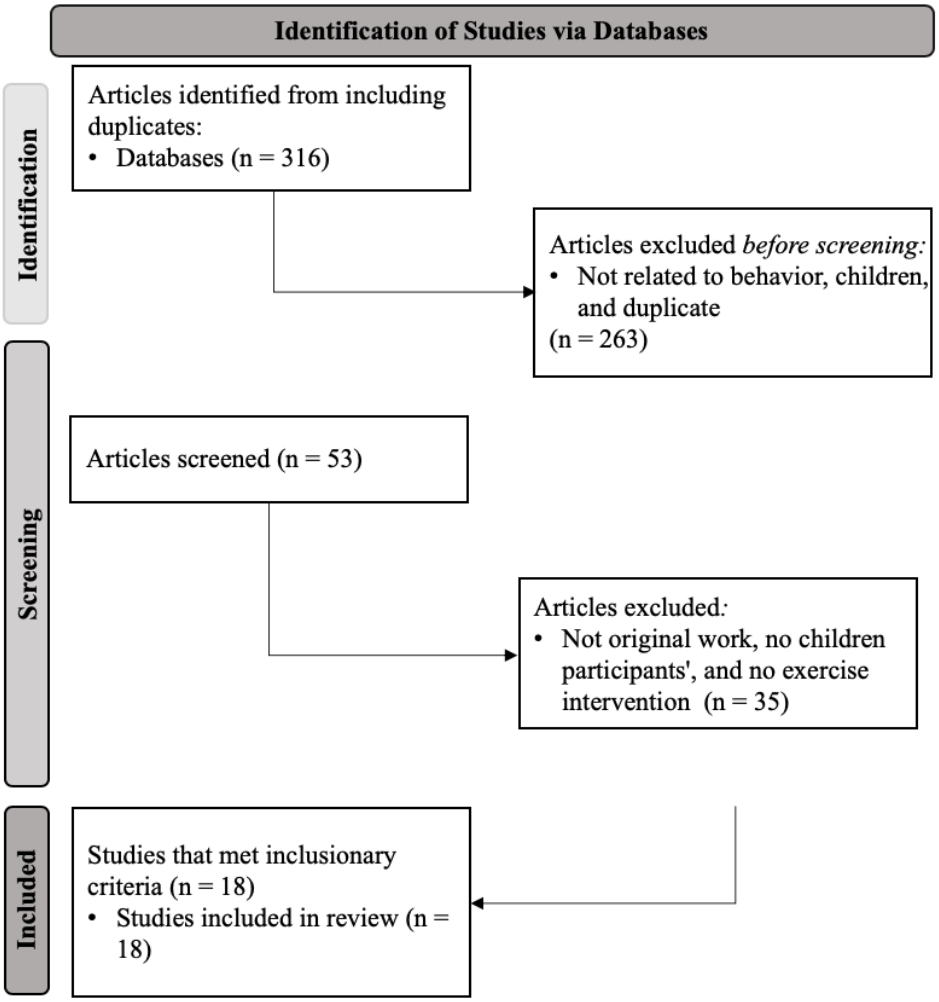
In regard to AAE intervention characteristics, future studies would benefit from indicating the exact length of exercise time, frequency of exercise, duration of intervention (e.g., weeks, months, days). The inclusion of these variables will allow researchers to determine the treatment intensity needed for the AAE intervention that can produce significant effects on participant behavior (e.g., 1 time per day for 15 minutes, 5 days a week). Likewise, in relation to Folino and colleagues (2014), future studies should investigate the temporal effects of AAE on students with emotional and behavioral disorders to better understand how long the effects last. Ensuring that future studies collect IOA with additional researchers and social validity data from participants' as well

as teachers (e.g., implementers) to determine the extent to which consumers value the implementation of AAE. Lastly, incorporating recommended physical activity guideline exercise length time (e.g., 60 minutes or more 3 days a week) and engaging exercises for children and adolescents.

Conclusions

The current meta-analysis investigated the literature testing effects of AAE on students with emotional and behavioral disorders. There are limited studies that have studied the implementation of AAE as an effective intervention. The overall omnibus effect in this study is large, indicating that AAE had large effects on behaviors. Although there were limited studies included in this meta-analysis showing the effectiveness of AAE, there are still many areas that must be explored.

APPENDIX A – Identification of Studies



APPENDIX B - Baseline-Corrected Tau per Phase Contrast by Dependent Variable

Study **Dependent Variable**	**Participant and Phase Contrast**	**Tau**	***p***	**SE**
Powers, Thibadeau, & Rose (1992)				
Self-Stimulation	Jake Contrast 1	-.563	.016	.302
	Jake Contrast 2	-.636	.001	.233
On-Task Behavior				
	Jake Contrast 1	.469	.045	.322
	Jake Contrast 2	.598	.001	.242
Neely et al. (2015)				
Stereotypy	Ally Contrast 1	.098	.784	.424
	Ally Contrast 2	-.745	.012	.298
	Ally Contrast 2	.452	.142	.399
	Chad Contrast 1	-.507	.095	.386
	Chad Contrast 2	-.745	.02	.314
	Chad Contrast 3	-.626	.037	.349
Academic Engagement				
	Ally Contrast 1	.739	.008	.287
	Ally Contrast 2	.745	.012	.298
	Ally Contrast 3	.745	.012	.298
	Chad Contrast 1	.507	.095	.386
	Chad Contrast 2	.745	.012	.298
	Chad Contrast 3	-.121	.753	.444
Losinkski et al. (2017)				
Stereotypy	Chad	-.351	.199	.382
	Samual	-.447	.144	.4
	Isaac	-.487	.11	.391
Engaged Behavior				
	Chad	-.082	.81	.407
	Samual	.03	1	.447
	Isaac	-.183	.594	.44
Harbin et al. (2021)				
Engagement (Circle Time)	Michael Contrast 1	.437	.104	.367
	Michael Contrast 2	.73	.014	.306
	Lucas Contrast 1	.739	.008	.287
	Lucas Contrast 2	.745	.012	.298
	Anna Contrast 1	.148	.648	.422
	Anna Contrast 2	-.03	1	.447
Engagement (Independent Time)	Michael Contrast 1	.51	.73	.367
	Michael Contrast 2	.745	.02	.314
	Lucas Contrast 1	.689	.014	.309
	Lucas Contrast 2	.626	.037	.349
	Anna Contrast 1	.542	.055	.358
	Anna Contrast 2	-.03	1	.447
Folino et al. (2014)				
Disruptive Behavior	Bobby (0-30 minutes)	-.664	.006	.283
	Bobby (30-60 minutes)	-.613	.011	.299

	Bobby (60-90 minutes)	-.581	.016	.308
	Bobby (90-120 minutes)	-.094	.739	.376
	Kyle (0-30 minutes)	-.707	.003	.267
	Kyle (30-60 minutes)	-.422	.083	.343
	Kyle (60-90 minutes)	-.707	.003	.267
	Kyle (90-120 minutes)	.016	1	.378
	Dan (0-30 minutes)	-.666	.004	.273
	Dan (30-60 minutes)	-.7	.003	.261
	Dan (60-90 minutes)	-.485	.037	.319
	Dan (90-120 minutes)	.166	.5	.36
	Tom (0-30 minutes)	-.563	.016	.302
	Tom (30-60 minutes)	-.56	.019	.303
	Tom (60-90 minutes)	-.28	.951	.365
	Tom (90-120 minutes)	.444	.057	.327
Prosocial Behavior	Bobby (0-30 minutes)	.604	.013	.301
	Bobby (30-60 minutes)	.463	.061	.335
	Bobby (60-90 minutes)	.407	.106	.345
	Bobby (90-120 minutes)	-.177	.502	.372
	Kyle (0-30 minutes)	.365	.141	.352
	Kyle (30-60 minutes)	.479	.052	.332
	Kyle (60-90 minutes)	.146	.591	.374
	Kyle (90-120 minutes)	.082	.787	.377
	Dan (0-30 minutes)	.622	.008	.286
	Dan (30-60 minutes)	.616	.008	.288
	Dan (60-90 minutes)	.316	.194	.346
	Dan (90-120 minutes)	-.144	.578	.361
	Tom (0-30 minutes)	.647	.006	.278
	Tom (30-60 minutes)	.418	.075	.332
	Tom (60-90 minutes)	.334	.158	.344
	Tom (90-120 minutes)	-.13	.62	.362
Compliance to Teacher Request	Bobby (0-30 minutes)	.33	.182	.357
	Bobby (30-60 minutes)	.598	.015	.303
	Bobby (60-90 minutes)	.397	.108	.347
	Bobby (90-120 minutes)	-.11	.689	.376
	Kyle (0-30 minutes)	.598	.015	.303
	Kyle (30-60 minutes)	.703	.003	.269
	Kyle (60-90 minutes)	.456	.062	.336
	Kyle (90-120 minutes)	.173	.505	.372
	Dan (0-30 minutes)	.662	.004	.274
	Dan (30-60 minutes)	.305	.198	.348
	Dan (60-90 minutes)	.193	.426	.358
	Dan (90-120 minutes)	.028	.951	.365
	Tom (0-30 minutes)	.607	.008	.29
	Tom (30-60 minutes)	.276	.245	.351
	Tom (60-90 minutes)	.333	.159	.344
	Tom (90-120 minutes)	-.279	.244	.351
Chazin et al. (2018)				
On-Task Behavior	Aaron Contrast 1	.802	.077	.345
	Beth Contrast 1	.707	.028	.333
	Beth Contrast 2	.258	.663	.558
Out of Seat Behavior	Aaron Contrast 1	-.775	.081	.365
	Beth Contrast 1	-.239	.517	.458

	Beth Contrast 2	-.445	.376	.517
Challenging Behavior	Aaron Contrast 1	-.43	.383	.521
	Beth Contrast 1	-.159	.697	.465
	Beth Contrast 2	.178	.827	.568
Celiberti et al. (1997)				
Physical Stereotypy	Mark Contrast 1	-.775	.081	.365
	Mark Contrast 2	0	1.227	.632
	Mark Contrast 3	-.775	.081	.365
	Mark Contrast 4	.258	.663	.558
Visual Self-Stimulation	Mark Contrast 1	-.258	.663	.558
	Mark Contrast 2	0	1.127	.632
	Mark Contrast 3	-.602	.19	.461
	Mark Contrast 4	-.086	1	.575
Out of Seat Behavior	Mark Contrast 1	-.775	.081	.365
	Mark Contrast 2	-.258	.773	.611
	Mark Contrast 3	-.602	.19	.461
	Mark Contrast 4	-.086	1	.575
Cannella-Malone et al. (2011)				
Challenging Behavior	William Contrast 1	-.628	.003	.252
	William Contrast 2	-.778	.018	.296
	William Contrast 3	-.683	.004	.258
	William Contrast 4	-.795	.048	.324
	Reece Contrast 1	-.772	0	.206
	Reece Contrast 2	-.755	.003	.248
	Reece Contrast 3	-.791	0	.199
	Reece Contrast 4	-.694	.014	.294
	Lonny Contrast 1	-.714	.001	.222
	Lonny Contrast 2	-.692	.001	.234
	Lonny Contrast 3	-.812	0	.162
	Lonny Contrast 4	-.597	.009	.275

APPENDIX C - Hedge's *g* by Study and Dependent Variable

Hedge's g

Study Dependent Variable	n (Contrasts)	Hedge's *g*	SE	95% Confidence Interval Lower	 Upper
Losinski et al. (2017)					
Stereotypy Behavior	3	.9775	.45344388	.0887	1.8662
Engaged Behavior	3	-.2532	.25721939	-0.7574	0.2509
Harbin et al. (2021)					
Engagement (Circle Time)	6	.9259	.53617347	-0.125	1.9768
Engagement (Independent Time)	6	1.0886	.41216837	.2807	1.8964
Folino et al. (2014)					
Disruptive Behavior (0-30)	16	1.8407	0.50176020	0.8572	2.8241
Disruptive Behavior (30-60)	16	1.4104	0.61428571	0.2064	2.6144
Disruptive Behavior (60-90)	16	1.2446	0.635	0.9845	3.4737
Disruptive Behavior (90-120)	16	.01877	0.27	-0.3415	0.7169
Prosocial Behavior (0-30)	16	1.3652	0.45056122	0.4821	2.2483
Prosocial Behavior (30-60)	16	1.0750	0.27239795	0.5411	1.6089
Prosocial Behavior (60-90)	16	.4612	0.27686224	-0.0815	1.0038
Prosocial Behavior (90-120)	16	-.4671	0.19081632	-0.8411	-0.0931
Compliance Teacher Request (0-30)	16	1.0042	0.48318877	0.0572	1.9513
Compliance Teacher Request (30-60)	16	1.2508	0.50594387	0.2591	2.2424
Compliance Teacher Request (60-90)	16	.5414	0.24979591	0.0518	1.031
Compliance Teacher Request (90-120)	16	-.2123	0.37599489	-0.9493	0.5246
Cannella-Malone et al. (2011)					
Challenging Behavior	12	6.8929	.69872449	5.5234	8.2624
Overall Effect	115	.7349	-	.5419	.9279

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