

Bethel University

Spark

All Electronic Theses and Dissertations

2022

Classroom Management Strategies That Prolong On-Task Behaviors and Increase Success for Special Education Students with ADHD

Renee A. Barstow
Bethel University

Follow this and additional works at: <https://spark.bethel.edu/etd>

Recommended Citation

Barstow, R. A. (2022). *Classroom Management Strategies That Prolong On-Task Behaviors and Increase Success for Special Education Students with ADHD* [Master's thesis, Bethel University]. Spark Repository. <https://spark.bethel.edu/etd/900>

This Master's thesis is brought to you for free and open access by Spark. It has been accepted for inclusion in All Electronic Theses and Dissertations by an authorized administrator of Spark. For more information, please contact kent-gerber@bethel.edu.

CLASSROOM MANAGEMENT STRATEGIES THAT PROLONG ON-TASK BEHAVIORS

AND INCREASE SUCCESS FOR SPECIAL EDUCATION STUDENTS WITH ADHD

A MASTER'S THESIS

SUBMITTED TO THE FACULTY

OF BETHEL UNIVERSITY

BY

RENEE A. BARSTOW

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

MASTER OF ARTS IN SPECIAL EDUCATION

DECEMBER 2022

BETHEL UNIVERSITY

CLASSROOM MANAGEMENT STRATEGIES THAT PROLONG ON-TASK BEHAVIORS
AND INCREASE SUCCESS FOR SPECIAL EDUCATION STUDENTS WITH ADHD

Renee A. Barstow

November 2022

APPROVED

Thesis Advisor: Michael Mignard, Ph.D.

Program Director: Katie Bonawitz, Ed. D.

Abstract

Attention Deficit Hyperactivity Disorder is one of the most common neurological disorders among youth, leading to symptoms of impulsivity, inattention, and cognitive processing differences when compared to same-age typically developing peers. Educators have long been challenged by finding ways to manage their classrooms while effectively benefiting the struggles students with ADHD face. The purpose of this literature review was divided into three separate goals: (1) to evaluate classroom management strategies and their effectiveness on ADHD symptoms, (2) to verify the affects that on-task/off-task behaviors have on academic outcomes, and (3) to investigate the negative and positive perceptions of students based on strategies and consequences. This review covers a broad scope of information that produces specific and encouraging results for educators of students with ADHD.

Table of Contents

Abstract	3
Table of Contents	4
Chapter I: Introduction	5
Chapter II: Literature Review	12
Literature Search Procedure	12
Evidence-Based Strategies: Effectiveness for ADHD	12
Comparison: Multi-Strategy Studies	13
Single Strategy Studies	22
Function-Based Interventions	22
Antecedent-Based Interventions	24
Self-Monitoring Interventions	28
Exploring Digital Cognitive Therapy	38
Inattention: Effects on Classroom Success	47
Comparison Studies: ADHD and Oppositional Defiant Disorder	48
Inattention: A Global Symptom of ADHD	52
Considering Inattention as a Whole and by Subtype	58
Perception of Strategies and Consequences	62
The Disability Label Stigma: Teacher Bias	62
Response, Reaction, and Reward	64
Positive Behavioral Interventions and Supports	72
Chapter III: Discussion and Conclusion	80
Summary of Literature	80
Professional Application	83
ADHD Culture	84
Limitations of Research	85
Implications for Further Research	86
Conclusion	88
References	90

CHAPTER I: INTRODUCTION

Attention Deficit Hyperactivity Disorder (ADHD) is defined by the Centers for Disease Control and Prevention (CDC) as a neurodevelopmental disorder, usually diagnosed in children that may produce symptoms of impulsivity, higher than usual levels of active energy, and difficulty of focus. As of 2015, a worldwide meta-analysis revealed that 7.2% of the global youth population has been diagnosed with ADHD (Children and Adults with Attention-Deficit/Hyperactivity Disorder [CHADD], (n.d.). As of 2019, 9.8% of children in the United States alone have been diagnosed with this disorder, and it is considered one of the most common neurological disorders among youth (CDC, 2021; Gallen et al., 2021).

Having ADHD does not automatically qualify a student for special education services; however, it is common for students with the diagnosis to qualify. Whether participating in a small setting for specialized instruction or part of a general education classroom, the symptoms of ADHD can often lead to a deficiency in learning, behavioral concerns, and affect life skills long term. Classroom Management Strategy (CMS) is an umbrella term for a variety of approaches and methods designed to help students improve and grow throughout their educational experience. There are a wide variety of factors that affect students' with ADHD abilities to focus and how it corresponds with individualized and generalized success in the classroom. Understanding these factors and implementing appropriate CMSs is critical in the future of education, not only for these unique learners, but for their peers and educators as well.

One factor that affects student success in the classroom is home life, such as patterns and communications. I have experienced it firsthand. In addition to writing this literature

review, I am a special educator, case manager, head of household, and parent of a child with ADHD. Close communication between educators and student families can build consistency across settings and make transitions easier for students with disabilities. Collaboration of professional and personal relationships to the student can lead to more successful CMS implementations and solutions.

Here is an example: I attended a meeting with my child's teachers to discuss her special education services and performance in the classroom. They stated they had been repeating instructions five or six times before she would engage in her assigned activities. Having similar experiences to this at home previously, I recommended they try the following steps: use her name, confirm eye contact, and then state the instructions. I explained that the first two steps were absolutely necessary if they wanted to be certain her mind was receiving the instruction. They found my feedback as a parent valuable because it proved to be highly successful by significantly triggering her on-task behaviors response. The problem was not an issue of non-compliance; the problem was that her focus was elsewhere. Identifying the problem became crucial in determining which strategy to use. Her teachers later reported that gaining her attention first took minimal time and effort and that she was engaging immediately upon receiving instructions. Although she still required occasional on-task reminders, her productivity in the classroom had increased.

My initial interest in writing a literature review related to ADHD started developing as a result of my child's diagnosis and qualifications for special education services. I found myself interchangeably applying my parental awareness with my knowledge as a special education teacher and case manager. I wondered how I would help my daughter's educational future

grow, and I questioned what more I could offer so she may thrive as an individual. As an educator, I felt pressure to have answers and to know what she needed. It wasn't until I witnessed these same concerns in a parent of a student on my caseload that I realized the potential impact of this research opportunity.

With only a few days remaining in the academic year, this student's mother contacted me upset that her daughter had received a behavior referral resulting in lunch detention. The referral was a result of a total of 5 incidents reported by her teacher - most of which were for being off-task and non-compliant to doing her work in class. Although I was the student's case manager, I did not have her in any of my own classes. Her mother was upset that her daughter was receiving disciplinary consequences. She stated that being off-task is a symptom of ADHD and her child should not be punished for it. She expressed that her daughter's teacher should find a way to help her students with special needs. I listened for a while and answered her questions. I was relieved to learn she was not seeking a final solution from me since the school year was ending; all she really wanted was to talk it through and feel heard.

That experience left me wondering what I would have told her if she had been seeking a solution. I realized in the upcoming year, her daughter would be a student in my classroom, and it would become my responsibility to implement effective CMSs for her. This, in addition to my own child's needs, secured my decision to concentrate my research on the needs of students with ADHD within the classroom setting.

In choosing my research topic, I had to decide if I was going to pick just one strategy or branch out and evaluate many. Each approach had advantages and disadvantages. By choosing just one strategy, I could have gained understanding in depth, leading to a more specialized

implementation when put into practice. I saw this as a risk, however. Neither humans nor disabilities fall into the *one size fits all* category, meaning that if this chosen strategy did not work for my focus student, or my daughter, I would end up back where I started. For this reason, I decided to broaden my scope and research several strategies. Although there would be limitations to the depth in which each could be researched, I felt more confident in having options for application. Therefore, I proceeded with the reasoning that finding a strategy that produces positive results will warrant more in-depth research at a later time.

With so many strategies to consider and endless possible outcomes for students with ADHD, the research reviewed in this thesis was narrowed to three focal points. The first aimed to identify evidence-based classroom management practices that effectively prolong focus, also referred to as on-task behaviors, for special education ADHD youth. The second aimed to analyze the connection between on-task/off-task behaviors and success in the classroom setting. The third aimed to investigate various strategies and consequences, with consideration to both negative and positive perceptions, for ADHD related behaviors in the classroom.

In addition to these three focal points, an unexpected area of research surfaced during the initial search process: digital cognitive therapy. Results showed that a significant volume of recent studies had been conducted focusing on implementation of digital technology as a treatment to improve ADHD symptoms. The research provided deep analysis of cognitive processing such as inhibitory control and executive functions of a brain with ADHD (Meyer et al., 2020). Inhibitory control involves the control of focus, behaviors, and emotions that lead to making appropriate choices; without it, impulses and stimuli take over, making it impossible for one to change habits and actions for the better (Diamond, A., 2013). Similarly, executive

functions affect one's ability to pay attention and maintain concentration when most needed. Based on the relevance of inhibitory control and executive function effects on academic performance, as well as the differences in cognitive processes of students with ADHD, four of these topic specific studies have been included in this literature review.

Choosing the right CMS for a situation has proven to be a challenge for many educators. It often requires identification of the concern or problem first, such as in the example with my daughter. This may include behaviors that affect the entire class, or it may be on an individual basis and be more easily defined by the goals of the student's Individualized Education Program (IEP) plan. This step is critical in CMS success because there is such a wide variety of options from which to choose. Furthermore, in seeking success, there is more than one meaning and perception based on ideals, social status, or beliefs. For this thesis, the term *success* will be defined as "the accomplishment of an aim or purpose" (Oxford University Press, n.d.). This applies academically and behaviorally in the classroom.

CMSs have multiple approaches and varied levels of effectiveness. Antecedent-based, consequence-based, and self-monitoring interventions are just a few of the strategies used in the classroom to support students with ADHD (Gaastra et al., 2016; Gaastra et al., 2020; Staff et al., 2021). Antecedent-based interventions (ABI) include those that modify the surrounding environment with the goal of reducing undesirable behaviors among students and learners with developmental disorders (Applied Behavior Analysis Edu.org [ABA], n.d.). An example of an ABI is the use of varied light source color appearances measured by correlated color temperature (CCT) in the classroom (Light Sources and Color, 2004). One such study was conducted by Pulay et al. (2018) and can be further explored in Chapter II. Like ABIs, consequence-based

interventions involve environmental modifications, but they are made after a behavior occurs in attempt to either increase or decrease the specific behavior (Corey, 2021). Lastly, self-monitoring strategies also referred to as self-regulating or self-management strategies are those that help students gain control of their own learning and behaviors over time by teaching them how to select, monitor, and use effective strategies for their learning (IRIS Center, n.d.).

Also reviewed within this thesis are strategies identified as function-based interventions (Cho & Blair, 2017). Although these can be implemented in a group setting, they are specifically designed for the needs of an individual student based on the results of a Functional Behavior Assessment (FBA). The FBA is a process of gathering information through interviews, direct observations, and a summary of collected data to form a hypothesis of why target behaviors may be occurring and determining which interventions may be appropriate for correcting those behaviors (Bureau of Special Education, n.d.).

Understanding the application relevance and implementation process of these CMSs is necessary for optimal results, but equally important is having an intended purpose. Research supports that inattention is one of the more prevalent symptoms of ADHD. For this reason, the second focal point of this review explores and provides evidence verifying that ADHD related inattention leads to poor academic outcomes (Gray et al., 2017). Included are studies that evaluate similar-symptom diagnoses and co-morbidity (Evans et al., 2020; Liu et al., 2017), investigate international results of ADHD symptomatic inattention (Lawrence et al., 2021; Morsink et al., 2021; Tan et al., 2022), and compare sub-categorized off-task behaviors (Moffett & Morrison, 2020). The findings within these studies validate that using effective CMSs can lead to more positive academic outcomes.

The final focal point of this literature review addresses perception of both teacher and student. Social validity is a key part of the effectiveness of CMSs, therefore the relationship between human perception and consequence is relevant and worthy of investigation. In the example of my caseload student, the parent expressed concern that her child's consequences seemed "unfair". Her perception of the consequence was negative, therefore ill received. The literature selected for this focal point considers both negative and positive perceptions. It includes qualitative research that reveals teacher and student viewpoints and levels of acceptance, and it presents student desired classroom management practices (Wiener & Daniels, 2016).

As a whole, this literature includes a broad scope of information to consider when selecting and implementing CMSs. The intentional selection of studies for this review provide evidence that interventions, behaviors, and perceptions are interconnected in achieving desired outcomes. The ultimate goal of this thesis is to answer the driving question: What classroom management strategies can prolong on-task behaviors and increase success for special education students with ADHD?

CHAPTER II: LITERATURE REVIEW

Literature Search Procedure

To collect literature for this thesis, searches were administered within Education Journals and by using research databases: ERIC and Academic Search Premier, featuring EBSCOhost. The primary articles selected were published within a recent five year time span from 2016-2022. Searches were implemented using advanced settings and key word combinations. A total of 40 combinations were used during the initial search process. Only 16 of the combinations produced results that met the pre-determined criteria for this review. Some of the key words and combinations used included (but were not limited to): "classroom management strategies and ADHD", "on task behavior and classroom success", "improvement and on task behavior and ADHD", "on task behavior and academic achievement and ADHD", "classroom management interventions and Attention Deficit Hyperactivity Disorder", "environmental interventions and ADHD and classroom", "antecedent-based interventions and ADHD", "self-monitoring interventions and ADHD", "focus and academic success and correlation", "movement and classroom and ADHD", "ADHD and academic performance", "inattention and academic performance", "classroom management and PBIS", and "behavior and ADHD and reward". As defined in the introduction, this literature review will explore the search results guided by the following three topics: (1) Effectiveness of Evidence-Based Strategies, (2) Inattention: Effects on Classroom Success, and (3) Perception of Strategies and Consequences.

Evidence-Based Strategies: Effectiveness for ADHD

Although a wide variety of CMSs are available to teachers, the literature states that the typical use of these CMSs in the past has been generalized in the classroom for a broad student population, resulting in non-specific implementation for students with ADHD. However, the increase of such diagnoses over the past few decades has motivated researchers to conduct more recent studies specific to the needs of students with this disability label. The following studies provide contextual information about strategy type effectiveness for comparison.

Comparison: Multi-Strategy Studies

For decades researchers have sought supportive techniques for children with ADHD as a result of continued social and academic concerns associated with this neurodevelopmental disorder. These symptomatic side-effects not only affect those with the diagnoses, but can directly and indirectly affect their peers and teachers as well. Gaastra et al. (2016) conducted a combination qualitative study with meta-analysis review, with a primary aim of determining the effectiveness of classroom interventions: ABIs, consequence-based, and self-regulating. Their secondary aim was to identify and analyze possible moderators. In addition, they qualitatively evaluated the affects of CMSs in relation to the “behavioral and academic outcomes” of non-disabled classroom peers (p. 3). For the purpose and concentration of this literature review, only the primary aim of CMS effectiveness was analyzed. It is worth noting, however, that the researchers anticipated such significant improvements of ADHD related behaviors that they hypothesized the CMSs would produce an overall positive effect on classmates’ experiences and outcomes.

The initial search of articles for meta-analyses resulted in 4,783 records. Search results were then screened and coded according to predetermined inclusionary/exclusionary

guidelines. Some of the required criteria included: academic journals, participants in grades 1 through 12 (or ages 6 through 17), participants with ADHD or ADD diagnoses or deficits in attention or hyperactive-impulsivity, and outcomes that had been measured by direct observation processes or teacher rating systems. In addition, the CMSs had to be categorized as either within-subjects group design (WSD), which was defined as “a design that applies the same intervention on each participant and assesses outcomes on at least two occasions” or single-subject design (SSD) defined as “a design that documents changes in behavior for an individual participant during intervention phases and non-intervention control phases” (p. 4). Upon completion of the screening process, a total of 89 articles were used, containing a total of 100 studies.

After extensive coding and analysis, the results of the systematic review supported other previous meta-analyses confirming that CMSs are effective in reducing off-task and disruptive behaviors in children with ADHD. The specific findings of the research showed that within the WSD group, consequence-based interventions were more effective than ABI's, self-regulation, and combination strategies. On the contrary, SSD group results confirmed that consequence-based interventions were least effective and that self-regulation techniques produced the greatest improvement. Furthermore, it was determined that implementation of these collective CMSs led to greater outcomes in the general education setting than in other classroom settings (Gaastra et al., 2016). Although discrepancies existed within some of the study characteristics, some discrepancies are inevitable when attempting to measure such broad strategies with a multitude of possible implementations and variables. Research

confidently concluded, however, that the use of CMSs had an undeniable positive effect in classroom outcomes inclusive to students with ADHD.

To explore these three CMSs further, the same group of researchers conducted a follow up study in 2020. This follow up study had four aims of examination: (1) “teachers’ reported frequency of use and the perceived effectiveness of different types of CMSs”, (2) “association between [the] reported frequency of use and the perceived effectiveness of CMSs”, (3) “association between [the] reported frequency of use of CMSs and teacher characteristics”, and (4) “teachers’ experience of barriers and their support needs” (Gaastra et al., 2020, p. 4). Consequently, multiple hypotheses were formulated.

First, it was hypothesized that teachers would report use of CMSs more frequently for students with ADHD symptoms than for their typically developing (TD) students. In addition, it was assumed that reported use of CMSs would be more frequent for primary grades teachers than for secondary school educators. Third, it was predicted that frequency of use and the effectiveness would correlate with each other, and that ABIs would be perceived as more effective than the other strategies. Lastly, no hypothesis for teacher characteristics was formulated, however the experiences teachers had and the barriers of support they faced were qualitatively explored.

Participating in this Netherlands study were 140 general education teachers and 140 students. The teachers ranged in age from 22 to 63 years of age, and were required to have a minimum of one year teaching experience. Educators from both primary and secondary level schools participated. The students ranged from 4 to 12 years old for the primary sample and 13 to 18 years old for the secondary sample group. All of the students displayed typical symptoms

of ADHD. Sixty percent of the student group had a formal diagnosis, 30% had no diagnosis, and approximately 9% had a possible diagnosis that hadn't yet been confirmed.

The researchers utilized several questionnaires and surveys and instrumentation to collect data for this study. Teachers filled out a 30-item CMS questionnaire specific to supporting the needs of students with ADHD symptoms. The questionnaire was derived from the research of the researchers' previous meta-analytic review from 2016. It contained specific questions about ABIs, consequence-based strategies, and self-regulation. Although, there was no active control group for this study, the teachers were instructed to compare the student with ADHD symptoms to a TD student in mind when scoring and answering the questions. The survey collected information on formal diagnoses, ADHD label subtypes, and used a 4-point Likert scale to rate strategy effectiveness.

Additional surveys included a 34-item survey about pre-existing knowledge of ADHD and a 25-item survey regarding attitudes toward ADHD. The teacher participants then used a 5-point Likert scale on the Classroom Management/Discipline subscale to rate their skills in this area. Lastly, they had the opportunity to report any barriers that hindered them from effective implementation of CMSs in their classrooms.

The results of the study showed that ABIs were the most effective CMS approach in their sampling; however, they were being implemented more frequently for students with ADHD than the other strategies. ABIs are generally associated with positive reinforcement, and the area of success within this subcategory was found to be academic, which is a primary focus for educators. Data from the surveys also revealed that educators used ABIs more because they were generalized, requiring less effort and planning. Furthermore, the most common barriers

reported by educators within the study survey were issues of large class sizes, having multiple students with disabilities in the classroom, and lack of time. For these reasons, consequence-based and self-regulation strategies were implemented far less frequently and were not specifically used for students with ADHD, but rather in the general classroom as a whole. It was reported, however, that both of these CMS subcategories were effective in improving behaviors of students with ADHD within these settings (Gaastra et al., 2020). Evidence supports that students with ADHD may benefit even more if these strategies were implemented with more individualized intention and educators felt they had the support necessary to commit to them.

Qualitative research methods such as semi-structured interviews also offer valuable insight from the minds of students and educators. Moore et al. (2017) conducted such a study by collecting the opinions and beliefs of educators based on their experiences working with students with ADHD. The aim of the study was to explore their experiences of management in the classrooms. Information was gathered by having educators participate in focus groups and interviews. The two main questions the researchers sought to answer were: (1) “How do educators respond to ADHD in the classroom?” and (2) “What are the barriers and facilitators to these responses?” (p. 490).

This study included 42 education practitioners over a span of nine different schools in the South West of the United Kingdom. Participants included those whom had worked in primary, secondary, and referral facilities separated from mainstream education. The platform used to collect data depended on whether the educator taught in the same school as other educators or if they were the only participant selected from their school. Interviews allowed the researchers to gain understanding of attitudes, beliefs and experiences in depth, whereas

focus groups allowed them to gain insight by consensus and cover a broader spectrum of experiences. Both platforms focused on the same topic of classroom management experiences with students with ADHD. All participants were also presented with the opportunity to share any additional thoughts or issues at the end of their session.

Six themes developed from the discussions and interviews, based on educator feedback. These themes covered whether the strategies helped or hindered and were identified as: *broad strategies*, *student-centered*, *inclusive strategies*, *labeling*, *medication*, and *relationships*. Each of the six themes provided valuable feedback that overlapped suggesting a multitude of educators had similar management approaches and techniques.

Within the *broad strategies* theme, many of the participants expressed common goals of preventing and avoiding undesired behaviors. They also expressed common intentions of the CMSs they used such as encouraging desired behaviors, increasing study skills, and student-to-student relationship building. A management technique that seemed to be targeted for students with ADHD was the implementation of physical activity. Movement breaks and learning that involved movement had shown positive results for these educators. They also agreed that offering rewards for desired behaviors was not as successful as it was for students without ADHD.

Student-centered strategies are designed around an individual student and their strengths as a learner. Educators often used their knowledge of students, such as personal interests, and used it in application for learning to capture and maintain focus for longer amounts of time. As a means of student engagement, it was found to be successful in other

previous literature the researchers had also studied. Its disadvantage is that individualization within a group may lead to implementation challenges based on the group's size or needs.

The third theme was *inclusive strategies*. These included adaptation based on an individual's needs. Although it was extra work for the teacher to prepare materials, it allowed the students to be included rather than have to withdraw from a general education setting or lesson. A disadvantage within this area of study was that the researchers concluded from educator responses that evidence-based practices had not been used.

Some of the *barriers and facilitators* found included the final three themes: *labeling*, *medication*, and *relationships*. Labeling was primarily seen as a barrier, medication was viewed as a facilitator, and relationships had produced both positive and negative results based on the participants' experiences and other literature findings. The educators reflected on whether each of the themes helped or hindered progression of the class.

In the area of *labeling*, the two main concerns were (1) stigmatization that came with the ADHD label and (2) validation of problematic behavior. Educators expressed that students sometimes used their label as an excuse to behave inappropriately. They also observed other educators either pre-judging the student, or validating and accepting the behavior without attempting intervention. The upside expressed by educators was that the diagnosis of ADHD assisted in knowing how to support the student with ADHD symptoms, and it provided families with access to additional support systems and resources.

The results in the area of *medication* were limited. It was agreed by most participants that the use of medication produced positive impacts when implementing interventions. It was described as a more effective use of the strategies. The hindering factor was that the side

effects of medication sometimes led to what one interviewee described as “[taking] the personality of that child out” like a “zombie” (p. 494).

Finally, the area of *relationships* was a key theme for the participants. It was believed to be a major factor behind success in school. For this reason, many participants had focused on social skills for students. It was agreed that positive relationships produce higher self-esteem, and although relationships with students with ADHD can be challenging, practicing empathy was valuable and allowed educators to think more like their students. It was expressed that these students needed advocates, needed to feel understood, and for their disability to be openly accepted. The hindering factor about relationships was that poor relationships between educators and students ultimately had a negative effect on the intervention experience.

The conclusive results of this study suggest that the participants used a broad range of strategies. However, the strategies focused on deficits and individual needs of a student with little or no mention of evidence-based practices. Researchers described the educators’ focuses as helping students to “cope in school” rather than implementation of “ADHD-specific interventions” (Moore et al., 2017, p. 495). This is valuable information, however, for the purpose of this literature review, it is critical to continue to explore specific and evidence-based strategies that can be duplicated for implementation across settings, even borders.

A multilevel analysis study was conducted in the Netherlands to research intervention types and conditions. The researchers aimed to evaluate antecedent-based as well as consequence-based CMSs in behavioral teacher training for students with ADHD symptoms (Staff et al., 2021). Based on their previous research, they hypothesized that both ABIs and consequence-based strategies would produce more positive effects on common ADHD

symptoms than the waitlist control group. However, they predicted that of the two, consequence-based strategies would produce greater results than ABIs.

Participants of this study included a group of teachers and 90 students from 52 schools, involving both urban and rural areas. The students ranged in age from 6 to 12 years old, and were selected based on results from a variety of instrumentation regarding ADHD symptoms and intelligence scales. The educator group was comprised of teachers that were seeking support in classroom behavior management for at least one of their students with symptoms of ADHD. Each teacher could participate with up to a maximum of two students during the study. The 90 students were randomized and evenly assigned to the three conditions along with their teachers.

For this micro-trial, two short interventions were designed in addition to a waitlist control condition. Each of the three conditions had measurement outcomes recorded at baseline, immediately after two intervention sessions, and three weeks after the interventions. Thirty students and their teachers participated in each condition. Instrumentation for the initial student selection process included the teacher rated Disruptive Behavior Disorders Rating Scale (DBDRS), a semi-structured Teacher Telephone Interview (TTI), the Netherlands' version of the Wechsler Intelligence Scale for Children- Third Edition (WISC-III-NL), and the Hyperactivity scale of the Strengths and Difficulties Questionnaire (SDQ) (p. 765).

To perform the study, teachers were first trained on implementation of the short-term interventions. They were instructed to apply the strategies in the classroom for four weeks. For the ABI, teachers were instructed to identify a targeted problem behavior that could be measured. Implementation strategies then included pre-establishment of clear rules and

instructions with students, structured time and space, and behavioral conversations in advance. Teachers then defined a desired behavior such as the student working quietly at their desk for five minutes without going off-task. The teacher then provided individualized instructions, a step-by-step plan, and placed a visible timer on their desk.

The consequence-based strategies followed the same structure such as selecting problem behaviors and desired behaviors, but involved different strategies than ABI. These teachers utilized techniques such as positive praise, rewards, ignoring minor misbehaviors and applying negative consequences as needed. For the desired behavior, the teacher frequently rewarded the on-task student with praise, praised others who were doing the task as instructed, and ignored minor negative attention-seeking behaviors.

The findings of this study align with much of the pre-existing literature. Both intervention strategies reduced the problem behaviors related to symptoms of ADHD in Dutch children. Something that was not predicted prior to the research was the effectiveness of each strategy per age category. Outcomes showed that consequence-based interventions were more effective for the younger aged children, whereas ABIs were more effective for the older students. It is explained that students develop greater intrinsic motivation over time and require less structure in the classroom, therefore allowing environmental factors to assist and support their classroom habits (Staff et al., 2021).

Single Strategy Studies

Function-Based Interventions

One CMS subtype that was not included in the previously mentioned studies is that of function-based interventions, which are designed with specific consideration to the results of a

FBA (FABAS, n.d.). A study by Cho and Blair (2017) uncovered the effects of multi-component function-based interventions with regard to “prevent[ing] problem behavior[s] and increas[ing] academic engagement” in students diagnosed with ADHD (p. 227). While many teachers tend to rely on reprimands and punitive consequences, function-based strategies focus on positive behavioral interventions and supports (PBIS) and are designed for the specific needs of the individual student. The purpose of this research was not only to examine the effectiveness of the multi-component strategies on classroom behaviors, but also to determine whether teachers could design and implement these strategies “with fidelity for students with ADHD” (Wood et al., 2009, as cited in Cho & Blair, 2017, p. 228).

The sampling for this research consisted of one 13-year-old male, Sam, and one 12-year-old female, Katrina. Both had an OHI diagnosis for ADHD. Sam received special education services but struggled with social behavior, transitions, and sensitivity to sound and touch. Katrina had an IEP that addressed her struggles with sustaining attention, task completion, and following directions. The participant teacher had seven years of teacher experience and was certified in both general and special education. According to the researchers, his classroom management skills were consider adequate, though the teacher admitted that he struggled to handle problematic behaviors and tended to implement reprimanding.

Within the study, multiple hypotheses were formulated that student engagement would increase with (1) preferred academic modifications and activities, (2) learned replacement behaviors, and (3) teacher attention increase. It was also hypothesized that Sam’s engagement would increase if provided with opportunities to rest when tired. The research was administered in a self-contained classroom, and data collection and IOA data was collected for

multiple academic subjects. Due to the multi-component focus of the research, multiple baselines were identified and compared to the problem behaviors that had been recorded and categorized. The teachers participating received training on PBIS and FBA procedures prior to conducting the research and were directed to use “response strategies [such as] social praise, assistance, and access to desired activities contingent on the use of target replacement behavior” (p. 232).

Additional preventative strategies were outlined in a Behavioral Intervention Plan (BIP) and implemented for both students. The teacher offered predictability and clear expectations by displaying an activities schedule and a seating chart. He also provided a 5-minute warning when changing from preferred to non-preferred activities. The results of the study showed that after a four-week implementation, both students’ problem behaviors had decreased by a profound rate. Their academic engagement had increased significantly, and all results were stable across academic periods with minimal variance during interventions (Cho & Blair, 2017).

Antecedent-Based Interventions

As previously seen, ABIs have proven to have positive and productive effects for students diagnosed with ADHD. Even a simple change to the learning environment can produce worthwhile results. A study by Pulay et al. (2018) showed that a variance in lighting in a classroom setting can produce changes in students’ academic and behavioral responses. Humans respond to environmental stimuli in a variety of ways. Lighting can influence cognitive response, alertness, and productivity (Heerwagen, 2010; IES, 2014, as cited in Pulay et al., 2018). In this study, CCT ranging from low level to high level was used to determine the effects on elementary students’ movement and on-task behavior in the classroom. Based on past

studies of fluorescent lighting effects on adults in the workplace, the authors hypothesized that youth would experience similar effects in their familiar learning environment. The sampling for this study consisted of 27 students, 7 to 8 years of age, 2 who wore eyeglasses, and all of which were perceivably healthy and showed no “visually recognizable physical disability” (Pulay et al., 2018, p. 59).

The research method used for Pulay et al.’s (2018) study consisted of behavior mapping and time-interval observation. All observations were taken in an already established classroom during regular school hours, at consistent times, and on alternating days. The on-task behaviors were scored based on the comparison of students in small groups around the room and were calculated to create a class average. Maps were also made of the classroom area so movement could be recorded. The teacher’s location was included in the mapping process throughout the observation. Once the data was analyzed, results supported the initial hypothesis that the range of CCT would affect students’ on-task behaviors. It was believed that the low frequencies put out by the low-level lighting affected student sensitivity, in turn, producing stressful behaviors and distractibility (Veitch & McColl, 2010, as cited in Pulay et al., 2018). Furthermore, it was concluded that the higher CCT light had influenced more desired on-task behaviors.

Another example of positive effects of ABIs was made available by Rosalez et al. (2019) through mixed methods of collected and applied research. The researchers’ purpose was to examine the effectiveness of an off-task behavior treatment for students with ADHD and to compare results of two specifically designed applications: (1) the use of white noise in both the classroom setting and in the nighttime home environment, and (2) the use of white noise applied in the classroom setting only. Based on results of previous studies connecting ADHD to

sleep problems, and sleep problems correlating with academic and behavioral concerns, they hypothesized that the use of white noise could improve sleep quality and classroom behaviors. The questions guiding their research was: could this “easy-to-use environmental manipulation...be an effective intervention for students with ADHD[?]” (p. 23).

The participant selection process for this study involved securing initial consent from school administrators and approval from a university Institutional Review Board (IRB) as well as receipt of student referrals by teachers. Sleep pattern details were heavily considered for candidacy and were determined by parent feedback through a series of interviews, questionnaires and daily sleep diaries. The finalized sampling for this research involved three students that received special education services under the Other Health Impairment (OHI) label as related to diagnosis of ADHD. According to Rosalez et al. (2019), two of the participants (Child A and Child B) received daily medication while the other (Child C) did not. Relevant to the classroom setting application, two of the participants (Child A and Child B) shared the same fourth grade classroom while the other (Child C) was in different classroom in the third grade. Relevant to the home setting application, one of the fourth grade participants (Child A) and the third grade participant (Child C) were siblings from the same home, but each with their own bedroom.

Instrumentation used for this study were described as white noise generators calibrated to a steady volume of 75 decibels (dB) and recalibrated every 2 weeks for accuracy. Participants were given the choice of wearing ear buds or headphones in the classroom setting for white noise application and were instructed to maintain the pre-determined volume of 75 dB. All three students opted to use ear buds. For the home setting, no hearing devices were offered.

The white noise generators were placed one meter from each of the participants' beds at the same marked dB level.

The researchers identified the study as an ABAC reversal design, where the following phases were implemented: (A) no white noise was administered, (B) white noise was delivered in the classroom as well as the home setting, (A) no white noise was administered to intentionally return to baseline, and (C) white noise was delivered in the classroom setting only. Throughout the study, classroom behaviors were observed and recorded during independent work time and calculated using an inter-observer agreement (IOA). Off-task behaviors were recorded using a momentary time sampling (MTS) of 15 second intervals. These off-task behaviors were categorized and defined as "talking to another student or the teacher about something unrelated to assignments (verbal off-task), standing or walking while not attending to the task (motor off-task), or looking at something other than the assignment or teacher while speaking (passive off-task)" (Rosalez et al., 2019, p. 26).

The overall findings of the study confirmed the use of white noise as effective in decreasing off-task behaviors for all three participants. This proved true when used in the combination of classroom and home settings (B) as well as when used in the classroom alone (C). All three students rated the white noise as helpful in staying on task, a non-distraction while learning, and as a supportive aid in restful sleep. Two expressed a desire to continue the behavior intervention in the classroom while the other participant remained neutral. All three, however, strongly desired to continue receiving white noise at night. Parents, and teachers alike, strongly agreed it was an easy-to-use, low effort delivery that made a significant positive impact. Both teachers strongly agreed the white noise had decreased the off-task behavior in

their classrooms, and their rating of its improvement on assignment completion was *agree-strongly agree*. By following the ABAC reversal design, the researchers were able to confirm the significance of the white noise (Phases B and C) by returning to the baseline mid-study (A) and observing that the off-task behaviors increased back to their baselines. When re-administering the white noise (C), off-task behaviors decreased once again (Rosalez et al., 2019).

Self-Monitoring Interventions

A CMS that has shown significant positive results across settings and research platforms is the self-monitoring strategy. Alsalamah (2017) gathered and researched information from nine different studies to review the effects that self-monitoring strategies may have on students with ADHD. Although there were several guiding research questions within the study, the exploration of significant outcomes from self-monitoring is the most relevant to the current literature review. The systematic literature review included a total of nine articles which explored studies of a total of 24 students ranging from elementary through high school grades, all of which had been diagnosed with ADHD. The articles were collected from the following databases: ERIC, EBSCO, and SAGE. The articles were then filtered and selected based on criteria. The articles were of studies that used a single-subject study design due to scientifically proven effectiveness of the design. They were also required to report both academic and behavioral outcomes and had to be sourced from educational and behavioral journals published between January 2000 and December 2016. Although the researcher did not state a clear hypothesis, they reasoned that alternative strategies are necessary for classroom management when working with students with ADHD.

The procedures used to analyze all nine of the studies' results included observation of students' target behaviors prior to and after the self-monitoring strategy implementation (Alsalamah, 2017). The results were then categorized into the following specific six areas: characteristics of the participant, school setting, study design, interventions, dependent variables, and study outcomes. Based on the results of the data comparison, it was noted that putting the self-monitoring strategies into practice led to "an increase in students' behavioral and academic outcomes" (pp. 122-123). More specifically, it was stated that language arts tasks were being completed more productively than had previously been and that algebraic math skills were being performed in reduced amounts of time. These findings support Alsalamah's initial reasoning that "ADHD symptoms are not the result of defiant behavior or a lack of understanding, and therefore [educators] use different strategies in schools to control unacceptable behavior that exists among students diagnosed with ADHD" (Rivera-Flores, 2015, as cited in Alsalamah, 2017, p. 118).

Another systematic review of single-case design (SCD) studies was conducted by Harrison et al. (2019) using meta-analysis to evaluate evidence-based classroom interventions implemented with students diagnosed with ADHD. The researchers divided the interventions into four categories (behavioral, instructional, self-management, and environmental) and analyzed each according to their effectiveness, scientific quality, evidence-based status, and moderators. Several research questions guided this study, but the most relevant to this literature review is, "What are the overall effects of the types of interventions implemented in classroom settings with students with ADHD and the effect for each type of intervention?" (p. 577). The sample size of the study was a total of 27 peer reviewed articles published from 1971

to 2018, and included 49 cases and 78 participants. The categorical break down of the interventions sampling included seven behavior studies, ten self-management studies, nine instructional studies, and one environmental study. The meta-analysis “was conducted in three phases: systematic literature review, coding, and data analysis” (p. 577).

The initial search for the study resulted in 6,364 articles. Each was screened to meet the specific criteria of the study and then coded by intervention characteristics, indicators of scientific quality, moderators, publication bias, intervention organization, evidence-based status and scientific quality, visual analysis, effect size and confidence intervals, and moderator analysis. Articles that had not been peer reviewed were intentionally excluded from the study to ensure validity, quality of scientific merit, and to meet research standards. Diagnosis of ADHD in participants was also a requirement in screening the articles. Studies that involved participants with as well as without ADHD were used, however, only the data of participants with ADHD was evaluated. The researchers analyzed studies that took place in both elementary and secondary schools, but limited the setting to be classroom specific; settings such as after-school programs were not included.

The results of the study indicated that each type of classroom-based intervention was moderately to largely effective for students with ADHD. Behavior interventions were most effective when implemented by researchers in secondary settings and when selected with FBA results in mind. In comparison, behavior interventions were found to be less effective than the instructional and self-management strategies. Instructional interventions proved to be more effective academically in the special education setting than in the general classroom, and moderate effects on essay writing, math fluency, and academic engagement increased with the

use of Computer-Applied Instruction (CAI) and cover-copy-compare (CCC). Self-management interventions also revealed a likely increase in academic achievement in the area of essay writing and were the strategies that produced the strongest effect. The results of this study suggest it is likely that “students with ADHD can learn the content standards being taught to typically developing peers and to self regulate their own behavior” with “the correct instructional and self-management interventions” (Harrison et al., 2019, p. 599). Environmental interventions were not considered in the final findings as a result of access to only one environment related case study.

Evidence continued to support self-monitoring strategies and their positive effects across settings. Researcher Ennis et al. (2018) sought to extend the work of a previous study by Amato-Zech et al. (2006). The purpose behind the extended study was to present implementation of this strategy within a resource room setting for three students with either a Specific Learning Disability (SLD) or ADHD. The three questions that drove the research were:

“(a) Can self-monitoring be implemented with integrity by an elementary classroom teacher and student teacher with limited research support? (b) Is there a functional relation between self-monitoring and students’ academic engagement (specifically active engagement) and work completion? and (c) To what extent do the teacher and students perceive the self-monitoring intervention as socially valid?” (p. 177).

Furthermore, the researchers desired to outline practical steps of application for educators in the classroom.

The sampling for this single-case study consisted primarily of three students and two teachers in a rural elementary school. Also involved was two research staff. All three students

received special education services in the resource room for a portion of their day. Two of the students had ADHD and were twins, Jay and John. They both received 100 minutes of specialized instruction in the areas of reading and math. The third student, Janice, had SLD and received 50 minutes of specialized reading instruction. These students were selected by reviewing report card scores and identifying their struggle to stay engaged in the classroom. All three students had a grade of C or lower in reading, and exhibited frequent inattentive behaviors across multiple classroom settings.

The teachers involved in the study consisted of a special education teacher with 19 years of experience in the classroom and a student teacher in undergraduate school completing an internship to become a special educator. The research staff involved was there to support the teachers during the study. They consisted of a “university special education faculty member and [an] undergraduate student research intern majoring in early childhood education” (p. 178).

To collect information about the students’ social behavior, teachers completed the Social Skills Improvement System—Rating Scale (SSIS-RS, Gresham & Elliott, 2008 as cited in Ennis et al, 2018). This took place one week prior to the baseline data collection. The most relevant subcategories of the rating scale were social skills, problem behavior, and academic competence. In addition to this survey, a rating scale for work completion was also used throughout the study. Students’ work completion was rated every 10 minutes on a 3-point scale ranging from *Not Meeting the Expectation* to *Meeting the Expectation*. Lastly, direct observation was used to track academic engagement of the students in 2-minute increments throughout the study. To specifically identify and define academic engagement, behaviors were

divided into three categories: “actively academically engaged (AAE), passively academically engaged (PAE), [and] off-task (OFF)” (p. 178).

AAE was defined as evident involvement in teacher assigned tasks and instructions such as raising their hands, writing, and speaking to the teacher on-topic. PAE was defined as quiet involvement such as reading assigned materials or listening to the teacher and on-topic peer response. The third category, OFF, was defined as involvement in tasks that were unrelated to the current topic such as wandering in the classroom, fidgeting without working, and wandering eyes during instruction or work time.

The self-monitoring instrumentation used in this study was implemented in an ABAB withdrawal design. An ABAB with withdrawal design uses the following sequence: (A) baseline, (B) intervention, (A) withdraw of intervention, (B) return to intervention. During the intervention, students wore a small electronic device called MotivAider®, which would pulse every two minutes. This was the students’ signal to stop what they were doing and rate themselves as *Working* or *Not Working*. Students were pre-taught what each meant. The teacher explained that honesty in their self-ratings would gain favor toward a reward after the study had been complete.

In addition to collecting behavioral data, the researchers sought to evaluate the social validity of this strategy. Student teacher input was collected pre-intervention and post-intervention by using a modified version of the Intervention Rating Profile (IRP-15). To measure the students’ perspectives, all three participants completed a modified version of the Children’s Intervention Rating Profile (CIRP). Both outcomes score high scores, suggesting acceptability

both before and after the implementation. The students' scores were in high favor of using this strategy.

The results of this study were consistent with many of the researchers' previous findings from pre-existing studies. Overall AAE increased from implementing the study, and work completion increased while the intervention was in place. It was later found that self-monitoring became a natural part of the classroom routine, leading to ongoing positive results. Furthermore, researchers found that the "social validity data [suggested] the intervention was feasible and acceptable as implemented" (Ennis et al., 2018, p. 188).

A significant finding for this literature review was the evidentiary support that this strategy combined with technology not only produces short term results, but also long term results with reduced need for implementation over time. Assistive technologies are widely used today and previous studies have proven that the use of digital tools have been beneficial to students with disabilities and learning challenges. A pilot study was conducted by Schuck et al. (2016) to evaluate iSelfControl, a web-based application, for classroom behavior management support. Researchers sought the following information for the study: (1) to assess the feasibility of students and staff making use of the application in the classroom, (2) to evaluate student self-awareness and self-regulation, and (3) to determine if the paired scores recorded in the application provided helpful information for classroom behavior management in correlation to challenges related to students' ADHD. The researchers hypothesized that "utilizing iSelfControl directly in the classroom in conjunction with a token economy system would lead to measurable improvements in self-awareness and self-regulation" (p. 2).

The twelve students that participated in the study were in grade 5, and attended a specialized school that was operated by a public university and concentrated on school-based behavioral health. The program was designed for children that were challenged with symptoms similar or related to ADHD diagnoses. All participants were males ranging from nine to eleven years old, and had a history of deficits in maintaining attention and self-regulation. Also participating was the classroom teacher, who was tasked with the job of observing actual student behaviors and scoring points associated with a token economy system.

The iSelfControl application was utilized in a laboratory classroom design for mixed research in collecting both qualitative and quantitative data. The data was gathered over a six week period and archived for immediate viewing and overall analysis. Possible points awarded to students were assigned within thirty minute observation intervals and were measured based on the following behaviors: “following directions, following rules, staying on task, and getting along with others” (Schuck et al., 216, p. 3). At the end of each observation interval, students were instructed to use the application to reflect on their behavior and rate themselves. Once completed, they were permitted to see how their teacher had rated them, followed by an opportunity to identify ways they may be able to improve for next time. The application was used to generate graphs so students could view their ratings per day and monitor weekly progress.

Findings of the study showed that the application was used consistently over the 6 week period and that it was well liked by all participants. The thirty minute intervals created several scheduled opportunities for student reflection. Students were surveyed and 70% stated they liked the application and found it helpful. The remaining 30% expressed they had difficulties

with operating the application. The researchers of the study confirmed that the application was capable of collecting discrepancies between teacher-student scoring as well as a variance in how students scored themselves. While some were considered too generous in their self-reflection, others were too hard on themselves, which suggested the application may benefit some students more than others based on self-perception variables. It was concluded, however, that with continued use, the student-teacher data provided by the iSelfControl application had the potential to support students in gaining a more realistic view of self-perception overtime (Schuck et al., 2019).

More confirming results, however, came from research conducted by Vogelgesang et al. (2016), involving a single-subject study to further explore and expand upon literature regarding technology-based self-monitoring. The study evaluated the effects of an iPad application called SCORE IT and determined social validity through teacher-perceptions data. The two questions the researchers sought to answer were: “Is there a functional relation between the self-monitoring iPad app, SCORE IT, and the academic engagement of adolescent students with ADHD?” and “What were the teacher perceptions of the goals, procedures, utility, and outcomes (i.e., social validity) of SCORE IT, before, during and after implementation of intervention?” (p. 482).

The study involved one teacher and three students from a Midwestern elementary school. The teacher had 13 years of teaching experience, and multiple degrees in education practices. She did not have any formal training in classroom management or working with students with disabilities. The three students selected for the study were teacher nominated based on their frequent off-task or disruptive behaviors and their low academic engagement.

All three students were 11 years of age and shared the same fifth grade classroom. Student 1 had a 504 Plan to accommodate his hyperactive/inattentive symptoms, but he did not have a formal diagnosis. Student 2 had a formal diagnosis for ADHD, but was not have a 504 Plan nor receive special education services. Student 3 was in the process of being formally evaluated by a medical team during the study. Both Students 1 and 2 rated “very high risk” for “hyperactivity and concentration difficulties” on the SDQ (p. 483). The risk rating results for Student 3 showed “slightly raised”.

Within the study, academic engagement was evaluated using a whole interval system. Students were observed for approximately 20 seconds in rotation, continuing through the entire period, totally approximately 15-18 minutes per student per session. Behaviors such as wandering eyes, purposeless movement around the classroom, and engagement in non-assigned tasks were examples of hyperactivity and inattention, suggesting non-preferred activities when measuring academic engagement. To validate the correlation between SCORE IT and academic engagement, the study utilized an ABAB with maintenance design as well as visual analysis to confirm effect immediacy. The maintenance design involved a gradual fade of interventions through a number of variables determined by individual student progress.

The instrumentation used for the study included the IRP-15 with a 6-point Likert scale. This was a teacher-rated questionnaire that assessed the intervention’s social validity. The teacher also participated in semi-structure interviews pre and post intervention; it focused on her experience with using the app. In addition to these tools, the teacher also participated in a weekly email journal over the 6 week period of the intervention implementation. The journal prompt included 1-2 questions in which she would reply to within a 24 hour period.

The focus instrument for the study, and independent variable was the iPad app SCORE IT, which was designed for interval self-monitoring ratings by using a 4-point Likert scale. The app prompted students with an audio cue every 10 minutes, to which they would then take a moment to rate their behaviors for that most recent time frame. The teacher would then follow up with a rating for each student based on her experience and observations. Results were then visible to both teacher and students to view their overall percentage of positive behavior for that interval. To assure fidelity, a procedural checklist was provided to all participants.

One final step of the study involved gradual fading of the intervention with the purpose of student self-awareness growth by needing fewer, less frequent reminders and/or a lower quantity of behaviors to be monitored. This maintenance data was collected two weeks after the initial ABAB design was complete. Results showed that Students 2 and 3 were no longer using SCORE IT and had achieved higher independent academic engagement. Student 1 was still using the app, however, his interval length had increased from every 10 minutes to every 15 minutes. One final data collection was administered another two weeks later (four weeks after the ABAB implementation). Student 1 was still using the SCORE IT app, but was monitoring only two remaining behaviors at 20-minute intervals. Overall findings suggest that technology-based self-monitoring applications like SCORE IT are favorable in both performance and fidelity. The participating teacher rated the intervention as easy to use as well as to teach how to use. All three students' behaviors improved significantly with approximately two months (or less) of implementation, suggesting its potential for rapid results for students showing symptoms of ADHD (Vogelgesang et al., 2016).

Exploring Digital Cognitive Therapy

This final subcategory was an unexpected find within the search for effective CMSs. Although the use of digital cognitive therapy is identified as a treatment and takes place in home and clinical settings, literature provides promising results of effectiveness on common ADHD symptoms. The following four studies are included in this present review due to the treatments' positive social validity, implementation fidelity, and cognitive outcomes. With further research, this strategy has potential for implementation in classroom settings, ultimately leading to greater academic outcomes. For the purpose of this review, the digital cognitive therapies and treatments will be referred to as interventions or strategies.

The first study explored was that of Gallen et al. (2021). Their research was aimed to determine the impact that attention neural marker targeted game-based digital therapy can have on attention control for students with ADHD. Previous studies had been administered on populations of participants without ADHD diagnoses, and the evidence showed positive improvements on their midline frontal theta (MFT). MFT rhythm can be described as “a distinct [neural oscillation] activity of [electroencephalography] in the frontal midline area [of the brain] that appears during concentrated performance of mental tasks... and reflects focused attentional processing” (Ishii et al., 1999, p. 1). Due to the lack of research administered for the effects of this type of therapy on children with ADHD, researchers Gallen et al. (2021) sought to address that gap. The purpose was to verify possible correlation between “intervention-related neural gains” and “behavioral tasks indexing attention” (p. 1).

Although behavior therapy and pharmacological treatments are commonly used for managing symptoms of ADHD, new research and evidence suggest that brain function modification through repetitive practices may result in increased attention and serve as an

alternative to medications with possible side effects (Peng & Miller, 2016, as cited in Gallen et al., 2021). *NeuroRacer*, a custom-designed video game, implemented multi-tasking prompts to support the repair of neural deficits in MFT and proved to positively affect “behavioral metrics of attention” as well as “cognitive control abilities” in adults without ADHD diagnoses (p. 2). The Akili Interactive developed therapy, *NeuroRacer- AKL-T01*, was the extended therapeutic tool used to collect further targeted data from the focus participants. The hypothesis for this study predicted that children with ADHD would experience MFT enhancement when using the game-based digital therapy.

The sample for this study consisted of 28 children, age eight to 12, with ADHD diagnoses. Participants were selected “from online parent groups, the Sensory Neurodevelopment and Autism Program research registry, and Cortica Healthcare, Marin Center” and were screened based on parent survey questionnaires whose results were validated by the Mini-International Neuropsychiatric Interview for Children and Adolescents (p. 3). The Vanderbilt Parent-Report was utilized for measurement and screening of criteria, and any participant chosen had to qualify by receiving an *Often* or *Very Often* rating on a minimum of six out of nine inattention symptom related questions. Participants were also required to stop taking any antipsychotic or ADHD related medications 30 days prior to the applied intervention.

Electroencephalography (EEG) recordings were taken to collect preprocessing data related to neural attention control and objective behavioral measures of attention. Participants performed *Go/No-Go* tasks on their computer screens to evaluate their selective attention abilities and specific stimuli responses. Researchers administering the study also considered

response times (RT) and response time variables (RTV) according to previous studies of children without ADHD in their analysis. The AKL-T01 was preloaded onto mini tablet devices and sent home with the participants to use as a self-guided intervention. They were instructed to complete a minimum of 100 *missions* over a four week period, which was broken down to regular intervals of five missions per day, for at least five days per week, each day equating to approximately 25 minutes of game play. Participation was monitored remotely for accuracy of data, and 25 of the 28 participants completed the intervention criteria successfully. Researchers then collected MFT EEG data post-intervention for comparison to the baseline.

The results of the study showed overall improvement in MFT. Behavioral measures of attention showed that participants improved in RT, suggesting faster performance after the AKL-T01. However, no significant improvement was observed for RTV. An improvement in sustained attention was also found as determined by fewer attention lapses occurring post intervention. Parent feedback was also measured by utilizing the inattentive subscale on the Vanderbilt Parent-Report after the AKL-T01. Collectively, parents were observing a significant decrease in inattentive symptoms in their children. In addition, 44% of the participants that had originally qualified for the study with “≥6 out of 9 Vanderbilt inattention symptoms in the *Often* or *Very Often* range” no longer met the qualification criteria (Gallen et al., 2021, p. 9).

Another digital intervention study conducted involved Virtual Reality (VR) to determine its feasibility and efficacy for enhancement in the areas of behavior, cognitive functioning, and dual-tasking for children with ADHD. According to Shema-Shiratzky et al. (2019), utilizing VR as a therapeutic platform trained users by combining their motor and cognitive skills in real world scenario examples. The game-based application of VR also created motivation for children and

was considered a preferred activity. This study specifically sought to determine the effects VR had for students with ADHD because such research results were still relatively undiscovered.

The researchers implementing the study hypothesized that six weeks of the VR-designed intervention would “reduce ADHD behavioral symptoms, improve attention and executive function, and increase the within subject consistency of gait during dual-task” (p. 432). They chose 14 children ranging from eight to 12 years old, all with a confirmed ADHD diagnosis, and who had been referred by a child neurologist at the Child Development Unit in Dana Children’s hospital. The participants were required to be non-medicated and to attend a regular education framework. Any children on active medication for ADHD treatment or with serious medical conditions were excluded from the study.

Quantitative data was collected by utilizing a single-group pretest/posttest design, and by collecting parent-provided ratings from the Conners’ Parent Rating Scale - Revised (CPRS-R). The CPRS-R is designed to evaluate various symptoms including (but not limited to) inattention, social problems, hyperactivity, and cognitive problems. Participants were tested three times throughout the study: first, to collect a baseline, second, to gather immediate results after the intervention, and third, for a six-weeks follow up. Eighteen sessions of the VR intervention were held for 30 minutes to one hour each session. They were implemented in regular intervals of three sessions per week over six active weeks.

The researchers used a computerized neuropsychological battery called NeuroTrax™ to evaluate cognitive function in the areas memory, executive function, and attention. This assessment tool captured participant data based on five specific tasks: (1) inhibition response to stimuli called the *Stroop* test, (2) *Go/No-Go*, a continuous performance test, (3) verbal and

(4) non-verbal memory tasks, with immediate and delayed recall measurement and (5) a *Catch* game, which involved shifting, adaptation and planning. While walking on a treadmill, students were directed in advance to count specific words within an audio set, then finish by answering multiple choice questions directly related to the text. Participants were monitored while they maneuvered a variety of virtual obstacles, and the level of difficulty was adjusted overtime based on their individual progression.

After the completion of the VR intervention, results showed improvement in several areas of the study. Parents noticed a decrease in social problems in their children. The researchers proposed the possibility of improvement connection between those social behaviors and the cognitive executive function based on their previous research findings suggesting that “social problems are the behavioral outcome of children’s central executive dysfunction” (Kofler et al., 2011, as cited by Shema-Shiratzky et al., 2019, pp. 433-434). Data also showed a significant improvement in psychosomatic behaviors and complaints commonly “related to hyperactivity and restless-impulsive behavior” (pp. 434-435). Scores in both executive function index and memory index had increased immediately after implementation. Furthermore, although the VR intervention was not specific to training the working memory, posttest results showed fewer sequencing mistakes than the previous baseline, and retention was still evident during the six-week follow-up assessment.

This next study targeted inhibitory control (IC) in cognitive training to see if it would reduce symptoms of ADHD in children. Although previous digital therapy studies had been conducted targeting attention and working memory, Meyer et al. (2020) recognized a gap in research on the effects of ADHD symptoms when targeting IC alone. The primary deficit

associated with ADHD is typically cognitive which leads to deficits in executive functioning. IC has been previously identified as one of the core executive functions (Diamond, 2013). The literature these researchers reviewed had “identified IC as a central deficit in ADHD” (Nigg, 2001, Willcutt et al., 2005, & Jester et al., 2009, as cited in Meyer et al., 2020). Furthermore, the presence of IC abnormalities is evident with ADHD which affect “behavioral performance [and] the structure and function of neural systems” (p. 2). These findings led to the hypothesis that digital therapy intervention concentrated on IC alone would result in reduced ADHD symptoms.

ADHD causes greater than average theta power frequencies during rest, so the researchers sought to evaluate theta oscillations when the participants were in a resting state using EEG (Arns et al., 2013, Barry & Clark, 2012, as cited by Meyer et al., 2020). Activity driven data was also collected and referred to as event-related potential (ERP). This involved computer game-play with adaptive and non-adaptive stop signal trials (SST). In addition to this data collected, quantitative data from parent and teacher rating scales were also calculated into the study. Parents utilized rating subscales for hyperactivity and inattention symptoms on the Swanson, Nolan, and Pelham-IV Questionnaire (SNAP-IV) and the Conner’s Parent Rating Scale. Teachers reported scores for the same symptoms based on the Conner’s Teacher Rating Scale. All of the above processes were measured at the time of both the pretest (baseline) and posttest sessions.

The sample size of participants for this study consisted of 40 children ranging from eight to 11 years of age, all with ADHD diagnoses from a licensed clinician. Their diagnosis criteria primarily met inattentive and combined subtypes of ADHD. They were selected from the

Participant Registry Database of Boston Children's Hospital. Thirty-six of the 40 participants took medications regularly for their ADHD symptoms. Any stimulant medications were prohibited 24 hours prior to each lab visit which consisted of the pretest and posttest sessions. During the intervention itself, prescribed medication routines continued unaltered. This intervention involved a total of 20 game-play sessions. Each was 15 minutes, administered five days a week over a four week period. Twenty children were randomly assigned to an adaptive treatment while the other 20 were assigned to a control condition. Conditions of their assignment were not revealed during the study.

At the end of the four weeks, the session completion count per participant was considered satisfactory. The children were asked to complete a Likert-scale rating that asked how much they enjoyed the games (5= *A lot!* and 1= *Didn't like*) and resulted in a mean score of 3.59 (p. 12). The comparison of pretest data and posttest data partially supported the initial hypothesis. Parents reported a significant decrease in inattentive symptoms, and the children's neural activity (theta oscillation) was reduced during the resting state. Specifically to the adaptive condition group, the children that demonstrated the greatest behavioral improvement in IC were the same to be reported by their parents as having the greatest improvement on ADHD inattention symptoms. Meyer et al. (2020) did not, however, observe any significant effects on hyperactivity symptoms, which were believed to be a consequence of so few hyperactive subtype diagnoses within the sample set.

The final study within the digital cognitive therapy strategy focused on working memory (WM). It is generally agreed within the literature that WM in children with ADHD does not perform at the same efficacy as their typically developing peers (Castellanos & Tannock, 2002,

as cited in Capodieci et al., 2019). Several previous meta-analyses suggest the measures of spatial WM and other executive functioning (EF) components, such as response inhibition, display consistent differences when comparing children with ADHD to those without. Academic outcomes of underachievement have been linked to these WM impairments. Studies concentrated on WM training have also suggested that behavioral symptoms of inattention can be improved. Based on these findings, Capodieci et al. (2019) conducted a study that implemented a combined training of both metacognition and WM with a sample group that contained children with ADHD as well as their TD peers. Metacognition can be described conceptually as: thinking about what one is thinking about.

A total of 27 children were involved in the study. Twelve had received a clinical diagnosis of ADHD, and 15 were identified as TD. All of the children were within the age range of six to eight years old. The training experience followed an ABA design: pretest (baseline), training implementation, and posttest. A wide range of instrumentation was used for the training which included: (1) Backward Corsi Blocks test for visuospatial WM, (2) Bells task and (3) test of Auditory Attention for metacognition, and the (4) Go/No-Go test, (5) Matching Figures test, and (6) Colored Progressive Matrices to measure impulsivity and inhibition response.

The children participated in the trainings twice a week for a total of 16 sessions. The metacognition focused activities took place during the first session of each week and was administered to groups of 4-5 children. The second session of each week involved computer-based activities that focused on the visuospatial WM and were completed individually in their home settings. In addition, parents and teachers contributed data by utilizing ADHD rating

scales. The collected data was categorized into the following areas of study: (1) specific effects, (2) transfer effects (near and far) on neuropsychological measures of WM, (3) attention, (4) inhibition, (5) reasoning, and (6) parent/teacher rated behavioral aspects. The six categories were then subdivided by gains according to the following: immediate (posttest), long-term (a month later), and comparison of ADHD related gains to those of typically developing peers.

The overall findings showed that the combined visuospatial WM and metacognition training was effective for both attention and inhibition. These findings were true for both objective measures as well as subjecting ratings. After the training, the levels of performance had improved in children with ADHD as well as those without. Although parent and teacher participants had both rated less inattention for children with ADHD at the follow-up, the ratings specifically from the teachers showed a highly significant decrease.

Inattention: Effects on Classroom Success

It is evident through past research findings that Executive Functioning (EF) has direct correlation to academic achievement. Students with ADHD commonly experience deficits in EF skills such as the ability to focus attention on instructional content for extended periods of time and to work on tasks independently. These skills are also referred to as behavioral self-regulation. In addition to ADHD, students with Oppositional Defiant Disorder (ODD) commonly experience similar EF effects. Comparing the two diagnoses to one another and related co-morbidity provided insight to the effects on students' classroom achievements. Furthermore, exploring a global view of inattention symptoms and academic outcomes provides researchers the opportunity to compare results across borders and gain deeper understanding.

Additionally, the literature that has focuses on students with ADHD has more recently expanded to including comparisons with typically developing children. CMSs in relation to inattention, or off-task behaviors, are generally understood as a whole, but research requires specific definitions and criteria for the most accurate of measures. For this reason, some studies have classified off-task behaviors by subtypes for analysis as they relate to academic achievement. Research proves that off-task behaviors in general are likely to result in lower academic outcomes, but differences between subtypes and their related outcomes remain under explored.

Comparison Studies: ADHD and Oppositional Defiant Disorder

Existing literature provides evidentiary support that inattention symptoms of ADHD have a direct and potential long-term effect on academic outcomes. This has been investigated within a variety of domains. A lesser explored research route is the comparison of symptomatic effects on academic outcomes for students with oppositional defiant disorder (ODD) and students with ADHD. Evans et al. (2020) conducted a study that included both diagnoses due to their predictive validity regarding functional outcomes, and specifically education functioning during middle childhood.

The aim of the study was to investigate symptom dimensions as predictors for typical and atypical trajectories of the following categories: (1) academic performance, (2) depressive symptoms, and (3) peer functioning. For the present literature review, details and findings of the first category (academic performance) as it relates to ADHD is the primary focus. It was hypothesized that inattention symptoms of students with ADHD would have a more significant

impact on academic performance than the symptoms of ODD. Furthermore, it was predicted that inattention would increase the risk of depression over time.

The sample for this study took place at a small town elementary school and included 379 students ranging in grades K-2. Data was collected seven times over a period of four years, with the same students finishing grades 3-5. Teachers also participated by providing ratings. Teacher ratings took place at baseline and again with each subsequent occasion, which was approximately two months prior to the end of each semester and did this by using an online survey. Students also participated in self-reporting during the final year of the study by having the report read to them and following along with their pencils. They were offered colored pencils as prizes for participation, demonstrating a token economy concept.

The specific instrumentation used by the teachers when rating students' symptoms was the Disruptive Behavior Disorder Checklist, which assessed Diagnostic and Statistical Manual of Mental Disorders symptoms for ODD and ADHD (APA, 2013, as cited by Evens et al., 2020). In addition, teachers used a 5-point scale ranging from *Well Below Average* to *Well Above Average* to rate the academic performance of their students. The students' GPAs were then calculated as a converging measure and utilized as a composite index of their overall academic functioning. Regarding the depressive symptoms category, specific rating instruments were used such as the Withdrawn-Depressed scale of the Teacher Report Form (teacher-rated) and the Short Mood and Feelings Questionnaire (student-rated). Peer functioning was also rated and analyzed, but is not discussed here due to results showing greater correlation with ODD and ADHD symptoms of hyperactivity/impulsivity than with ADHD inattention.

Data analysis confirmed that the researchers' predictions were accurate. In the area of academic performance, "inattention robustly predicted lower levels of academic performance at Grades K–2... and... persisted to Grades 3–5" (p. 921). In addition, the inattention symptom of ADHD was predominantly tied to lower levels of academic achievement whereas hyperactivity/impulsivity was disconnected from such outcomes. Furthermore, teachers reported depressive symptoms as a result of long-term inattention symptoms (Evans et al., 2020). These ratings were supported by the self-reported outcomes of the students as well. This result is included in the present review because depression has potential negative effects on academic performance. According to the International Board of Credentialing and Continuing Education Standards (n.d.), depression may negatively impact classroom engagement, relationships with teachers, and retention of new information (working memory) which collectively leads to under-achievement. It was concluded in this study that inattention symptoms of ADHD have a substantial influence on academic outcomes.

Research results of ADHD symptoms and their outcomes can be affected by a number of limitations within each study. Equally so, it is necessary to consider the effect additional factors such as combined disability diagnoses may have on students' inattention tendencies and their subsequent outcomes. Liu et al. (2017) implemented a study motivated by previous reports that Western societies and Chinese student populations have shown similar results of academic achievement but less anti-social and juvenile disruptive behavioral ratings within China's population samples. Furthermore, multiple reports of Opposite Defiant Disorder (ODD) and Conduct Disorder (CD) diagnoses co-existing with ADHD produced evidentiary support

suggesting poor academic outcomes. The aim of their study was to compare student outcomes over a broad range of school related functions in Taiwan according to diagnosis categories.

Within the sample selected, students were divided into the following groups: (1) *combined*, which was coded as ADHD+ODD/CD, (2) *ADHD only*, and (3) *controls*, which included children without a clinical diagnosis or exhibiting related symptoms (p. 871). The researchers then formulated three hypotheses based on pre-existing reports. They predicted the combined group would show greater social and behavioral concerns than the ADHD only group. They also believed that poor academic outcomes would be primarily related to core ADHD symptoms versus the co-existence of ODD/CD symptoms. The third and final hypothesis stated that students with ADHD would display positive illusory bias by underestimating their functional impairment.

Students with ADHD were selected for the study from the Department of Psychiatry, National Taiwan University Hospital, Taiwan. Students for the control group were referred by teachers and involved school districts. Excluded from the study were any students that had any of the following diagnoses: “major psychosis, autism spectrum disorders, or learning disability; and with a full-scale IQ lower than 80” (p. 871). The final sample for the study included 395 students with ADHD (ADHD only and combined) and 156 students without ADHD, all of which met the age range criteria of 10-18 years old. Parents of the selected students also participated in the study by providing interview and questionnaire feedback.

Instrumentation and tools for this study included medical history records, the Chinese versions of the Kiddie epidemiologic version of the Schedule for Affective Disorders and Schizophrenia (K-SADS-E), the Social Adjustment Inventory for Children and Adolescents

(SAICA), the SDQ, and Wechsler Intelligence Scale for Children—3rd edition (WISC-III). The K-SADS-E is a semi-structured interview scale that assesses psychiatric disorders in youth, and was administered to the participants and their parents. The SAICA is a semi-structured interview scale that uses a 4-point Likert scale and assesses youth's functioning within the school, free time, peer relationships, and behaviors at home. This was also administered to students and parents. The SDQ was used to assess youth's psychological adjustment as reported by the youth participants, parents, and teachers. Lastly, the WISC-III was used to confirm that each participant met the appropriate IQ range requirements.

Results of the study showed evidence that the students with ADHD (ADHD only and combined) showed higher ratings than the control group in the following categories: poor grades, negative attitude toward schoolwork, discrepant social interaction, problem behaviors, and classroom interference. The combined group also showed results of a more severe impairment for school functioning than the ADHD only group. However, their grades were neither better nor worse than the ADHD only group. Both ADHD groups were also rated as “a higher burden on teachers” than the control group, with the combined group rating as the “greatest burden” (p. 875). Finally, the student-reported ratings confirmed the third and final hypothesis of positive illusory bias. Students with ADHD diagnoses had “under-reported their behavioral impairments” (Liu et al., 2017, p. 876).

Inattention: A Global Symptom of ADHD

As seen in the previous study, factors such as culture and origin of study bring value to the validity and depth of understanding effects of the ADHD diagnosis. A study in Australia was administered to compare the academic outcomes and trajectories of students with ADHD to

those without. Specifically, the comparison sample comprised of typically developing learners without mental disorders. This study by Lawrence et al. (2021) evaluated a national sample of Australian students, and was motivated by literature with evidentiary support confirming the negative outcomes that correlate with ADHD. The aim of the study was to compare the academic performance of the two groups by year level as well as to identify if any socio-demographic factors were linked to potential poor outcomes. They hypothesized the lower academic achievements would be linked to the group with ADHD and that socio-demographics may play a part, but not be solely responsible for the academic deficits.

The sample size consisted of 5,051 participating families with children ranging in age from four to 17 years old. Participant data was collected from the Young Minds Matter: the second Australian Child and Adolescent Survey of Mental Health and Wellbeing (YMM) (p. 757). The primary care givers participated in the Diagnostic Interview Schedule for Children Version IV (DISC-IV), which assesses mental disorder diagnostic criteria. A total of seven other disorders were assessed to ensure the group of students without ADHD did not have other mental disorders that would skew the study results. The students' socio-economic status was determined by the analysis of the school by the using the Index of Community Socio-Educational Advantage (ICSEA). Additionally, all students 11 years of age or older were encouraged to complete a self-report questionnaire.

Researchers assessed eight years of cumulative academic achievement data by linking test scores from the National Assessment Program – Literacy and Numeracy (NAPLAN). NAPLAN tested students in numeracy, reading, writing, and language conventions, however the results for language conventions does not apply to this present review. Students were tested in May of

Year 3 of their education and were tested subsequently in Years 5, 7, and 9. The first primary set of analysis compared the NAPLAN results of students with ADHD to those without. The second primary set used the test results to examine trajectories of academic outcomes over time. These trajectories were multilevel modeled using the GLIMMIX SAS procedure, which included all available testing data over the eight year period (2008-2016).

The findings of this study supported existing literature by confirming an achievement gap between unique and typical learners. Within all three domains (numeracy, reading and writing), students with ADHD had lower test results at all of the targeted Year levels. Specifically, Year 3 (baseline) already showed a 9-month to 1-year deficit across domains for children with ADHD, which exponentially grew long-term. By Year 9, average gaps for students with ADHD were as follows: “2.5 years behind their peers in reading, 3 years behind in numeracy, and 4.5 years behind in writing” (Lawrence et al., 2021, p. 766). In addition to these trajectories, it was confirmed that students experiencing socio-economic disadvantage do have higher prevalence of ADHD, however, this attributes to only a small portion of the achievement gaps as hypothesized.

Another study by Tan et al. (2022) conducted a three cohort study across age groups to investigate the impact ADHD has on the academic competence of Chinese students. Researchers noticed that sub-categorical research remained limited regarding Chinese students with ADHD and sought to further examine the effects of inattention and hyperactivity/impulsivity symptoms both independently and combined. The study was divided into sub-studies according to age and targeted domain, which were referred to as *Study 1*, *Study 2*, and *Study 3*. Study 1 targeted school readiness in preschool children. Study 2 targeted

math and language arts test scores of first graders, and Study 3 targeted the academic competence of high school students.

Each sub-study varied in location, sample size, and measures. Study 1 consisted of 167 preschool students in Beijing, China. They were recruited for participation according to parent provided data using the preschool version of the ADHD-RS-IV, which uses a 4-point Likert scale to assess symptoms of inattention and hyperactivity/impulsivity. The students' school readiness was assessed using the UNICEF Multiple Cluster Surveys for the Learning and Development of Chinese 3- to 6-Year-Old Children (UNICEF-China, 2020, as cited by Tan et al., 2022, p. 87). This instrumentation utilized a 5-point scale for parents to rate their children's performance in the following areas: language and literacy, numeracy, motor development, curiosity and learning interests, autonomy and safety awareness, and artistic development.

Study 2 involved 303 first grade students attending an urban elementary school in the Futian District of Shenzhen, China. Parents of the participants also rated their children's symptoms using the ADHD-RS-IV (age appropriate), but were provided with the home version. The researchers also obtained the students' test scores for math and language arts from the school registrar's office at the end of the first and second semesters.

Study 3 had the largest sample size of 1,003 middle and high school students with grade levels ranging from seven to 12. The schools were located in a relatively underdeveloped area of Western China, and the participants volunteered based on their interest in the study. Instrumentation for this sub-study included the Behavioral Assessment System for Children-Self Report of Personality - Third Edition (BASC-SRP-III). Students self-reported by answering questions with a 4-point Likert scale or by selecting either *True* or *False*. They also rated their

self-perceived placement within their class by using an academic performance 5-point scale common in Chinese schools, which was adopted from the Social Skills Rating System (SSRS).

Although variances of results existed between sub-studies, overall results showed that inattention had the most significant impact on academic outcomes. Scores of lower academic performance were present when assessing inattention alone as well as when combined with hyperactivity/impulsivity. When hyperactivity/impulsivity was assessed separately from inattention symptoms, the scores on academic outcomes were not as low. This concluded in their research that inattention held the most variance in students' academic results (Tan et al., 2022).

It is evident that students with ADHD commonly experience academic problems, though much of the literature focuses on symptomatic reasoning such as inattentiveness and hyperactivity. To further explore the causes of these academic difficulties, Morsink et al. (2021) conducted a study utilizing a series of questionnaires linking academic topics to Belgium student motivation. The aim was to compare the motivation and academic performance of students with ADHD to those of TD peers. The study included three main points for comparison between the two student groups: (1) how the academic tasks would be rated on a scale of motivation, (2) how positive or negative self-reported experiences would rate along with student GPAs, and (3) if Child and Adolescent Motivational Profile (CHAMP) scores showed a direct reflection of students' ADHD status and their academic impairment.

The sample size of this study included 469 children and adolescents that had been recruited from community schools as well as the Child and Adolescent Psychiatry department of UPC-KU Leuven. All participants met the age requirements of eight to 16 years old. They

were divided into two groups: those with ADHD and those without. Some of the students with ADHD also displayed symptoms of Opposite Defiant Disorder (ODD). The students without ADHD were assessed for other disabilities and disorders and were identified as TD peers. A variety of tools were used to determine participant qualification for the study. Instrumentation included: the DBDRS, Diagnostic and Statistical Manual of Mental Disorders IV (DSM-IV), and the K-SADS.

Instrumentation used to collect data for the study included the CHAMP, a questionnaire that prompted students to self-report their motivational attitudes toward eight specific task subcategories. The eight subcategories were: (1) *Requiring Focus*, (2) *Predictable*, (3) *Graded/Marked*, (4) *Rewarded*, (5) *Socially Evaluated*, (6) *Cognitively Challenging* (7) *Competitive* and (8) *Collaborative* (p. 133). Students rated tasks within each subcategory according to a 5-point Likert scale.

Prior to implementation, the group of researchers came to multiple hypotheses. First, it was predicted that students with ADHD would rate Rewarded and Competitive tasks higher and the tasks considered as Cognitively Challenging and Requiring Focus lower than the TD group ratings. The second prediction was that students with ADHD would have the lower GPAs of the two groups. The third and final prediction was that the CHAMP would link academic impairment and motivation in the areas of Cognitively Challenging and Requiring Focus for students with ADHD.

Results of the study showed that the students with ADHD rated Marked/Graded, Collaborative, Requiring Focus and Cognitively Challenging significantly lower than their TDP. Of those four subcategories, Cognitively Challenging was the only to be significantly rated as “as

not particularly motivating” by students with ADHD (Morsink et al, 2021, p. 137). This result supported the researchers’ previous findings that tasks involving higher cognitive effort have proven to be more difficult as a result of the diagnosis, therefore reducing academic motivation.

Considering Inattention as a Whole and by Subtype

The previous study compared academic outcomes within ADHD diagnosis types. The following study evaluates another area of research less examined: off-task behavior subtypes. Moffett and Morrison (2020) classified off-task behaviors into three subtypes and examined which types could predict academic gains for the following school year according to EF components. The three subtypes of off-task behavior were listed as (1) Non-engaged, (2) Other activity, and (3) Interacting with peer. *Non-engaged* meant the student was not engaged in the directed activity, nor were they engaged in anything else. *Other activity* meant that the student was not engaged in the directed activity however, they were engaged in a different activity. *Interacting with peer* meant that that the student was talking to (or playing with) a peer when they had not been instructed to. A fourth category called *Other* was later created for any observed incidences that did not fall within the three identified subtypes.

For the study, a total of 172 kindergarten students from four different elementary schools were divided into three cohorts. Students with IEPs were included in the study as well as 13 participating teachers. A total of 22 classrooms were observed for a single day, each on a different date. Each class within a cohort group was observed within a 69 days (or less) timeframe. All students were administered a battery of EF and academic achievement measures, which took approximately 45 minutes (with breaks). The assessment was

administered two times with the observation period in-between: (1) assessment in the fall of kindergarten (baseline), (2) observations in the spring of kindergarten, and (3) assessment in the fall of first grade (gains).

The instrumentation used for EF included the Backwards Digit Span subtest of the Wechsler Scales for working memory, the heads-toes-knees-shoulders (HTKS) task for inhibitory response, and the Pair Cancellation subtest from the Woodcock-Johnson III Tests of Achievement (WJ-III; Wechsler, 1991, Ponitz et al., 2008, & Woodcock, McGrew, & Mather, 2001, as cited by Moffett & Morrison, 2020). The WJ-III was also used to assess academic achievement in math and literacy skills by utilizing three subtests: Applied Problems, Letter-Word-Identification, and Passage Comprehension.

Classifying off-task behaviors into subtypes paid off in terms of new discoveries about each subtype's relation to EF and academic success. It was concluded that not all off-task behaviors should be referred to as bad or negative. For example, the *Integrating with peer* behavior did not significantly correlate with the EF baselines or the academic achievements. In fact, the study revealed that the students' tendencies to go off-task were more likely to occur than the other subtypes based purely on natural social needs of children. Furthermore, these interactions suggest social competence, which past research findings support as associated with positive academic outcomes. It is noted that too much of this subtype behavior during instructional time can result in academic loss, but findings within this study did not cause concern.

In addition, a connection was made between the *Other activity* subtype and students who had lower scores for response inhibition. It was observed that these students would often

show little resistance to their desires and fidget or play with perceivably more appealing activities than what had been assigned. This demonstrated a high correlation between motor impulsivity and the response inhibition component of EF. Similar to the *Interacting with peer* subtype, research did not find high concern for these students' academic achievements.

Of the three subtypes, *Non-engaged* behaviors resulted in the most concern regarding academic outcomes. This subtype proved to be related to the working memory EF component. Students that scored lower on WM had tendencies of total disengagement such as staring off during instruction and independent work time. They also achieved lower scores in reading comprehension performance. Although a number of limitations existed within the study, Moffett's and Morrison's (2020) findings proved that the term "off-task" should not be treated as a unitary construct. Each subtype evaluated was related to different behaviors with different outcomes, suggesting a gap in research to pinpoint specific needs within each subtype and further CMS design for potential solutions.

These, among other, previous studies have resulted in a large body of literature proving that inattention is a cause of poor academic achievement and classroom performance for students with ADHD. Behavioral inattention is an observable behavior that refers to "distractibility, difficulty with organization, forgetfulness and difficulty with following directions and attending to a relevant stimulus" (American Psychiatric Association, 2013, as cited by Gray et al., 2017). With ADHD diagnoses numbers on the rise, more recent studies are surfacing, and results are confirming inattention as a real educational risk factor. However, it has been less explored whether these academic deficits are exclusive to ADHD or if inattention without diagnoses has a similar effect academically.

Gray et al. (2017) completed a qualitative review synthesis to determine if similar results would hold true for non-clinical samples of children. Its purpose was to examine relationships between inattention and academic outcomes from a community sample across a variety of ages. They also sought to provide an updated comprehensive review of a total of 19 studies that had not been included in previous reviews. Inclusion criteria for this review were broad to account for a variety of academic outcome forms as well as age ranges. The sample criteria included studies comparing teacher-ratings of inattention with academic outcomes (such as standardized tests), peer-reviewed articles, and validated teacher/parent-rated measures of attention. Excluded were any studies with a clinical focus such as ADHD, co-morbid disorders, inattention linked to hyperactivity/impulsivity, and any intervention-based or medical-based manipulative.

In conducting this systematic review, initial search for related articles resulted in 1,748 finds with a final sampling of 27 articles after screening for inclusion criteria. The researchers followed a protocol that included rating the articles' quality by using the QUIPS tools which determined strengths and weakness in the study design. Researchers then reported based on PRISMA guidelines. Results suggested the literature as a whole was rated low to moderate in regard to risk of bias. In addition, the articles that were also rated as high quality provided consistent findings study wide.

A variety of relationships were analyzed. For example, the relationship of inattention and classroom performance was analyzed separately from the relationship of standardized achievement and classroom performance. Twelve high quality rated studies showed results that high ratings of inattention had significant links to poor standardized academic achievements. Of

the three high quality articles using classroom performance measures, all of them had findings of negative results in correlation to inattention. Age groups were also considered when comparing relationships of inattention and academic outcomes, ultimately showing a connection to poor outcomes. There were not enough studies to secure solid evidence regarding the longevity effects from elementary to high school, however, some articles supported predictive measures suggesting students with high inattention ratings long-term are less likely to graduate high school (Pingault et al., 2011, as cited by Gray et al., 2017). Overall findings were consistent across relationship measures, and it was confirmed that inattention generally leads to poor classroom-related and educational outcomes.

Perception of Strategies and Consequences

CMSs, including those designed for children with ADHD have long been researched, but literature findings have generally discussed data calculations, reports of surveyed teacher feedback, and results as concluded by the researcher(s). Less explored are the qualitative findings of perception. The following studies explore the positive and negative perceptions of the teacher and students correlated to the interventions and practices of classroom management.

The Disability Label Stigma: Teacher Bias

One factor in perception that has limited research is the teacher bias associated with ADHD stigma. Past studies have confirmed that students with ADHD diagnoses are more likely to struggle academically, socially, and behaviorally which has become well known to educators. As a result, these findings may have automated teachers to assume students with ADHD are “less promising than non-diagnosed peers” in their behaviors and academic achievements

(Metzger & Hamilton, 2021, p. 258). Research of teacher expectations was carried out using a social-psychological lens to answer the question: “Does the ADHD label lead teachers to evaluate the academic performance of students more negatively?” (p. 259). The research was approached with the argument that teachers are not immune to the effects of the stigmatized label and stereotypes associated with ADHD.

Data was collected utilizing a multistage sampling design and relied on the nationally represented annual collection source Early Childhood Longitudinal Study, Second, Third, and Fourth Grade Waves (ECLS-K:2011). Within the large groups of available data, the researchers set criteria for screening qualifiers for the specific purpose of this study. After several screening stages were implemented, 23 kindergarten students were randomly selected from each school listed within the qualifying criteria. This equated to 18,174 unique learners for data analysis. The ECLS-K:2011 collected data annually using base year samples of students from kindergarten through fifth grade. This research analysis focused on the grade 2 through grade 4 waves because these are the prime grades for diagnosis of ADHD. The final sample size was represented as a range of 11,014 to 11,287 unique learners.

The researchers used a modified labeling approach for this study. Modified labeling theory supports the process of understanding mental illness stigmatization consequences, and identifies the primary disadvantage as discrimination from others. The risk factor of discrimination from teacher perceptions was measured throughout the second-grade to fourth-grade sample waves. Perceptions according to ADHD diagnoses, Item Response Theory (IRT) test scores, and a positive classroom behavior scale were examined.

Results of the study confirmed strong bias and supported the prediction that teachers would rate students with ADHD at below-grade level ratings. Evidence showed that teachers were perceiving students' achievements at lower ratings than the actual academic test results. Furthermore, the above-grade level analysis proved that teachers often struggled to acknowledge when students with ADHD are performing above grade level. This confirms the modified labeling theory that the stigmatization of this diagnosis has led to negative stereotypes and educator beliefs. Metzger and Hamilton (2021) called the ADHD diagnosis a "double-edged sword"; while students gain access to additional supports and resources, they face unwarranted assumptions that discredit and limit their full potential.

Reaction, Reward, and Response

An important part of CMS effectiveness is understanding how implementation will be perceived and responded to. The relationship between teacher behavior and student behavior is relatively unexplored as it pertains to achieving implementation integrity benchmarks. This was investigated and studied by Owens et al. (2020) over a period of four months where they sought to examine two very specific aims. The first was to assess the relationships of teachers' appropriate responses to students violating the rules with the rate at which the violations occurred. The second was to examine the rate of rule violations in accordance to whether or not teachers met the recommended integrity and growth benchmarks in Months 1 and 2. The integrity of application of an intervention was determined by that teacher receiving training of a specific strategy, implementing it, and receiving consultation after. Based on a previous study conducted by Owens, Coles, et al. (2017), the desired integrity benchmark determined for this study was 51%.

Before this study was conducted, it was hypothesized that higher levels of appropriate teacher responses to rule violations would produce lower levels of such violations. It was also predicted that teachers who reached the 51% integrity benchmark by Month 2 would experience less disruptive behavior in the classroom than those who did not achieve 51%. Lastly, researchers expected that the teacher who experienced the lowest rate of rule violations and disruptive behaviors would be those who achieved their integrity benchmark in the first half and maintained it for the remainder of the study.

The study included 48 participating general education teachers. Approximately half was from Ohio, and the slightly larger half was from Florida. All of the teachers had previously participated in the earlier stated 2017 study trials and met one of the three criteria: “(a) low baseline levels of knowledge and intervention-supportive beliefs... or (b) low classroom management skills at baseline with target student, or (c) low classroom management skills at baseline with whole class” (p. 56). All of the teachers averaged approximately 14 years of teaching experience, and the majority had obtained a master’s degree.

The student participants included 48 elementary age students known to demonstrate disruptive or inattentive behavior. They either met ADHD diagnosis criteria or they were identified as at-risk of having ADHD. ADHD criteria were determined by the following instrumentation results: the DSM-IV, the Children’s Interview for Psychiatric Syndromes–Parent Version (P-ChIPS), the DBDRS, and the Impairment Rating Scale. Additionally, some of the sample group was reported by parents to have a specific learning disability (SLD, 10.4%), use prescribed psychiatric medications (25%), or had to repeat a grade level (18.8%). Overall,

the students averaged an IQ of 98.57 according to the Wechsler Abbreviated Scales of Intelligence, Second Edition (WASI-II).

To test the teachers' knowledge and beliefs about ADHD, several tools were implemented. Teachers first completed a questionnaire with answer option of *True*, *False*, or *Don't know*. Teachers then took a multiple choice knowledge test that was modeled and inspired by the Behavior Modification Test (Kratochwill, Elliott, & Busse, 1995, as cited by Owens et al., 2020). This was followed by a beliefs measure called the Teacher Locus of Control measure. During the classroom observations, the Student Behavior-Teacher Response Observation Rating System (SBTR) was used to obtain response and violation variables.

Prior to the observations, teachers received training for specific strategy responses. Seven common classroom rules were set as the standard for student behaviors, and observations ensued for 15 to 45 minutes, accompanied by frequency counts in four categories. The specific categories included: (1) rule violations (RVs) by a targeted student, (2) daily report card rule violations (DRCRVs) by a targeted student, (3) RVs by any of the other students, and (4) the teacher's appropriate responses to each RV (ARRVs).

The first finding within the study is that the relationship between teacher behaviors and student behaviors started at a modest rating at baseline, but became significantly relevant as teachers developed integrity of appropriate responses. The second finding supported the first result significantly. The teachers that reached the desired integrity rate of 51% during Months 1 and 2 experienced half of the rule violations compared to the teachers below 51%. The third finding revealed that while all teachers received the same consultation, their implementation and understanding varied significantly, suggesting a need to individualize the training for a

variety of learning styles. Lastly, there was considerable difference in teachers reaching the 51% percent benchmark when comparing implementation for the target student versus all other students. Less than 20% of the teachers with a targeted student focus were able to achieve their integrity benchmark, whereas 60% of the teachers focused on all other classroom students met their 51% in the first two months. This finding supports the suggestion that implementing appropriate teacher response strategies for target students is more difficult than those in the remaining class population (Owens et al., 2020).

While the research outlines these positive results associated with appropriate teacher responses, rarely have the voices of the students, particularly those with ADHD diagnoses, been considered. Student perceptions of consequence and teacher reactions hold value and carry significance for study results. To address this gap, an interview study with narrative research was conducted by Honkasilta et al. (2016) in Finland. The researchers' aim was to discover insight from the viewpoint of those receiving the CMSs with specific consideration to the following concerns:

“(1) how the literature dominantly views ADHD as the object of [classroom management], thus subduing student voice and experience; (2) the similarity of classroom misbehaviour [*sic*] attributions made by students (with or without the label), begging the question of what role if any the concept of ADHD plays in this; and (3) the dearth of research literature on ADHD and CRM that voices student experience” (p. 102).

The study included 13 students selected from Finland's ADHD Association. The required screening criteria were that each student expressed willing participation of their own will, had a

formal diagnosis of ADHD, and met the age range of 11 to 16 years old. The interviews primarily took place within each participant's home environment in a room of their choice. Any interviews held in a different setting were per the families' requests. Interviews lasted approximately 90 minutes and were administered with a narrative interview method. The interview discussions were designed to promote student freedom to share and reflect on their experiences related to CMS. They also discussed broad topics of attendance, teachers, and ADHD.

Functional methods of research were also included such as Feelings Cards ranging through positive, neutral, and negative emotions. Though the cards-chosen data was not analyzed, the function of the cards was to guide the interviewer in asking open-ended questions correlating with the Feelings Cards that were selected by the participants. Post interview, the CMSs, which were identified as consequence-based reactive strategies, were categorized into having emotional and social consequences. They were then coded into the following subcategories of perceived teachers' behaviors: (1) *Disproportionate*, (2) *Traumatizing*, (3) *Negligent*, (4) *Unfair*, and (5) *Understanding*. Students were also asked to consider responsibility of their own behaviors within retelling their stories. They understood, however, that the reactions of their teachers were the intended point of focus, not their personal behaviors.

The qualitative research showed that 12 of the 13 student interviews contained negative evaluations of teacher conduct. *Disproportionate* was the subcategory that was dominantly identified by the participants in combination with describing their own misbehavior as having been minor. The narratives of the interviews suggested they had been victimized and

unjustly treated. There were very few narratives that suggested their teachers had understanding reactions or behaviors, and very few incidents that participants acknowledged the questionability of their misbehaviors. Within the literature discussion of this study, researchers identified that student narratives led to potential power struggles and aligned with the concept of blame culture - both teacher and student placing blame on the other. The most significant conclusion stated by Honkasilta et al. (2016) was that ADHD was barely mentioned or considered in the narratives of the students, and it was the student-teacher interactions and their perceptions of the those interactions that had made the greatest impact.

Although there is not one single strategy that will work for everyone, understanding how a chosen strategy makes students feel is critical in creating an optimal learning environment. Comparing how different CMSs are perceived and received helps educators as researchers make efficacious decisions for their classroom students' futures. A common and well received strategy used today is token economy. This CMS uses contingency management, where students can work toward rewards by executing desired targeted behaviors.

Humans' reward processing takes place within the ventral striatum region of the brain. The ventral striatum is strongly connected with emotion generators and plays a prominent role in the anticipation of reward (Sturm et al., 2016). This part of the brain tracks subjective values related to stimuli, makes predictions that signal expectation of reward, and is generally more active when anticipating positive stimuli (Tremblay et al., 2009). It functions in congruency with dopaminergic neurons which play a key role in controlling voluntary movement and behavior processes, which are both well known areas of challenge for students with ADHD (Chinta & Anderson, 2004).

Researchers van Hulst et al. (2017) investigated changes in brain activity performance of students with ADHD symptoms during the anticipatory stage of earning a reward. They sought to compare this activity with that of typically developing children. The study targeted children prior to adolescence. Previous studies of adolescents and adults with ADHD showed ventral striatum hypoactivity when anticipating a reward. For this reason, the researchers hypothesized similar results in the child participants' targeted brain region. In addition, it was hypothesized that the hypoactive effect would not be specific exclusively to ADHD diagnoses, but also among children diagnosed with Autism Spectrum Disorder (ASD) that displayed ADHD symptoms. This prediction was motivated by similar reports of changes in reward processing among people with ASD, schizophrenia, and major depressive disorder (Dichter et al., 2012, Dichter et al., 2010, Juckel et al., 2006, Kohls et al., 2014, & Smoski et al., 2009, as cited by van Hulst et al., 2017). Additional findings have suggested that children with ADHD generally prefer small immediate rewards over the larger delayed option, and that their task performance after having received the reward tends show greater improvement than their TD peers.

The study included a total of 76 right-handed boys that ranged in age from eight to 12 years old. The group of 76 was comprised of three categories for diagnoses: (1) children with ADHD diagnoses, (2) children with ASD diagnoses and ADHD symptoms, and (3) typically developing children. To participate in the study, the children with diagnoses could not be using medication unless it was a short-acting psychostimulant, in which case they agreed they would not take their medication for 24 hours prior to testing. Additional measures were used to indicate inclusionary criteria for the applicants. The instrumentation included a modified monetary incentive delay (MID) paradigm within a functional MRI (fMRI) scan context, the

parent version of the DISC-IV, the WISC-III, and the Child Behavior Checklist (CBCL). Exclusionary criteria included major illnesses, neurological illnesses (past or present), IQ score of less than 70, and metal object interference in or around the applicant's body.

In addition to the CBCL, parents were asked to complete the Strengths and Weaknesses of ADHD and Normal Behavior (SWAN) questionnaire as well as the Sensitivity to Punishment and Sensitivity to Reward Questionnaire for children (SPSRQ-c). Reward sensitivity refers to motivation and can reveal to what degree the students' behavior is driven by the offered reward. The researchers used the monetary incentive delay task (modified for children) to assess brain activity. The participants were told they could win money and were shown an image of a wallet with three prize values. Following, they were shown images of two cartoon characters that were said to be hiding the wallet. The children were instructed to predict correctly which character had the wallet to earn the reward. With each round, they would see an image of their cumulative earnings. They were not told, however, that the task outcome was fixed and their correct or incorrect choices had no bearing on the reward payout. The data was captured using a 3.0 T Achieva MRI scanner which is a whole-brain, three-dimensional fast field echo (p. 208). The effects were tested by diagnoses category and contained baseline data of a no-reward condition as well as changes to a high-reward condition. Furthermore, reward sensitivity was "assessed at three different levels: behavior in daily life (SPSRQ-C reward subscale), neuropsychological task performance (B0 vs. 15), and activity in ventral striatum" (p. 211).

The overall findings of the group showed that children with ADHD symptoms had less reward processing brain activity than the TD children but higher reward sensitivity in daily life.

van Hulst et al. (2017) described this as seeming “counterintuitive”, but described that children with ADHD may exhibit “behavior focused on short-term reward as a mechanism to normalize dopaminergic neurotransmission in striatum” (pp. 211-212). This study served additional motives relating to possible treatments, which were not discussed for the purpose of this literature review. Ultimately, the immediate reward (token economy) strategy was well received by students with ADHD symptoms and produced positive changes in their performance before and after the task.

Positive Behavioral Interventions and Supports

Another student feedback-based study was conducted to gain insight into the school experiences of adolescents diagnosed with ADHD. This interview-based study by Wiener and Daniels (2016) utilized mixed methods by collecting qualitative information through semi-structured interviews and collective quantitative research using rating scales, work samples, academic assessments, and a coding system for the interview transcripts. The aim was to link the students’ feedback and perceived experiences to their academic performance and social engagement. In addition, students were asked to describe their ideal teacher and ideal classroom practices. The purpose was to collect valuable details that may aid in designing new and improved support deliveries and strategies for students with ADHD.

Twelve adolescents ranging in age from 14 to 16 years old participated in the study. All participants were required to have been formerly diagnosed by a clinician and to have obtained parent and teacher rated scores ranging within “borderline” to “clinical” categories on the Conners Rating Scales- Revised (Conners, 1997, as cited by Wiener & Daniels, 2016). Some of the participants had been diagnosed with a learning disability, and some took psychostimulant

medication regularly. Potential applicants of the study were excluded, however, if they had any of the following: “intellectual disability... autism spectrum disorder, psychotic disorder, bipolar disorder, or Tourette disorder” (p. 569).

In addition to the parent and teacher rating scales utilized, students were instructed to provide previous work, samples of tests, and report cards. Before their interviews, each participant filled out a questionnaire about friendships. The interviews varied in length from two hours to three hours and 15 minutes. They were semi-structured interviews with preselected topics, but allowed for flexibility depending on the information students wished to share. After, students completed rating scales and were administered parts of the WJ-III as standardized academic assessment. Students participated in a follow up interview two to four months later to overview their initial interview, clarify vague commentary, and ask questions.

The researchers then used grounded theory methodology to develop a explanation of the data. They found that three main themes developed when analyzing the interview transcripts, and within each of them, subthemes. The first theme was titled “Support for a Performance Deficit” which divided interview responses into three subgroups of *inadequate and inconsistent study skills, procrastination, and absence of goals and plans* (pp. 570-572). The second theme was “Social Engagement”, which was sorted into *challenges with social relationships and benefits of a singular pursuit* (pp. 573-574). They called the last theme “From Dependence to Independence” which addressed the areas of *decreased parental involvement, increased demands for autonomy, and self-advocacy* (pp. 574-575). These themes were the result of what Wiener and Daniels (2016) described about the interviewees as “quite open” and having “frankly shared their perceptions” (p. 576).

The findings of the study suggested that CMSs focused on organization skills, mindfulness, and advocacy would benefit students with ADHD. During the interviews, many of the students expressed a desire to learn, but often had feelings of defeat due to distractions, difficulties in materials management, teacher acceptance, and homework accountability. When the students were asked what their ideal teacher would be like, they stated the following: open-minded, nice, helpful, supportive, holding students accountable, not too laid back, informed about ADHD, and funny (pp. 572-573). In addition, when asked about ideal teaching methods and conditions within their classrooms, students expressed a desire for minimal visual distractions, content taught in active and engaging ways, consistent homework checks, interactive discussions, content explained in ways children can understand, and fun. The participants expressed that these characteristics would create a more enjoyable school experience and atmosphere.

Lastly, results in the area of social engagement revealed a lack of awareness among the student participants. All twelve students shared experiences of having been bullied in school yet appeared to have an overextended count of their friendships. When asked to recite the names of their friends, they could properly name only a small sample of those initially stated. This effect of positive illusory bias (PIB) is common in children with ADHD. These results suggest that strategies integrating social skills opportunities in the classroom may be beneficial to their peer relationships and social outcomes.

With such a vast variety of student needs, behavior management has been a longtime mystery for educators. Past research has confirmed that strategies of positive behavioral interventions and supports (PBIS) can and do produce positive results and is generally

implemented as a school wide practice (SW-PBIS). This requires a significant amount of teacher buy-in, however, and does not guarantee classroom-level implementation or long lasting fidelity. Reinke et al. (2013) administered direct observations in schools that implemented PBIS at the classroom-level in alignment to their school-wide program. They examined the correlation between how teachers specifically used the strategies and their classroom outcomes. They sought specific measures of teacher-reported management efficacy and emotional exhaustion. They hypothesized that the higher ratios of positive-to-negative interactions in congruency with low counts of harsh reprimands would result in more positive classroom behaviors. In addition, they anticipated results of higher self-efficacy with lower emotional exhaustion than in an opposing scenario (negative-to-positive).

The sample of this study was randomly selected from a group of teachers recruited by the Incredible Years Teacher Classroom Management Program (WebsterStratton, 1997, as cited by Reinke et al., 2013). A total of 33 (K-3) teachers from three urban district elementary schools participated. These teachers were rated as practicing PBIS with high fidelity. Each teacher had anywhere from two to 29 years of teaching experience. In addition, six observers completed four weeks of training and practice to master the computerized analysis instrumentation prior to the actual observations.

Upon observation time, hand computer observation systems called Multi-Option Observation System for Experimental Studies (MOOSES; Tapp, 2004, as cited by Reinke et al., 2013) were used to capture classroom interactions such as student-to-student and student-teacher. Observations ranged in time, but the average length was 47 minutes. Each classroom's direct observation took place within a single day in the month of October to collect data early

within the academic year, and took place during the subjects of either reading or math.

Frequency counts were taken of behaviors of both teachers and students. Each student was specifically targeted for 5 minutes before shifting to another student. Overall totals were calculated.

The behavioral data observed was divided into six categories and were defined by the Reinke et al. (2013) as follows:

“[1] Student disruptive behavior was defined as any behavior that interrupts instruction; [2] general praise was defined as any verbal statement or gesture that indicates approval and does not name a specific behavior; [3] specific praise was defined as any verbal statement or gesture that indicates approval and names a specific behavior; [4] explicit reprimands were defined as verbal comments or gestures by the teacher that indicate disapproval of behavior, but were concise (brief) and issued in a normal speaking tone; and [5] harsh reprimands were defined as verbal comments or gestures indicating disapproval of a behavior that is prolonged, uses excessive force, or uses a voice louder than typical for the setting or a harsh, critical, or sarcastic tone (e.g., teacher grabbing a student by the arm, reprimand that stops instruction and lasts for 30 s or more). [sic] [6] Opportunities to respond were defined as an instructional prompt (statement, gesture, or visual cue) that requires an immediate academic response to the teacher” (p. 43).

Immediately upon completion of each observation, the observers completed a 20-item questionnaire called the Classroom Ecology Checklist. In addition, teacher-reported data was gathered through two rating scales throughout the three week process. The Teacher Sense of

Self-Efficacy Scale was utilized to rate 24 areas of teacher efficacy, and 22 areas of emotional exhaustion were rated using the 7-point scale, Maslach Burnout Inventory (teacher version).

The findings of this study aligned with the researchers' hypotheses with regard to positive-to-negative strategy ratios and outcomes. Teachers that had higher rates of using general praise also reported they felt more efficacious with their classroom management. In turn, teachers that experienced higher volumes of disruptive behavior in their classrooms had lower ratings for using praise and higher ratings for the use of reprimands. These teachers also reported higher rates of emotional exhaustion. Further data showed that of the 33 teachers, only one of them used specific praise frequently. All other praise was generalized, which Reinke et al. (2013) referred to as "less than optimal" for positive outcome potential (p. 39). Based on an overview of the findings, it was concluded that classroom-level PBIS are effective CMS options that require minimal resources to initiate and maintain.

The final study of this literature review is neither explicit to CMSs for unique learners nor perception based research. Its purpose within this review is to demonstrate and confirm the effectiveness of positive management strategies in the classroom setting. As previously investigated, PBIS has been consistent in producing improved outcomes in comparison to harsh reprimands (Reinke et al., 2013). Haydon & Kroeger (2016) conducted a replication study to evaluate the reliability and effectiveness of combined interventions as they had been previously investigated. The specific PBIS strategies included a combination of active supervision, pre-correction, and explicit timing procedures with the goal of reducing problem behaviors, decreasing transition time, and supporting long-term implementation within the classroom setting.

Data collection involved an interobserver agreement, which required training and concise definitions for data reporting accuracy. Active supervision included a teacher circulating and scanning the room in addition to interacting with students and demonstrating expectations. Pre-corrections involved specific prompts and reminders prior to class starting as students entered the room. Explicit timing procedures were implemented as specifically announced limits of time to complete tasks, then holding the students accountable by announcing when the allotted time was over. The two questions that drove this study were: (1) “What is the effect of active supervision, pre-correction, explicit timing procedure on the level of student problem behavior?” and (2) “What is the effect of active supervision, pre-correction, explicit timing on the duration of transition?” (p. 71).

The study was conducted in an urban area high school with a PBIS initiative. The classroom observed was a grade 9 co-taught class. Three teachers participated in the study, and were identified as lead, co-teacher, and student teacher. The lead teacher had 21 years of previous experience and was certified by the National Board for Professional Teaching Standards in English language arts. The co-teacher had 13 years of experience and was certified in secondary social studies. Both of these teachers’ experience was spent teaching within the targeted school district. The student teacher was in-process of completing his final year of graduate school to obtain a master’s degree in secondary education. All three teachers shared responsibilities in instruction planning.

The method of the study involved an experimental withdrawal design. The baseline phase involved the teachers raising their voices with reprimands in response to inappropriate classroom behaviors. The interventions phase used the combination of active supervision, pre-

correction, and explicit timing procedures. Interventions were then withdrawn to return to the baseline phase and ended with the reintroduction of interventions. In addition, a maintenance period was recorded at three weeks post-completion of the observations. Its purpose was to see if the teachers chose to continue the strategies, and if so, how the results compared to the prior data.

One of the most profound findings occurred before the implementation of the study had been completed. During the withdrawal process, the researchers intended to allow for a period of time relative to the baseline and intervention periods. However, the removal of the interventions resulted in an immediate and significant increase in inappropriate classroom behaviors. The researchers chose to take only that one data point and have the teachers return to the combined interventions. Overall results showed a decrease in transition time and a significant decrease in problematic classroom behaviors with the use of these PBIS strategies. These same findings proved true during the maintenance phase of the study. Furthermore, it was confirmed that educators can improve behaviors and routines in their classrooms with as little as 30 minutes of PBIS training, and the willingness to practice it with fidelity (Haydon & Kroeger, 2016).

CHAPTER III: DISCUSSION AND CONCLUSION

Summary of Literature

The purpose of this thesis was to explore effective CMS options for teachers of students with ADHD in correlation to diagnosis related symptoms, academic and behavioral outcomes, and consequences. Thirty peer reviewed studies were involved to answer the driving question: What classroom management strategies can prolong on-task behaviors and increase success for special education students with ADHD? The studies reviewed were categorized into three focal points: (1) CMS effectiveness, (2) the effect of inattention on academic achievement, and (3) perception of consequences. The findings of this literature review show there is no one CMS that it recommended over the others. However, it does provide evidence of positive results for each CMS as they relate to target concerns and desired outcomes.

ABIs proved to be a fairly simple application, providing a preventative approach by adjusting the academic environment. Taking these steps proved that both academic success and on-task behaviors could be increased (Gaastra et al., 2020; Pulay et al., 2018). Some research produced slightly contradictory results, however. While the Gaastra et al. (2020) study concluded that academic success was the result of ABIs and behavioral success was the result of consequence-based interventions, Staff et al. (2021) found both strategies resulted in academic improvements based on student age. They found that younger students with ADHD were more motivated by consequence-based interventions while older youth were motivated by ABIs, which was believed to be a result of their ability to process intrinsic motivation.

A CMS that produced profound results was function-based interventions. This strategy proved to decrease problem behaviors and increase academic achievement with stability

throughout the study (Cho & Blair, 2017). The down side to this strategy is that it is designed for specific needs of a target student after an FBA. While function-based CMSs benefit ADHD subtypes and symptoms better than generalized interventions they require more time and individualized planning (Moffett & Morrison, 2020). Furthermore, in a group setting, multiple function-based interventions may need to be designed to meet a variety of student behaviors.

The final CMS reviewed was self-monitoring. This strategy produced more literature results in the initial search than any other, and had produced the most consistent results when comparing studies. Alsalamah (2017) and Harrison et al. (2019) found that self-monitoring produced vast improvements in both academic performance and classroom behaviors. Evidence also showed that significant outcomes were produced within a short period of time, and students were able to develop greater self-control over a period of time, leading to lasting results with a faded demand for intervention (Schuck et al., 2016; Vogelgesang et al., 2016). Furthermore, ratings among teachers and students proved the strategies' social validity and ease of implementation (Ennis et al., 2018).

One additional method worthy of mention is digital cognitive therapy. It is not currently identified as a CMS but is a clinical therapy designed to potentially treat ADHD. This unexpected topic of research surfaced repeatedly during the initial search process, and it appears to be an increasingly popular topic since 2019. Although these studies took place in clinical and home settings, the tools and application processes are feasible for classroom use based on the current implementation of digital learning platforms in the educational setting. Research results such as those of Shema-Shiratzky et al. (2019) present potential for successful classroom application.

The second aim of this thesis focused on the connection between on-task/off-task behaviors and academic outcomes. With inattention being one of the most prevalent symptoms of ADHD, the literature provided evidence that poor academic outcomes are a result of inattention. Of all the studies reviewed, none suggested or proved otherwise. Studies by both Evans et al. (2020) and Gray et al. (2017) supported that inattention is directly related to poor academic outcomes. This was proven, in part, by comparing similar symptom diagnoses. Furthermore, another study showed that when students with ADHD were given the opportunity to rate their own academic motivators, they rated *Marked/graded*, *Collaborative*, and *Requiring focus* activities much lower than their TD peers; they also rated *Cognitively challenging* activities as non-motivating (Morsink et al., 2021). An inability to practice prolonged attention is sure to affect performance within these categories, putting into perspective the students' challenges and points of view.

Looking at ADHD related inattention with a broad scope, the literature supported that academic performance is affected regardless of culture or setting. Similar results were found throughout regions of the United States, across international borders, rural areas, and urban areas. The academic achievement when comparing students with ADHD to their TD peers was significant in each of these studies, and although socio-economics could be a contributing factor for students, it was determined by Lawrence et al. (2021) that it was not the primary cause. Each of the studies confirmed that inattention was a key contributing factor to poor academic results.

The third and final aim of this review was to consider CMS consequences and how they are perceived. Multiple articles suggested that students with ADHD face stigmatization. These

studies showed how teacher bias and reprimand-based reactions led to negative student-teacher relationships and missed their desired outcomes (Honkasilta et al., 2016; Metzger & Hamilton, 2021). When students were given the opportunity to express their desires in the classroom, the majority of the participants stated they wanted a positive, fun, and encouraging teacher (Wiener & Daniels, 2016). These findings encourage and support the use of PBIS in the classroom. As found in additional studies, the implementation of strategies perceived as positive produced higher management efficacy in the classroom and decreased transition time and problem behaviors (Haydon & Kroeger, 2016; Reinke et al., 2013).

Professional Application

As studied by Rosalez et al. (2019), the use of white noise was a CMS that produced significant results. Not only did the researchers witness greater on-task behaviors, assignment completions, and sleep quality, but these improvements in classroom behaviors and sleep patterns were found during Phase C, when white noise was administered in the classroom setting only. These results suggest that application in the classroom alone can have a positive impact even when outside stakeholders, such as parents are unable or unwilling to implement the strategy at home. This ABI can be implemented with a simple device and headphones and would require minimal cost and training for staff.

A few of the studies within the literature showed that training, fidelity, and integrity of implementation play a considerable part in the outcomes. Gaastra et al. (2020) found that some basic consequence-based and self-monitoring interventions were not being carried out with fidelity because teachers felt they needed more support and resources. However, Owens et al. (2020) found that even when teachers were trained on using appropriate positive

responses, only 60% of the participating teachers reached their desired benchmark of implementation for their class, and less than 20% met their desired benchmark of implementation for their targeted ADHD students. Although a low percentage of implementation integrity, the strategy led to evident results of less rule violations consistently throughout the classroom. Furthermore, using a positive approach achieved greater social validity from students, and PBIS was rated by teachers as a strategy that reduced emotional exhaustion (Reinke et al., 2013).

ADHD Culture

As educators approach the variety of CMSs available, it may be beneficial to consider that the population of youth with ADHD share similarities within their experiences, challenges, and cognitive nuances. For example, several researchers have put into consideration the positive illusory bias that has been found within the self-ratings of students with ADHD (Liu et al., 2017). Having this background knowledge may assist educators in gathering less skewed data through proactive measures such as clearly defining the self-monitoring categories, explaining them to students, and checking for understanding prior to implementation.

Furthermore, subtypes of ADHD diagnoses have proven to lead to variations in academic outcomes. While every student is unique with individualized needs, the diagnosis is subcategorized, and inattention plays a larger role in some subtypes than in others. Tan et al. (2022) discovered that ADHD Inattention type and ADHD Combined type have the lowest academic outcomes in comparison to ADHD Hyperactive type where inattention is not the primary or key symptom. Moffett & Morrison (2020) took research even further by

subcategorizing types of inattention and recording the variance within related academic incomes.

Limitations of Research

The initial search for this literature review was conducted using the key word combinations and databases as outlined in Chapter II. A *peer reviewed* filter was also used, which produced a total of 1,649 results. Only articles with the specific predetermined criteria were considered. Articles were first screened according to date. To be sure the results were recent the articles were required to be published from 2016 through 2022. One exception was made for the Reinke et al. (2013) study for its research topic of classroom-level PBIS as compared to the more common school-wide approach.

The next method of screening was title scanning. The title was required to meet one of the three main focal points of this thesis. The first included CMSs that applied to students with ADHD. The second did not have to include ADHD, but did have to demonstrate direct connection between on-task/off-task behavior effects on academic outcomes. The third had to include student or teacher perceptions in direct relation to strategies and/or consequences. If the title suggested one of those three, the abstracts were then read to ensure each study's purpose met the suggested focal point as it related to this review. A total of 53 articles were collected using this method.

The 53 articles were coded according to the focal point category as well as their strength and relevance of their findings. Upon further research, some studies proved to be less relevant to the guiding question and focal points than expected and were later excluded. Examples of this are articles about CMSs excluding application to students with ADHD and articles about

strategies intended for post-secondary students rather than grades K-12. A total of 30 articles were selected as the body of literature for review. Additional research references were included for clarification and definitions as needed. Twenty-three of the original coded articles were not used.

A limitation in the research was in the area of classroom incorporated therapeutic movement. In attempt to research alternative seating, therapy seating, and the use of fidgets for prolonged focus, very few articles were produced within the search. Another limitation in the research was the comparison of CMS effects for students with ADHD who use medications for their related symptoms and those who do not. The studies within this review required their participants to stop taking medications during intervention application. If these students with ADHD were studied in comparison to their TD peers, it seems relevant to study them in comparison with peers of the same diagnosis who participate in medical interventions.

Implications for Further Research

Three topics of research that remain limited or provoke questions within this literature review are the token economy concept, the use of alternative seating and fidgets, and the use of digital cognitive therapy treatments. The first, token economy is a strategy commonly used in classrooms by associating positive reward with positive behaviors. Literature was limited in this area and produced varied results. While the findings of the van Hulst et al. (2017) study supported token economy as being well received and capable of making an impact on students' with ADHD behaviors, Morsink et al. (2021) questioned the effectiveness of token economy concepts after performing the student-rated motivators study. The effectiveness for token economy application with students with ADHD remains unclear.

Searching the second topic produced very few results. Evidentiary support for the effectiveness of alternate seating and fidgets to prolong focus was near obsolete during this literature review search. Only three results were found, and the abstracts suggested that the use of these items did not prolong focus or increase on-task behaviors. Yet, wobble chairs, therapy balls, and fidgets are being heavily used in Minnesota schools. What evidence exists then to support the use and funding of these classroom materials?

The final topic, digital cognitive therapy did not fall within the original criteria guidelines and was not something initially being researched. However, as recently published articles continued to surface within the search results, it became apparent that this treatment method is a topic of growing interest and exploration for ADHD symptoms. Although this is a clinical therapy, not a CMS, the findings of these studies show evidence of outcomes that have the potential to directly affect student performance. Gallen et al. (2021) discovered an overall improvement in MFT, improvement in attention sustainability, and 44% of the participants no longer qualified under the original ADHD symptom related criteria after implementation of the therapy. The Shema-Shiratzky et al. (2019) study showed evidence of decreased social problems, EF and memory index score increase, and retention at the six-week follow up after implementation had stopped. Children with ADHD that received this treatment were rated for their inattentiveness in the Capodeici et al. (2019) study, and the treatment was found to be positively effective for inattention, particularly as rated by teachers.

All of the digital cognitive therapy literature within this review involved implementation within the clinical and/or home setting and was applied through a series of game play sessions. These sessions were rated with high social validity by the children, and implemented with

fidelity by parents. A question less explored, or unexplored, is: why hasn't this been introduced as an intervention in the classroom setting? Offering this in the clinical and home setting only, limits access for children with ADHD based on parents'/guardians' level of involvement, abilities, resources and fidelity, which may limit the results and application potential. Used as an intervention in a classroom environment, fidelity could be monitored, better controlled and potentially reduce some of the demands of intervention planning for special education staff.

Conclusion

The driving question of this literature review sought to find which CMSs can prolong on-task behaviors and increase success for special education students with ADHD. The conclusion of this research is that there is no solitary winner when comparing evidence-based CMS effectiveness. ABIs, consequence-based, function-based, and self-monitoring interventions all have the potential to increase academic outcomes and desired behaviors, with self-monitoring showing the most consistent results across studies. Although it requires high fidelity by staff, it has proven to produce long term results and teach independence to students.

In addition to these findings, all of the literature recognized the importance of on-task behaviors for positive academic outcomes. Inattention was identified as a key concern for students with ADHD as it relates to their ability to perform commensurate to their TD peers. Evidence suggests that the CMSs educators choose should be easy to use, well defined, and take a positive approach. These characteristics have proven to produce valued teacher-student relationships and positive perceptions leading to high social validity. While every student has unique needs and every educator has individualized strengths, the literature of this review provides a wide variety of proven methods that can be implemented to address the concerns of

ADHD related inattention regardless of the diagnosis subtype, classroom resource access, and international educational platform.

References

- Alsalamah, A. (2017). Use of the self-monitoring strategy among students with Attention Deficit Hyperactivity Disorder: A systematic review. *Journal of Education and Practice, 8*(14), 118-125. <https://files.eric.ed.gov/fulltext/EJ1143820.pdf>
- Applied Behavior Analysis Edu.org. (n.d.). *What is an antecedent-based intervention in applied behavior analysis?* <https://www.appliedbehavioranalysisedu.org/what-is-an-antecedent-based-intervention/>
- Bureau of Special Education. (n.d.). *Functional behavior assessment (FBA) process*. Pennsylvania Department of Education. [https://www.pattan.net/getmedia/eca12015-858b-4448-962d-753816d71e20/FBA_ProcessBklt0516#:~:text=BEHAVIORAL%20ASSESSMENT%20\(FBA\)-,PROCESS,is%20serving%20for%20the%20student](https://www.pattan.net/getmedia/eca12015-858b-4448-962d-753816d71e20/FBA_ProcessBklt0516#:~:text=BEHAVIORAL%20ASSESSMENT%20(FBA)-,PROCESS,is%20serving%20for%20the%20student)
- Capodieci, A., Maria Re, A., Fraccaa, A., Borella, E., & Carretti, B. (2019). The efficacy of a training that combines activities on working memory and metacognition: Transfer and maintenance effects in children with ADHD and typical development. *Journal Of Clinical and Experimental Neuropsychology, 41*(10), 1074–1087. <https://doi.org/10.1080/13803395.2019.1651827>
- Centers for Disease Control and Prevention. (2021). *What is ADHD?* <https://www.cdc.gov/ncbddd/adhd/facts.html>
- Children and Adults with Attention-Deficit/Hyperactivity Disorder. (n.d.) *General prevalence of ADHD*. <https://chadd.org/about-adhd/general-prevalence/>

- Chinta, S. J., & Andersen, J. K. (2005). Dopaminergic neurons. *The International Journal of Biochemistry & Cell Biology*, 37(5), 942–946.
<https://doi.org/10.1016/j.biocel.2004.09.009>
- Cho, S. & Blair, K. C. (2017). Using a multicomponent function-based intervention to support students with Attention Deficit Hyperactivity Disorder. *Journal of Special Education*, 50(4), 227-238. <https://doi.org/10.1177/0022466916655186>
- Corey, T., (2021). *Comparison of a consequence based-intervention and an antecedent/consequence hybrid intervention in the classroom* (Publication No. 28678931) [Master's Thesis, Youngstown State University]. ProQuest Dissertations Publishing.
- Diamond A. (2013). Executive functions. *Annual Review of Psychology*, 64, 135–168.
<https://doi.org/10.1146/annurev-psych-113011-143750>
- Ennis, R. P., Lane, K. L., & Oakes, W. P. (2018). Empowering teachers with low-intensity strategies to support instruction: Self-monitoring in an elementary resource classroom. *Preventing School Failure*, 62(3), 176–189.
<https://doi.org/10.1080/1045988X.2017.1408055>
- Evans, S. C., Cooley, J. L., Blossom, J. B., Pederson, C. A., Tampke, E. C., & Fite, P. J. (2020). Examining ODD/ADHD symptom dimensions as predictors of social, emotional, and academic trajectories in middle childhood. *Journal of Clinical Child & Adolescent Psychology*, 49(6), 912-929. <https://doi.org/10.1080/15374416.2019.1644645>
- FABAS (n.d.). *Function based intervention*. <https://www.fabasinc.org/schools/function-based-intervention/>

- Gaastra, G. F., Groen, Y., Tucha, L., & Tucha, O. (2016). The effects of classroom interventions on offtask and disruptive classroom behavior in children with symptoms of Attention-Deficit/Hyperactivity Disorder: A meta-analytic review. *PLOS ONE*, *11*(2), 1-19.
<https://www.doi.org/10.1371/journal.pone.0148841>
- Gaastra, G. F., Groen, Y., Tucha, L. & Tucha, O. (2020). Unknown, unloved? Teachers' reported use and effectiveness of classroom management strategies for students with symptoms of ADHD. *Child & Youth Care Forum*, *49*(1), 1-22. <https://doi.org/10.1007/s10566-019-09515-7>
- Gallen, C. L., Anguera, J. A., Gerdes, M. R., Simon, A. J., Cañadas, E., & Marco, E. J. (2021). Enhancing neural markers of attention in children with ADHD using a digital therapeutic. *PLOS ONE*, *16*(12), 1-14. <https://doi.org/10.1371/journal.pone.0261981>
- Gray, S. A., Dueck, K., Rogers, M., & Tannock, R. (2017). Qualitative review synthesis: The relationship between inattention and academic achievement. *Educational Research*, *59*(1), 17-35. <https://doi.org/10.1080/00131881.2016.1274235>
- 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. <https://doi.org/10.3102/0034654319857038>
- Haydon, T., & Kroeger, S. T. (2016). Active supervision, precorrection, and explicit timing: A high school case study on classroom behavior. *Preventing School Failure: Alternative Education for Children and Youth*, *60*(1), 70-78.
<https://doi.org/10.1080/1045988X.2014.977213>

Honkasilta, J., Vehkakoski, T., & Vehmas, S. (2016). 'The teacher almost made me cry' Narrative analysis of teachers' reactive classroom management strategies as reported by students diagnosed with ADHD. *Teaching and Teacher Education, 55*, 100-109.

<https://doi.org/10.1016/j.tate.2015.12.009>

International Board of Credentialing and Continuing Education Standards. (n.d.). *Impact of anxiety and depression on student academic progress.*

<https://ibcces.org/blog/2019/05/01/impact-anxiety-depression-student-progress/>

IRIS Center. (n.d.). *Which study skills strategies can improve students' academic performance?*

<https://iris.peabody.vanderbilt.edu/module/ss2/cresource/q1/p08>

Ishii, R., Shinosaki, K., Inouye, T., Ishihara, T., Yoshimine, T., Hirabuki, N., Asada, H., Kihara, T.,

Robinson, S. E., & Takeda, M. (1999). Medial frontal cortex generates frontal midline theta rhythm. *Neuroreport, 10*(4), 675-679. [https://doi.org/10.1097/00001756-](https://doi.org/10.1097/00001756-199903170-00003)

[199903170-00003](https://doi.org/10.1097/00001756-199903170-00003)

Lawrence, D., Houghton, S., Dawson, V., Sawyer, M., & Carroll, A. (2021). Trajectories of academic achievement for students with Attention-Deficit/Hyperactivity Disorder.

British Journal of Educational Psychology, 91, 755–774.

<https://doi.org/10.1111/bjep.12392>

Light Sources and Color. (2004). *NLPIP: Lighting Answers, 8*(1).

[https://www.lrc.rpi.edu/programs/nlPIP/lightinganswers/lightsources/whatiscct.asp#:~:text=Correlated%20color%20temperature%20\(CCT\)%20is,required%20to%20specify%20a%20chromaticity](https://www.lrc.rpi.edu/programs/nlPIP/lightinganswers/lightsources/whatiscct.asp#:~:text=Correlated%20color%20temperature%20(CCT)%20is,required%20to%20specify%20a%20chromaticity)

- Liu, C., Huang, W., Kao, W., & Gau, S. S. (2017). Influence of disruptive behavior disorders on academic performance and school functions of youths with Attention Deficit/Hyperactivity Disorder. *Child Psychiatry & Human Development*, *48*, p. 870–880.
<https://doi.org/10.1007/s10578-017-0710-7>
- Metzger, A. N. & Hamilton, L. T. (2021). The stigma of ADHD: Teacher ratings of labeled students. *Sociological Perspectives*, *64*(2) 258–279.
<https://doi.org/10.1177/0731121420937739>
- Meyer, K. N., Santillana, R., Miller, B., Clapp, W., Way, M., Bridgman-Goines, K., & Sheridan, M. A. (2020). Computer-based inhibitory control training in children with Attention-Deficit/Hyperactivity Disorder (ADHD): Evidence for behavioral and neural impact. *PLOS ONE*, *15*(11), 1-25. <https://doi.org/10.1371/journal.pone.0241352>
- Moore, D. A., Russell, A. E., Arnell, S., & Ford, T. J. (2017). Educators' experiences of managing students with ADHD: A qualitative study. *Child: Care, Health and Development*, *43*(4), 489–498. <https://doi.org/10.1111/cch.12448>
- Moffett, L., & Morrison, F. (2020). Off-task behavior in kindergarten: Relations to executive function and academic achievement. *Journal of Educational Psychology*, *112*(5), 938 – 955. <http://dx.doi.org/10.1037/edu0000397>
- Morsink, S., Sonuga-Barke, E., Van der Oord, S., Van Dessel, J., Lemièrè, J., & Danckaerts, M. (2021). Task-related motivation and academic achievement in children and adolescents with ADHD. *European Child & Adolescent Psychiatry*, *30*, 131–141.
<https://doi.org/10.1007/s00787-020-01494-8>

Owens, J. S., Evans, S. W., Coles, E. K., Holdaway, A. S., Himawan, L. K., Mixon, C. S., & Egan, T.

E. (2020). Consultation for classroom management and targeted interventions: Examining benchmarks for teacher practices that produce desired change in student behavior. *Journal of Emotional and Behavioral Disorders*, *28*(1), 52–64.
<http://doi.org/10.1177/1063426618795440>

Oxford University Press. (n.d.). Success. In *Oxford Languages*.

<https://www.google.com/search?q=success+definition>

Pulay, A., Read, M., Tural, E., & Lee, S. (2018). Examining student behavior under two correlated color temperature levels of lighting in an elementary school classroom. *Educational Planning*, *23*(3), 58-69. <https://files.eric.ed.gov/fulltext/EJ1208410.pdf>

Reinke, W. M., Herman, K. C., & Stormont, M. (2013). Classroom-level positive behavior supports in schools implementing SW-PBIS: Identifying areas for enhancement. *Journal of Positive Behavior Interventions*, *15*(1), 39–50.
<https://www.doi.org/10.1177/1098300712459079>

Rosalez, E., Johnson, C. M., Bradley-Johnson, S., & Kanouse, S. (2019). Effects of white noise on off-task behavior and sleep for elementary-age students with ADHD. *Child & Family Behavior Therapy*, *42*(1), 20-36. <https://doi.org/10.1080/07317107.2019.1690735>

Schuck, S., Emmerson, N., Ziv, H., Collins, P., Arastoo, S., Warschauer, M., Crinella, F., & Lakes, K. (2016). Designing an iPad app to monitor and improve classroom behavior for children with ADHD: iSelfControl feasibility and pilot studies. *PLOS ONE*, *11*(10), 1-13.
<https://doi.org/10.1371/journal.pone.0164229>

Shema-Shiratzky, S., Brozgol, M., Cornejo-Thumm, P., Geva-Dayan, K., Rotstein, M., Leitner, Y., Hausdorff, J. M., & Mirelman, A. (2019). Virtual reality training to enhance behavior and cognitive function among children with Attention-Deficit/Hyperactivity Disorder: Brief report. *Developmental Neurorehabilitation*, *22*(60), 431–436.

<https://doi.org/10.1080/17518423.2018.1476602>

Staff, A. I., van den Hoofdakker, B. J., van der Oord, S., Hornstra, R., Hoekstra, P. J., Twisk, J. W. R., Oosterlaan, J., & Luman, M. (2021). Effectiveness of specific techniques in behavioral teacher training for childhood ADHD behaviors: Secondary analyses of a randomized controlled microtrial. *Journal of Clinical Child & Adolescent Psychology*, *50*(6), 763-779.

<https://doi.org/10.1080/15374416.2020.1846542>

Sturm, V. E, Haase, C. M., & Levenson, R. W. (2016). Chapter 22 - Emotional dysfunction in psychopathology and neuropathology: Neural and genetic pathways. In Lehner, T., Miller, B. L., & State, M. W. (Eds.), *Genomics, Circuits, and Pathways in Clinical Neuropsychiatry* (pp. 345-364). Academic Press. <https://doi.org/10.1016/B978-0-12-800105-9.00022-6>

Tan, T. X., Liu, Y., Damjanovic, V., Ledford, E., Li, G., & Li, Y. (2022). Inattention, hyperactivity/impulsivity, and academic competence: Findings from three cohorts. *British Journal of Educational Psychology*, *92*, 82–104.

<https://doi.org/10.1111/bjep.12439>

Tremblay, L., Worbe, Y., & Hollerman, J. R. (2009). Chapter 3 - The ventral striatum: A heterogeneous structure involved in reward processing, motivation, and decision-

making. In Dreher, J., & Tremblay, L. (Eds.), *Handbook of Reward and Decision Making* (pp. 51-77). Academic Press. <https://doi.org/10.1016/B978-0-12-374620-7.00003-0>

van Hulst, B. M., de Zeeuw, P., Bos, D. J., Rijks, Y., Neggers, S. F. W. & Durston, S. (2017).

Children with ADHD symptoms show decreased activity in ventral striatum during the anticipation of reward, irrespective of ADHD diagnosis. *Journal of Child Psychology and Psychiatry*, 58(2), 206-214. <https://doi.org/10.1111/jcpp.12643>

Vogelgesang, K. L., Bruhn, A. L., Coghill-Behrends, W. L., Kern, A. M., & Troughton, L. C. W.

(2016). A single-subject study of a technology-based self-monitoring intervention. *Journal of Behavioral Education*, 25, 478–497. <https://doi.org/10.1007/s10864-016-9253-4>

Wiener, J. & Daniels, L. (2016). School experiences of adolescents with Attention-

Deficit/Hyperactivity Disorder. *Journal of Learning Disabilities*, 49(6), 567–581. <https://doi.org/0.1177/0022219415576973>