Florida International University
FIU Digital Commons

FIU Electronic Theses and Dissertations | University Graduate School

6-17-2022

The Interplay Between Parental Executive Functioning, Parental Stress, and Parenting Skills Across a Parenting Intervention

Taylor Landis
Florida International University, tland018@fiu.edu

Follow this and additional works at: https://digitalcommons.fiu.edu/etd

Part of the Clinical Psychology Commons

Recommended Citation

Landis, Taylor, "The Interplay Between Parental Executive Functioning, Parental Stress, and Parenting Skills Across a Parenting Intervention" (2022). *FIU Electronic Theses and Dissertations*. 5055.
https://digitalcommons.fiu.edu/etd/5055

This work is brought to you for free and open access by the University Graduate School at FIU Digital Commons. It has been accepted for inclusion in FIU Electronic Theses and Dissertations by an authorized administrator of FIU Digital Commons. For more information, please contact dcc@fiu.edu.

FLORIDA INTERNATIONAL UNIVERSITY

Miami, Florida

THE INTERPLAY BETWEEN PARENTAL EXECUTIVE FUNCTIONING, PARENTAL STRESS, AND PARENTING SKILLS ACROSS A PARENTING INTERVENTION

A dissertation submitted in partial fulfillment of

the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

PSYCHOLOGY

by

Taylor Danielle Landis

2022

To: Dean Michael R. Heithaus
College of Arts, Sciences and Education

This dissertation, written by Taylor Danielle Landis, and entitled The Interplay between Parental Executive Functioning, Parental Stress, and Parenting Skills across a Parenting Intervention, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

Joseph Raiker

Daniel Bagner

Andy Pham

Paulo Graziano, Major Professor

Date of Defense: June 17, 2022

The dissertation of Taylor Danielle Landis is approved.

Dean Michael R. Heithaus
College of Arts, Sciences and Education

Andrés G. Gil
Vice President for Research and Economic Development
and Dean of the University Graduate School

Florida International University, 2022

© Copyright 2022 by Taylor Danielle Landis

All rights reserved.

ACKNOWLEDGMENTS

I'd like to take this space to recognize and thank the people and places that have contributed to my journey beyond this mere milestone. I wouldn't be here if it weren't for those who supported every step of the way. Thank you to my professional and academic mentors, professors, and colleagues at Penn State. You can take a girl out of PA, but you can't take PA out of the girl. Miami, you will always have a special place in my heart. I'd like to thank my advisor and dissertation committee for their time, guidance, and direction. Thank you to my FIU colleagues who have inspired me to think about the world differently. I wouldn't be half the psychologist I am today if it weren't for my supervisors, and mentors from Mailman and Texas Children's—I am so appreciative. To the families, and my littles in particular, thank you for the fun and the laughter—you are the reason I love what I do.

Most importantly I want to thank my support system, my loved ones—it truly takes a village. Thank you to my family for always encouraging my curiosity and pushing me to follow my dreams. I am a product of your love and wouldn't be here without your support—always. To the friends who became family, I'm forever grateful for you, the memories, and the love. I want to especially thank my #SoulSisters, p hat, kitty, the Tweeters, pb&j, M, E, my Houston crew, and my soybean. You've been an amazing life raft and I am lucky to have you in my corner; everyone should have friends like you. Thank you to my partner for the endless love and support; you're the real MVP, Becky. As the great Snoop Dogg (2018) said, last but not least, I wanna thank me. I wanna thank me for believing in me. I wanna thank me for doing all this hard work . . . I wanna thank me for never quitting.

ABSTRACT OF THE DISSERTATION

THE INTERPLAY BETWEEN PARENTAL EXECUTIVE FUNCTIONING, PARENTAL STRESS, AND PARENTING SKILLS ACROSS A PARENTING INTERVENTION

by

Taylor Danielle Landis

Florida International University, 2022

Miami, Florida

Professor Paulo Graziano, Major Professor

Behavioral parent training (BPT) interventions are the gold standard treatment for preschoolers with Attention-Deficit/Hyperactivity Disorder (ADHD), and have been shown to improve parenting, and therefore children's behavior. However, treatment outcomes are dependent upon various child and parent factors. Less research has examined predictors of treatment response in preschoolers, including parental factors, which is important given the known benefits of early intervention.

This dissertation is comprised of three manuscripts focused on parent and child executive functioning (EF), and intervention outcomes for children with ADHD and their parents. Study I examined the extent to which individual differences in EF and emotion regulation (ER) were uniquely associated with preschoolers' symptoms of ADHD prior to treatment. Findings suggest that as early as preschool, underlying deficits in EF and ER differentially relate to ADHD symptoms. The extent to which inattention relates to underlying ER and the association between EF and ER is also discussed. Implications include the importance of targeting these processes in intervention. The purpose of study

II was to examine the additional benefit of an adaptive Cogmed working memory training (CWMT) to a social-emotional/self-regulation classroom curriculum for preschoolers with externalizing behavior problems (EBP). Children were randomly assigned to either adaptive CWMT, or non-adaptive CWMT. Findings suggest that while children in both groups improved on all measures (d's = .23-.86), CWMT does not provide any incremental benefits to children's EF, behavior, or academics when implemented within a comprehensive behavioral modification intervention. Lastly, the purpose of study III was to longitudinally examine 1) the malleability of stress, parental executive functioning (EF), and parenting skills across an early BPT intervention, 2) the association between stress and parental EF and parenting skills, and 3) the extent to which parental stress moderates the association between parental EF and parenting skills for parents of children with ADHD. Findings from this study suggest that parental stress, parenting skills, and parental EF are malleable over the course of BPT (d's = |.33-2.07|).

Combined, this body of work contributes to the existing literature on BPT by examining both child and parent factors across intervention, which is critical for optimizing intervention outcomes.

TABLE OF CONTENTS

LIST TABLES

TABLES PAGE

ABBREVIATIONS AND ACRONYMS

ADHD	Attention-Deficit/Hyperactivity Disorder
AHEAD	ADHD Heterogeneity of Executive Function and Emotion Regulation Across Development study
APA	American Psychiatric Association
APQ	Alabama Parenting Questionnaire
AWMA	Automated Working Memory Assessment
BASC	Behavior Assessment System for Children
BPT	Behavioral parent training
BRIEF	Behavior Rating Inventory of Executive Function, Preschool Version
COPE	Community Parent Education Program
CWMT	Cogmed working memory training
DBD	Disruptive Behavior Disorder
DPICS	Dyadic Parent-Child Interaction Coding System
DSM-5	Diagnostic and Statistical Manual for Mental Disorders, 5th edition
EBP	Externalizing behavior problems
EF	Executive functioning
EMC	Emergent Metacognition
ER	Emotion regulation
ERC	Emotion Regulation Checklist
HTKS	Head Toes Knees Shoulders
L1	Level-1
L2	Level-2

Lab-TAB	Laboratory temperament assessment battery
NIH Toolbox	NIH Toolbox for the Assessment of Neurological and Behavioral Function
ODD	Oppositional Defiant Disorder
PCIT	Parent-Child Interaction Therapy
PSI	Parenting Stress Index, Fourth Edition, short form
REML	Restricted maximum likelihood
SES	Socioeconomic status
SPSS	Statistical Package for the Social Sciences
SRPP	School Readiness Parenting Program
STP-PreK+	Summer Treatment Program for children transitioning to kindergarten, first, or second grade
WJ	Woodcock-Johnson Test of Achievement
WM	Working memory
WPPSI	Wechsler Preschool and Primary Scale of Intelligence

I. INTRODUCTION

Behavioral parent training (BPT) is the gold standard treatment for preschoolers with Attention-Deficit/Hyperactivity Disorder (ADHD), and has been shown to improve parenting, and therefore children's behavior (American Academy of Pediatrics, 2011; Chronis et al., 2004). However, treatment outcomes and maintenance of treatment gains vary and are dependent upon numerous child and parent factors (Bagner & Graziano, 2012; Chacko et al., 2016; Lee et al., 2012). However, less research has examined predictors of treatment response in preschoolers, and with a particular dearth of literature examining parental factors predicting treatment outcomes. Therefore, examining factors that potentially interfere with BPT interventions remains critical for understanding and maximizing treatment outcomes, particularly for young children with ADHD.

This dissertation is comprised of three manuscripts focused on parent and child executive functioning (EF), and intervention outcomes for children with ADHD and their parents. Study I examines self-regulation processes, including EF and emotion regulation (ER) in preschoolers with behavior problems prior to treatment. More specifically, this study examines the associations between parent/teacher report of EF and ER, as well as child task performance on an EF battery and ER tasks, and hyperactivity and inattention. Study II explores interventions targeting treatment outcomes, with a focus on child outcomes. The additional benefit of an adaptive Cogmed working memory training (CWMT) to a social-emotional/self-regulation classroom curriculum for preschoolers with externalizing behavior problems (EBP) is presented. Lastly, the purpose of study III was to examine parental factors across BPT longitudinally. This study uses multilevel modeling to examine 1) the malleability of stress, parental EF, and parenting skills across an early BPT intervention, 2) the association between stress and parental EF and parenting skills, and 3) the extent to which parental stress moderates the association between parental EF and parenting skills for parents of children with ADHD.

This collection of work in particular contributes to the existing literature on BPT by examining both child and parent factors across intervention. More specifically, the work presented focuses on self-regulation processes, especially EF. Understanding predictors of treatment response are of utmost importance for maximizing intervention outcomes for both children and parents. Implications of findings, as well as directions for future research are discussed.

II. STUDY I

Differentiating Symptoms of ADHD in Preschoolers: The Role of Emotion Regulation and Executive Function

This manuscript is published in Journal of Attention Disorders.

Landis, T. D., Garcia, A. M., Hart, K. C., & Graziano, P. A. (2021). Differentiating symptoms of ADHD in preschoolers: the role of emotion regulation and executive function. *Journal of Attention Disorders*, *25*(9), 1260-1271.

Abstract

Objective: The purpose of this study was to examine the extent to which individual differences in executive function (EF) and emotion regulation (ER) were uniquely associated with inattention and hyperactivity symptoms of Attention-Deficit/Hyperactivity Disorder (ADHD), respectively. **Methods**: Participants for this study included 249 preschool children ($M_{age} = 4.96$, 78% male; 82% Hispanic/Latino) with at-risk or clinically elevated levels of externalizing behavior problems (EBP). Regression analyses were conducted to examine the association between parent/teacher report of EF and ER, as well as child task performance on an EF battery and ER tasks, and hyperactivity and inattention. **Results**: Even after accounting for IQ, age, sex, and severity of Oppositional Defiant Disorder, greater levels of parent/teacher reported EF problems, $\beta = .55$, $p < .001$, and worse EF performance, $\beta = -.20$, $p < .05$, were associated with greater levels of parent/teacher reported inattention. Additionally, better observed ER was associated with lower levels of inattention, $\beta = -.12$, $p < .05$. Parent/teacher reported ER was not associated with inattention. On the other hand, greater levels of parent/teacher reported EF problems, $\beta = .27$, $p < .001$, and worse parent/teacher reported ER, $\beta = -.17$, $p < .05$, were associated with greater levels of parent/teacher reported hyperactivity. Neither EF performance, nor observed ER were associated with hyperactivity. **Conclusions**: Although more longitudinal work is needed, our findings suggest that as early as the preschool period, underlying deficits in EF and ER do differentially relate to ADHD symptoms. The extent to which inattention relates to underlying ER and the association between EF and ER is also discussed.

Introduction

Self-regulation broadly refers to the planning and control of behavioral, emotional, and cognitive skills necessary for optimal functioning (Calkins, 2007; Ponitz et al., 2008; Bandura, 1991). Theoretical models of self-regulation along with neuroscience research support a distinction between top-down (instruction-driven) and bottom-up (stimulus-driven) components to self-regulation (Hugdahl, 2000; Martel, Nigg, & von Eye, 2009; Sergeant, Geurts, Huijbregts, Scheres, & Oosterlaan, 2003). Associated with the top-down processing, executive functioning (EF) encompasses planning and execution of goal-directed behaviors (Barkley, 1997), such as working memory, inhibition, set shifting, planning, contextual memory, and fluency (Welsh, 2002; Pennington & Ozonoff, 1995). On the other hand, emotion regulation (ER) is conceptualized as a bottom-up process as it entails experiencing, expressing, and modulating emotional experiences (Gross, 1998; McRae, Misra, Prasad, Pereira, & Gross, 2012). Assessing these interrelated, yet distinct self-regulation processes during the preschool period is especially important given the well documented links between EF and ER and children's school readiness (Graziano, Reavis, Keane, & Calkins, 2007; Blair & Razza, 2007; Welsh, Nix, Blair, Bierman, & Nelson, 2010). Furthermore, and the focus of the current study, is understanding how individual differences in young children's EF and ER relate to the heterogeneity of Attention-Deficit/ Hyperactivity Disorder (ADHD) symptoms (Mahone & Hoffman, 2007; Cole, 1986; Southam-Greow & Kendall, 2002).

ADHD is a neurodevelopmental disorder characterized by symptoms of inattention and/or hyperactivity that affects 5-7% of school-age children (Polanczyk, Willcutt, Salum, Kieling, & Rohde, 2014; American Psychiatric Association, 2013). ADHD is associated with significant impairments across functional domains (Wehmeier, Schacht, & Barkley, 2010), emerging as early as preschool (Egger & Angold, 2006; Lavigne, LeBailly, Hopkins, Gouze, & Binns, 2009; Connor, 2002; American Psychiatric Association, 2013) and extending into adulthood (Barkley, 2016; Biederman, 2005; Mash & Barkley, 2003). A significant body of research highlights the heterogeneity of ADHD symptom presentation, and associated impairment (Wåhlstedt, Thorell, & Bohlin, 2008; Chhabildas, Pennington, & Willcutt, 2001). For example, Grizenko, Paci and Joober (2010) found that children with ADHD combined presentation are more likely to have comorbid internalizing and externalizing problems and be disruptive at school compared to children with ADHD with a predominately inattentive presentation. Work by Martel and colleagues (2008, 2009) has found preliminary support with older children and adolescents for the notion that such heterogeneity in ADHD symptoms can be explained by differential underlying processes. Specifically, inattention symptoms appear to be more closely tied to underlying deficits in EF, while the hyperactive symptoms of ADHD are more closely linked to ER deficits (Wåhlstedt et al., 2008; Martel et al., 2008). However, limited work has examined these associations in the preschool period, despite the significant impact of early EF and ER deficits on children's behavioral, academic and social functioning (Lonigan et al., 1999; Graziano, Garb, Ros, Hart, & Garcia, 2015).

ADHD and EF

Theoretical models of ADHD suggest that individuals with ADHD have an underlying deficit in EF that contributes to poorer recall, planning and anticipatory or preparatory behaviors (Barkley, 1997; Barkley, 2015; Nigg, Willcutt, Doyle, & Sonuga-

Barke, 2005). Early deficits in EF have also been identified as an etiological risk factor for ADHD (Nigg et al., 2005). These EF deficits found among children with ADHD are documented across observational/neuropsychological and parent/teacher report measures. Mahone & Hoffman (2007) found that 3- to 5-year-olds with ADHD are reported by parents as having significantly poorer EF compared to typically developing children. Moreover, preschool children with ADHD demonstrate deficits in inhibitory control, verbal working memory (WM), spatial memory, and verbal fluency on laboratory tasks (Thorell & Wåhlstedt, 2006). Despite robust findings demonstrating EF deficits in individuals with ADHD, less work has examined the association between EF and symptoms of ADHD. Examining such associations is particularly important since EF has been established as one neuropsychological component associated with ADHD, yet not all children with ADHD suffer from EF deficits (Nigg et al., 2005).

One of the few studies to date examining the association between EF and ADHD symptoms in children and adolescents demonstrated that when examining performance on neurocognitive tasks, deficits in EF, but not ER, are significantly associated with inattention symptoms (Martel et al., 2008). Similarly, longitudinal research in preschoolers has demonstrated that early deficits in EF, as measured by task performance, are associated with later symptoms of reported symptoms of inattention, but not hyperactivity (Wåhlstedt et al., 2008). Given that children with ADHD and EF deficits have significantly worse academic and school outcomes (e.g., repeating a grade, diagnosis of a learning disability) than typically developing children (Biederman et al., 2004), it is important to understand how EF (measured both by rating scales as well as objective measures) may contribute uniquely to the heterogeneity of ADHD symptoms in preschoolers.

ADHD and ER

A recent meta-analysis found that children with ADHD not only have EF deficits but also, and potentially relatedly, suffer significant deficits in emotion recognition/understanding, emotional reactivity, and emotion regulation (Graziano & Garcia, 2016). Additionally, the behavioral inhibition theory suggests that children with ADHD display a greater dependency on external factors affecting motivation and arousal (Barkley, 1997; Bunford, Evans, & Wymbs, 2015). Empirically, both preschool and elementary children with ADHD demonstrate deficits in ER (measured both at the behavioral and biological levels) when compared to typically developing children (Musser et al., 2011; Cole, Zahn-Waxler, Fox, Usher, & Welsh, 1996).

When relating ER deficits to symptoms of ADHD, studies with older children demonstrate that only symptoms of hyperactivity are associated with performance on ER tasks (Martel et al., 2008). However, in an adolescent sample, ER was uniquely associated to symptoms of inattention, but not hyperactivity (Martel et al., 2008). These contradicting results suggest that a) there are differences in the heterogeneity of ADHD symptoms across development and b) underlying self-regulation processes such as ER may also differentially relate to ADHD symptoms. Indeed, longitudinal studies have shown that children's ADHD presentation varies tremendously from the preschool to the adolescent years (Lahey, Pelham, & Loney, 2005; Waschbusch, King, & Gregus, 2007). On the other hand, it remains unclear the extent to which individual differences in ER contribute to the heterogeneity in ADHD symptom presentation during the preschool period. Considering the associations between ER and poor academic and social outcomes in kindergarteners (Graziano et al., 2007; Rubin, Coplan, Fox, & Calkins, 1995), identifying how ER deficits relate to symptom presentation of ADHD may help to identify which children may benefit most from intervention.

Current Study

In summary, it is well established that children with ADHD have significant impairments in both EF and ER (Barkley, 1997; Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005; Graziano & Garcia, 2016). Studies with older children and adolescents suggest that EF deficits are uniquely associated with inattention symptoms of ADHD, while deficits in ER are mostly uniquely associated with deficits in ER (Martel et al., 2009; Sonuga-Burke, 2003). In preschoolers, EF performance deficits are predictive of later symptoms of inattention (Wåhlstedt et al., 2008). Given that EF and ER processes are rapidly developing during the preschool period (Garon, Bryson, & Smith, 2008; Denham, 2006), it is critical to examine their association with emerging symptoms of ADHD. Identifying subgroups of children with the most impairing EF and/or ER deficits may not only provide understanding of the heterogeneity within ADHD, but yield more personalized treatment (Reid, Trout, & Schartz, 2005). The goal of the current study was to examine the extent to which individual differences in EF and ER were uniquely associated with symptoms of ADHD (i.e., inattention and hyperactivity). In line with prior research with older children (Martel et al., 2009), it was expected that in preschoolers, deficits in EF would uniquely relate to symptoms of inattention, while deficits in ER would uniquely relate to symptoms of hyperactivity.

Method

Participants and Recruitment

The study was conducted at a large urban university in the Southeastern United States with a large Hispanic/Latino population. Children and their families were recruited from local preschools and mental health agencies through brochures, radio ads, and open houses/parent workshops to participate in an intensive summer treatment program for children transitioning to Pre-K or Kindergarten (STP-PreK; Graziano, Slavec, Hart, Garcia, & Pelham, 2014). Participants in the current study met eligibility criteria if they (a) had an externalizing problems composite t-score above 60 on either parent, M = 64.80, SD = 12.35, or teacher, M = 66.75, SD = 13.23, ratings on the Behavior Assessment System for Children—Second Edition (BASC-2; Bird, Gould, & Staghezza, 1992; Piacentini, Cohen, & Cohen, 1992), which was collected during the initial assessment, (b) were enrolled in preschool the previous year, (c) obtained an estimated IQ of 70 or higher, M = 91.58, SD = 14.93, on the Wechsler Preschool and Primary Scale of Intelligence 3rd (WPPSI-III) or 4th edition (WPPSI-IV; Wechsler, 2002; Wechsler, 2012), and (d) were able to attend an eight-week summer program prior to starting kindergarten.

The final study sample consisted of 249 preschool children (78% boys) with at-risk or clinically elevated levels of externalizing behavior problems and whose parents provided consent to participate in the study. The mean age of the participating children was 4.95 years, SD = .53 years. In terms of the ethnic and racial makeup, 82% of the children were Hispanic/Latino. See Table 1.1 for sample demographics, including rates of diagnoses derived from a combination of parent structured interview (C-DISC; Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000 or K-DBDS; Keenan et al., 2007) and parent and teacher ratings of symptoms and impairment [i.e., Disruptive Behavior Disorders Rating Scale (Pelham, Gnagy, Greenslade, & Milich, 1992) and Impairment Rating Scale (Fabiano et al., 2006)], as is recommended practice (Pelham, Fabiano, & Massetti, 2005). According to parent report at intake, only 11 children were on any psychotropic medication.

Study Design and Procedures

The university's Institutional Review Board approved this study. As part of the initial assessment for this study, parents and teachers also completed several questionnaires about the child's behavior and self-regulation skills. Eligible participants were invited to attend a second laboratory visit in which children and their parents were video recorded during various tasks, including an EF battery and two ER tasks discussed in further detail below.

Measures

ADHD

Inattention and hyperactivity. To assess children's behavioral functioning, parents and teachers completed the BASC-2 (Reynolds & Kamphaus, 1992). The BASC-2 is widely utilized tool that allows one to understand several emotional and behavioral domains. Several scales include internalizing, externalizing, and behavior symptom domains, and adaptive/social functioning skills. The attention problems and hyperactivity gender normed t-scores were examined in the present study as a proxy for symptoms of inattention and hyperactivity (αs = .80-.91; Pelham et al., 2005). Consistent with prior work (Bird et al., 1992; Piacentini et al., 1992; Martel et al., 2009) the highest t-score among parent and teacher reports was used.

EF, Top-Down Processing

HTKS task. The head-toes-knees-shoulders task (HTKS; Ponitz et al., 2009) is a widely used tool for assessing EF in preschool populations (Graziano et al., 2015; McClelland et al., 2014). During HTKS, children are required to follow a set of behavioral rules, such as “touch your head,” that is paired with a conflicting behavioral response. There are two parts to the task with 10 trials each. Prior to each part, children are presented with a set of rules (i.e., head and toes), such that the child is required to do the opposite/different move from what is stated aloud. For example, when the examiner says, “touch your toes” the correct behavioral response would require the child to touch their head. In the second part, a new set of paired rules is added, touching shoulders and knees. The measure is scored by giving the child 0, 1, or 2 points for each response. The child receives 0 points for an incorrect response, 2 points for an immediate correct response, and 1 point for self-corrections. Scores range from 0-40, with higher scores indicating better EF.

AWMA. Children were individually administered four subtests of the Automated Working Memory Assessment (AWMA; Alloway et al., 2004). Subtests included: (a) Word Recall (auditory short-term memory); (b) Listening Recall (auditory working memory); (c) Dot Matrix (visuospatial short-term memory); and (d) Mister X (visuospatial working memory). In the Word Recall task, children are required to remember a sequence of words and repeat them back to the examiner. The Listening Recall subtests requires children to determine the validity of a sentence, then repeat the last word of the sentence with increasing difficulty. During Dot Matrix, children must recall the location of dots on a 4 X 5 grid, in the order. In the Mister X task, two similar figures are next to each other, each holding a ball in its hand. One of the figures is rotated between 45 to 315 degrees. The child is required to determine spatial orientation (i.e., "Are they holding the ball in the same hand or different hands?"), and recall the location of the ball from six different possibilities. Raw scores from the subtests are converted to standard scores according to gender and age norms. Scores from the AWMA show adequate test–retest reliability and has established convergent validity (Alloway et al., 2008). Due to the moderate to high correlation among the four subtests, $r = .30\text{-}.50$, $p < .01$, an average standardized score was calculated and used for the analyses in the current study. Due to the strong correlation between performance on HTKS and AWMA, $r = .50$, $p < .01$, both measures were standardized and averaged to create an EF performance composite.

Emergent metacognition-BRIEF. Parents and teachers completed the Behavior Rating Inventory of Executive Function-Preschool Version (BRIEF-P; Gioia, Isquith, Guy, & Kenworthy, 2000). The BRIEF-P yields five non-overlapping clinical scales (inhibit, shift, emotional control, working memory, and plan-organize). The BRIEF-P has well-established internal consistency, reliability and validity (Isquith, Gioia, & Espy, 2004). For the purpose of the present study, the emergent metacognition index t-score, which focuses on the cognitive aspects of self-regulation and is comprised of the working memory and plan/organize subscales, was used as a measure of EF. Consistent with prior work, the highest report between parent and teacher report was used, $\alpha = .93 \text{-} .92$ (Bird et al., 1992) with higher scores indicating greater EF problems.

ER, Bottom-Up Processing

Emotion regulation checklist (ERC). To assess for children's emotion regulation skills, parents and teachers completed the Emotion Regulation Checklist (Shields & Cicchetti, 1997). The ERC yields two scales: Negativity/Lability and Emotion Regulation Scale. The Negativity/Lability scales is composed of 10 items that capture negative affect and mood lability. The Emotion Regulation scales is composed of 14 items that assess adaptive regulation. To more comprehensively assess emotion dysregulation and consistent with prior work (Graziano et al., 2014; Ramsden & Hubbard, 2002), both scales were transformed to z-scores. The Negativity/Lability scale was then divided by negative one to produce its inverse. The inverse Negativity/Lability z-score and the Emotion Regulation z-score, $rs = .20\text{-}.23$, $p < .01$, were then averaged for a standardized Mean Emotion Regulation score, $\alpha = .76\text{-} .78$ with higher scores indicating better ER. To ensure we capture the highest level of impairment, the lowest report between teacher and parent was used.

Laboratory temperament assessment battery (Lab-TAB). To elicit frustration, two frustration tasks adapted from the Laboratory temperament assessment batter (Lab-TAB; Goldsmith & Rothbart, 1996) were administered: *I'm not sharing* and *impossibly perfect circles*. In the *I'm not sharing* task, an assistant brings a container of candy and tells the experimenter to share it equally with the child. The experimenter begins by equally dividing the candy with the child, but slowly begins to take more than the child, eat a piece of the child's candy, takes more than given to the child, and eventually takes all the child's candy without allowing the child to eat any of the candy. In the *impossibly perfect circles* task, children were asked to draw circles repeatedly. After each one, the examiner criticizes something minor about the circle (e.g., too small) and tells the child to draw another. The tasks were discontinued if the child was highly distressed or cried for more than 30 seconds. The global measure of regulation was coded on a scale from 0 (dysregulated) to 4 (well regulated). The reliability Kappas for global regulation codes in this study were all above .80. For data reduction purposes, the most severe rating of dysregulation between the two tasks was used for the current study.

Measures: Covariate

Oppositional Defiant Disorder (ODD). Parents and teachers completed the Disruptive Behavior Disorder (DBD) Rating scale (Pelham, Gnagy, Greenslade, & Milich, 1992). Each symptom of ODD on the DBD Rating Scale is rated on a 4-point frequency scale (*not at all, just a little, pretty much, or very much*). The DBD Rating Scale was adapted to reflect the newest edition of the Diagnostic and Statistical Manual for Mental Disorders (DSM-5; American Psychiatric Association, 2013). For this study, the highest mean item severity of ODD symptoms between parent and teacher report was used, α= .85-.88.

Data Analytic Plan

All analyses were conducted using Statistical Package for the Social Sciences, version 20 (SPSS 20). For the measures used, there was some missing data for parent and teacher report measures (11% and 22% respectively), and EF task performance (11%). According to Little's Missing Completely at Random test, the missing data was missing completely at random, χ^2 (320) = 320.69, p = .22. There were no significant differences between children with complete versus partial data in terms of any demographic variables or any outcomes examined in the current study. Multiple imputation was conducted with

5 imputations, which is a sufficient estimate for the given sample size (Rubin, 1987). Preliminary analyses were conducted to examine the associations between demographic variables and the study variables. Multiple hierarchical regression equations were conducted to examine the association between EF and ER and symptoms of ADHD.

Results

Preliminary Analyses

Preliminary analyses examined any potential associations between demographic variables and any of the study's outcomes (see Table 1.2). Children's age was significantly associated with EF performance, $r = .39$, $p < .001$, indicating that older children performed better on the EF battery. Age was also significantly associated with observed ER, $r = -.20$, $p < .05$, such that older children displayed poorer regulation. Child sex was significantly associated with parent/teacher reported hyperactivity and attention problems, $r = -.15$, $p < .05$; $r = -.23$, $p < .001$; respectively, such that males had less reported hyperactivity and attention problems than females. Additionally, child IQ was significantly associated with attention problems, $r = -.24$, $p < .001$, and both parent/teacher reported EF and EF performance, $r = -.31$, $p < .001$; $r = .59$, $p < .001$; respectively. Children with higher IQ had less attention problems and better EF. Furthermore, parent/teacher reported symptoms of ODD were significantly associated with observed EF, $r = .18$, $p < .01$, parent/teacher reported ER, $r = -.57$, $p < .001$, and observed ER, $r = -.17$, $p < .05$. Specifically, children with higher levels of ODD had significantly better performance on EF tasks, and worse reported and observed ER. No other demographic variables were associated with ADHD symptoms, EF, or ER.

Therefore, subsequent analyses included IQ, age, sex, and symptoms of ODD as covariates.

Bivariate correlations were examined between EF and ER and ADHD symptoms (see Table 1.2). Both parent/teacher reported EF and EF performance were significantly associated with parent/teacher reported inattention, $r = .58$ $p < .001$, $r = -.22$ $p < .001$, respectively. Children with greater parent/teacher reported EF deficits, and poorer performance on the EF battery were rated by parents/teachers as having higher levels of inattention. Additionally, observed ER was significantly associated with inattention, $r = -.20$, $p < .05$. Children who displayed greater regulation, were rated as being less inattentive. Parent/teacher reported ER and EF was also significantly associated with hyperactivity, $r = -.57$ $p < .001$, $r = .25$ $p < .001$, respectively. Children rated by parents/teachers as having poorer ER and greater EF problems demonstrated higher levels of hyperactivity.

Regression Analyses

Hierarchical regression analyses were conducted to examine the unique associations between top-down and bottom-up regulatory processes (i.e., EF and ER) and symptoms of ADHD. Both regression analyses (i.e., inattention and hyperactivity) were conducted with separate EF and ER models, and the results were consistent. Therefore, the combined models are presented below. As seen in Table 1.3, IQ and sex were both significantly associated with inattention, $\beta = -.23$, $p < .001$ and $\beta = -.23$, $p < .001$, respectively, while age and ODD severity were not, *ps* > .05. Children with higher IQ were less inattentive, and males were rated as having less attention problems than females. Additionally, higher parent/teacher reported EF problems, $\beta = .55$, $p < .001$, and worse performance on an EF battery, $\beta = -.20$, $p < .05$, were significantly associated with inattention, even when controlling for IQ, age, sex, and symptoms of ODD. Children rated by parents and teachers as having more EF problems, and demonstrating worse EF performance had higher levels of inattention. Additionally, observed ER was significantly associated with inattention, $\beta = -.12$, $p < .05$, such that children who were more regulated were rated by parents and teachers as being less inattentive. Parent/teacher reported ER was not significantly associated with inattention, $p > .05$.

In terms of hyperactivity, sex and ODD severity were significantly associated with hyperactivity, $\beta = -.16$, $p < .01$ and $\beta = .49$, $p < .001$, respectively, while IQ and age were not, *ps* > .05. Males were less hyperactive than females. Additionally, children with more severe ODD were rated as being more hyperactive. Additionally, parent/teacher reported ER was significantly associated with hyperactivity, $\beta = -.17$, $p < .05$, even when controlling for symptoms of IQ, age, sex, and ODD severity. Children rated by parents and teachers as being more regulated demonstrated lower levels of hyperactivity. Observed ER was not significantly associated with reported hyperactivity, $p > .05$. Additionally, parent and teacher reported EF problems were significantly associated with hyperactivity, $\beta = .27$, $p < .001$, even when controlling for IQ, age, sex, and ODD severity. Children with greater reported EF problems were more hyperactive. There were no significant interactions for either inattention or hyperactivity; therefore, they were not included in Table 1.3.

Discussion

This is one of the first studies to examine the extent to which individual differences in preschoolers' EF and ER are uniquely associated with inattention and hyperactivity symptoms of ADHD. Findings from this study suggest that over and above IQ and symptoms of ODD, deficits in EF, as measured both by parent/teacher reports as well as performance on an EF battery, are significantly associated with inattention symptoms of ADHD. Observed ER was also significantly associated with inattention, over and above IQ and symptoms of ODD. On the other hand, both parent/teacher reported ER and EF were significantly associated with symptoms of hyperactivity, while neither observed ER nor performance on an EF battery was associated with hyperactivity. These findings are discussed in further detail below.

The associations found in this study between deficits in EF and greater symptoms of inattention are consistent with prior conceptualizations of top-down processes that require the ability to focus on task-relevant stimuli (Gazzaley & Nobre, 2012). More specifically, both selective attention and WM, involve top-down modulation of the prefrontal and parietal cortices as demonstrated by performance on neuropsychological tests, electroencephalography (EEG), and functional imaging studies (Sergeant et al., 2003; Gazzaley & Nobre, 2012). Greater activity in the prefrontal cortex, near the precentral sulcus is associated with filtering and attending to only relevant stimuli, along with activation in the medial and lateral prefrontal cortex areas when focusing attention (Gazzaley & Nobre, 2012). Given the similar underlying processes, children demonstrating deficits in EF are likely to demonstrate deficits in attention as well. Empirical research has supported this with both cross-sectional and longitudinal studies. Martel and colleagues' (2008) work in older adolescents found that poor performance on neurocognitive EF tasks is uniquely associated with inattention, while Wåhlstedt and colleagues (2008) demonstrated longitudinally that early deficits in EF are associated with later symptoms of inattention. Our findings support the findings of previous studies, suggesting that deficits in EF relate to symptoms of inattention, as early as preschool. Consistent with prior work, IQ accounted for some of the variance in inattention (Wåhlstedt et al., 2008). This may be indicative of the correlation between IQ and deficits in EF (Ardila, Pineda, & Rosselli, 2000; Mahone et al., 2002).

In addition to EF, the results from the current study indicated that children who were less regulated during the frustration tasks had higher levels of inattention. While this was contrary to the hypotheses predicting that ER would uniquely be associated with hyperactivity, it is important to note the potential role of EF in ER (Blair & Ursache, 2011). While ER is usually conceptualized as a bottom-up process, literature has identified that there are also top-down processes that occur (Graziano & Garcia, 2016; Gross, 1999). Gross' (1999) emotion generation process model states that emotions begin with a cue that provokes an emotional response, which may be modulated. As part of the modulation process, an individual may engage in situation selecting, situation modification, attentional deployment, cognitive change, or response modification (Gross, 1999). Executive functions, such as alerting, orienting, and executive attention, may be especially critical in these situations for the regulation of both behavior and emotions as early as preschool (Blair & Ursache, 2011). More specifically, research has demonstrated the importance of controlling attention in distracting oneself from distress (Kopp, 1989). It is possible that in the current study, children with ADHD were not able to shift attention as an effective distraction or coping technique in response to frustration. However, subsuming the association between ER and inattention in the current study as a related function of EF is only one possible explanation. As the current study's observed global regulation measure does not disentangle bottom-up ER from top-down ER, one should exercise caution when considering the impacts of EF on ER.

When examining the associations between self-regulation deficits and symptoms of hyperactivity, the findings were mixed. On one hand, parents/teachers reported that children with poorer ER demonstrated greater levels of hyperactivity. However, observed ER was not significantly associated with hyperactivity. These null findings may be a result of the standardized tasks used in the current study. Due to the time-limited nature of the frustration tasks used in the current study, the standardized assessment used may not have captured broader trait-like characteristics related to ER, such as reactive control or surgency (Martel el al., 2008). Alternatively, parent/teacher reported self-regulation might be more indicative of these broader, more chronic trait level dimensions of self-regulation. This could explain why parent/teacher ER was significantly associated with hyperactivity, while observed ER was not.

In addition to poorer parent/teacher reported ER, children who were rated as having more EF problems had significantly greater levels of hyperactivity in the current study. As previously mentioned, it is possible that this reflects the role of top-down EF processes in the modulation of emotions (Blair & Ursache, 2011). However, our findings align largely with the findings of Martel and colleague's (2008) work examining differential associations between top-down and bottom-up traits and symptoms of ADHD, such that hyperactivity was related to both bottom-up and top-down traits. The current study contributes to the existing literature as one of the strongest studies examining the associations between self-regulation deficits and symptoms of ADHD, given the utilization of both report measures and standardized/observed tasks for both EF and ER. Our findings, in combination with the previous literature, suggest that top-down EF processes, may be more important than bottom-up reactivity during the preschool years. Therefore, interventions that target deficits in EF may yield better long-term outcomes for children in terms of both inattention and hyperactivity.

Limitations & Future Directions

While major strengths of this study include a multi-informant, multi-method approach to understanding differential associations between symptoms of ADHD and self-regulation (while controlling for ODD), some limitations should be addressed. The global codes used to code ER were not specific enough to examine which strategies of emotion regulation children may be employing (Gross, 1999), or the extent to which EF may be related to ER (Blair & Ursache. 2011). To further explore the extent to which hyperactivity or inattention/attention shifting occurred during EF and ER tasks, future research should include observation, report, and physiological measures. More specifically, for inattention, observing whether a child is attending away from a frustrating or stressful task in vivo, may provide further clarification as to whether attention shifting is being used to regulate emotions in a time of distress. Additionally, physiological measures (e.g., Respiratory Sinus Arrhythmia and Pre-ejection Period) could further our understanding on the non-observable, biological processes underlying inattention and hyperactivity.

Within the EF domain, though the HTKS task has been validated as a measure of EF, it encompasses both EF and behavioral regulation (Graziano et al., 2015; McClelland et al., 2014). Thus, due to the complex nature of the task, it is difficult to disentangle which aspects of self-regulation are being employed throughout. Additionally, even though the EMC scale of the BRIEF was used, the BRIEF has been criticized for measuring self-regulation more globally, and being associated with a wide range of behavior problems (Mahone & Hoffman, 2007). However, Toplak, West, and Stanovich (2013) demonstrated that despite tapping into different constructs, there is utility in both performance-based and rating measures of EF. This study showed that higher levels of inattention were associated with deficits in EF across measures, potentially supporting the use of the HTKS task, and the EMC as valid measures of EF.

The measures used for this study may not represent all components of ER. Previous meta-analysis identified four distinct constructs of ER: emotion recognition/understanding, emotion reactivity/negativity/lability, emotion regulation, and empathy/callous-unemotional traits (Graziano & Garcia, 2016). More specifically, the ERC primarily represents emotional negativity/lability and global regulation, while the global regulation codes are primarily assessing overall emotion regulation. Future research should examine other measures assessing all domains of ER, such as an emotion recognition task and a measure of empathy and callous/unemotional traits. However, this study is among the first to our knowledge to use multiple reports, both parent/teacher as well as laboratory task observation when examining ER in preschoolers.

Another limitation is the cross-sectional design of the study. It is unclear if changes in self-regulation results in a change in symptoms of ADHD, or conversely, if a change in symptoms of ADHD results in changes in EF and ER. Given that the symptom presentation of ADHD changes throughout the lifespan, future research should examine the development of the associations between self-regulation processes and symptom domains across the lifespan (Wåhlstedt et al., 2008; Chhabildas et al., 2001). Because this study was not longitudinal, it is not possible to disentangle the development of ER as it potentially relates to EF. For example, if the ability to learn coping skills is imperative in effectively modulate emotional responses is, then deficits in EF could have compounding effects on the development of effective ER strategies. Longitudinal research would be able to disentangle the directionality in the parallel associations found between EF/ER and symptoms of ADHD, as well as the potential effects of EF on ER.

Furthermore, the primarily Hispanic/Latino sample in this study limits the interpretations of the results found in a preschool sample to preschoolers of other racial/ethnic backgrounds. However, previous work was limited to in generalizability to Caucasian populations. The present study expanded upon the population for which results from previous research may apply. Given that Hispanic/Latino children are the fastest growing minority in the United States (La Greca, Silverman, & Lochman, 2009), it is important to examine self-regulation processes in this population.

Conclusions

Despite the limitations, the current study provides initial evidence that deficits in EF differentially relate to symptoms of inattention, while both deficits in EF and ER predict symptoms of hyperactivity. This study addresses a gap in the literature, examining the association between self-regulation processes and symptoms of ADHD in preschoolers. While work with older children and adolescents has established unique associations between EF and inattention, and ER and hyperactivity (Martel et al., 2009), this study was the first to our knowledge to examine underlying self-regulations in preschoolers with ADHD. The findings from this study may aid in identifying subgroups of children with EF and/or ER impairments to better understand heterogeneity within

ADHD. One proposed suggestion given the results of the current study is for interventions to target EF deficits in preschoolers, such as circle time games (Tominey & McClelland, 2011). This would not only yield improvements in attention, but also potentially improve the ability to learn effective coping skills to modulate bottom-up processes as well. Future research should examine the parallel associations between self-regulation processes and symptoms of ADHD with a) observed measures of hyperactivity and inattention, b) neurobiological measures (e.g., fMRI) to examine biological underpinnings of self-regulation profiles in children with ADHD, and c) most importantly, longitudinal studies to better understand if changes in EF/ER predict changes in symptoms of ADHD, or if changes in symptoms of ADHD predicts changes in EF/ER.

Table 1.1. *Descriptive Statistics*

Screening Measures	
Child sex (% male)	78
Child age	4.96 (0.52)
Hollingshead SES	43.63 (12.63)
Child Ethnicity (% Hispanic/Latino)	82
Child full scale IQ	91.64 (14.93)
BASC-2 Externalizing T-score (P)	64.87 (12.32)
BASC-2 Externalizing T-score (T)	66.75 (13.23)
ADHD only diagnosis (%)	32
ODD only diagnosis (%)	14
ADHD + ODD diagnosis (%)	43
ADHD Symptoms	
BASC-2 Hyperactivity T-score (P)	68.95 (12.41)
BASC-2 Hyperactivity T-score (T)	66.45 (11.98)
BASC-2 Attention Problems T-score (P)	64.66 (8.02)
BASC-2 Attention Problems T-score (T)	60.70 (7.73)
Executive Function	
BRIEF—EMC T-score (P)	71.42 (14.69)
BRIEF—EMC T-score (T)	68.53 (13.67)
HTKS and AWMA z-score composite (O)	0.00 (.88)
Emotion Regulation	
ERC z-score (P)	0.00 (.77)
ERC z-score (T)	0.00 (.78)
Lab-TAB—*I'm Not Sharing*, Global Regulation (O)	2.43 (1.15)
Lab-TAB—*Circles*, Global Regulation (O)	2.76 (.87)

Note. P = Parent report, T = Teacher report, O = Observed/standardized measure. DBD-ODD = Disruptive Behavior Disorder Rating Scale—Oppositional Defiant Disorder, EF = Executive Functioning, BRIEF—EMC = Behavior Rating Inventory of Executive Function—Emergent Metacognition, ERC = Emotion Regulation Checklist, Lab-TAB = Laboratory Temperament Assessment Battery, *Circles = Impossibly Perfect Circles* task.

Table 1.2. *Variable Correlations*

	1	2	3	4	5	6	7	8	9	10
1. Age	1									
2. Sex	-.09	1								
3. IQ	.04	.02	1							
4. $ODD^{P/T}$	-.02	.03	.16*	1						
5. BASC-H $^{P/T}$	-.01	-.15*	.06	.48***	1					
6. BASC-I $^{P/T}$	.04	-.23***	-.24***	-.03	.46***	1				
7. EF^{O}	.39***	-.02	.59***	.18*	.09	-.22**	1			
8. $EMC^{P/T}$	.07	.00	-.31***	-.02	.25***	.58***	-.19*	1		
9. ER^{O}	-.20*	-.11	.06	-.17*	-.15	-.20*	-.05	-.18*	1	
10. $ERC^{P/T}$	.11	-.08	.04	-.57***	-.41***	-.11	-.02	-.20**	.18*	1

Note. ***p < .001, **p <.01, *p < .05. P/T = Parent/Teacher report, O = Observed/standardized measure. ODD = Disruptive Behavior Disorder Rating Scale—Oppositional Defiant Disorder, EF = Executive Functioning, EMC = Emergent Metacognition, ER = Emotion Regulation: *I'm Not Sharing* and *Impossibly Perfect Circles* tasks, ERC = Emotion Regulation Checklist.

Table 1.3. *Dimensions of Self-Regulation on ADHD*

	β	T-value	Model R^2	R^2 Change	F Change
EF: Inattention (P/T)					
Step 1. IQ	-.23***	-3.72	.11	.11	7.59***
Age	.09	1.35			
Sex	-.23***	-3.76			
ODD (P/T)	.02	.36			
Step 2. EF Performance (O)	-.20*	-2.34	.45	.34	36.24***
EF Problems (P/T)	.55***	10.11			
Observed ER (O)	-.12*	-2.12			
Reported ER (P/T)	-.04	-.55			
EF: Hyperactivity (P/T)					
Step 1. IQ	-.02	-.39	.25	.25	20.78***
Age	.03	.47			
Sex	-.16*	-2.81			
ODD (P/T)	.49***	8.47			
Step 2. EF Performance (O)	-.01	-.14	.35	.10	8.99***
EF Problems (P/T)	.27***	4.39			
Observed ER (O)	-.02	-.32			
Reported ER (P/T)	-.17*	-2.16			

Note. ****p* <.001, ***p* <.01, * *p* < .05. ODD = Oppositional Defiant Disorder, P/T = parent-teacher report, O = observed/standardized measure. EF = Executive Functioning, EF Performance = Head Toes Knees Shoulders Task and Automated Working Memory Assessment composite, EF Problems = Behavior Rating Inventory of Executive Functioning-Preschool Version, Emergent Metacognition index, ER = Emotion Regulation, Observed ER = Laboratory Assessment of Temperament Battery, Global Regulation, Reported ER = Emotion Regulation Checklist.

III. STUDY II

Targeting Self-Regulation and Academic Functioning Among Preschoolers with Behavior Problems: Are There Incremental Benefits to Including Cognitive Training as Part of a Classroom Curriculum?

This manuscript is published in Child Neuropsychology.

Landis, T. D., Hart, K. C., & Graziano, P. A. (2019). Targeting self-regulation and academic functioning among preschoolers with behavior problems: Are there incremental benefits to including cognitive training as part of a classroom curriculum?. *Child Neuropsychology*, *25*(5), 688-704.

Abstract

The purpose of this study was to examine the additional benefit of an adaptive Cogmed working memory training (CWMT) to a social-emotional/self-regulation classroom curriculum for preschoolers with externalizing behavior problems (EBP). Participants for this study included 49 children (71% boys, $M_{age} = 4.52$) with at-risk or clinically elevated levels of EBP. Children participated in an 8-week summer treatment program for Pre-Kindergarteners (STP-PreK), where they were randomly assigned to either adaptive CWMT ($n = 24$), or non-adaptive CWMT ($n = 25$). Multiple repeated measures analyses were conducted to examine the impact of adaptive versus non-adaptive CWMT on pre and post-treatment parent/teacher reported behavioral functioning, parent/teacher reported and child task performance of executive functioning, and standardized academic achievement measures. Repeated measures analyses found that children in both groups improved on all measures (*d*'s = .23-.86). However, there were no significant time X condition effects for parent or teacher reported behavior, reported or observed executive functioning, or standardized academic measures. These findings suggest that CWMT does not appear to provide any incremental benefits to children's executive functioning, behavior, or academics when implemented within a comprehensive behavioral modification intervention.

Keywords: preschool, externalizing behavior problems, cognitive training, executive function, self-regulation, intervention

Introduction

Executive functioning (EF) is an important self-regulatory process involved in the planning and control of goal-directed behavior, emotion, and cognition (Calkins, 2007; Ponitz et al., 2008). EF includes processes such as working memory, inhibition, set shifting, planning, contextual memory, and fluency (Welsh, 2002; Pennington & Ozonoff, 1996). Prior research has highlighted the importance of self-regulation processes in many functional domains, including school readiness and academic success (Blair & Diamond, 2008; Graziano, Reavis, Keane, & Calkins, 2007). A meta-analysis by Schoemaker and colleagues (2013) demonstrated that preschoolers with externalizing behavior problems (EBP; i.e. hyperactivity, impulsivity, inattention, defiance, aggression; Wichstrom et al., 2012) exhibit moderate deficits in EF, especially inhibition (Schoemaker, Mulder, Deković, & Matthys, 2013). Hence, emerging research has focused on the malleability of EF and EF interventions.

One of the most researched interventions targeting EF in children is cognitive training (Diamond & Lee, 2011; Douglas, 2005). Cognitive training programs (e.g., CogMed, Pay attention!, Jungle Memory) are theoretically based in neuroscience, proposing that through computerized technology, both anatomical and functional neural modification can occur through repeated performance (Vinogradov, Fisher, & de Villers-Sidani, 2012). More specifically, cognitive training programs utilize learning-dependent brain plasticity in the prefrontal cortex, associated with cognition (Vinogradov et al., 2012). Given the development of the frontal lobe and changes in cognitive functioning during early childhood, theoretically young children may especially benefit from cognitive training (Peijnenborgh, Hurks, Aldenkamp, Vles, & Hendriksen, 2016).

Alternatively, older children who have the ability to recognize their cognitive deficits, and the need to improve them, may benefit more from cognitive training (Peijnenborgh et al., 2016). Consistent with transfer of learning theories, repeated practice improves performance; such that playing computer games, may in turn reflect cognitive and affective improvements (Simons et al., 2016). However, it is important to note that most cognitive training programs focus on working memory, which is only one component of EF.

Over the past 5 years, many meta-analyses have examined the effects of cognitive training. In a review of studies sampling healthy adults, cognitive training (i.e., N-back tasks) produced task-specific improvements on non-trained N-back tasks, as well as some other working memory tasks (e.g. digit span; Soveri, Antfolk, Karlsson, Salo, & Laine, 2017). However, these effects did not transfer to other, non-trained tasks of cognitive control (e.g., Stroop task; Soveri et al., 2017). Similarly, in typically developing children, cognitive training improved task-related working memory (e.g., AWMA, number span, and digit span), with maintenance (Sala & Gobet, 2017). However, this review found that these effects did not transfer to fluid intelligence (e.g., block design), academic achievement (e.g., reading fluency), or cognitive control (e.g., go/no-go task; Sala & Gobet, 2017).

Given the cognitive impairments associated with a variety of clinical populations, a large body of literature has also examined the effects of cognitive training in atypical samples. Cortese et al. (2015) examined the effects of a variety of cognitive training programs targeting components of EF, such as working memory, attentional control, and inhibition in children/adolescents with Attention-Deficit/Hyperactivity Disorder

(ADHD). Cognitive training demonstrated moderate to large near-transfer effects on working memory improvement (e.g., AWMA, digit span, and dot matrix; Cortese et al., 2015). However, cognitive training was not associated with improvements in academic achievement (e.g., word reading fluency), or reduction in ADHD symptoms (Cortese et al., 2015; van der Donk, Hiemstra-Beernink, Tjeenk-Kalff, Van Der Leij, & Lindauer, 2015). Furthermore, in children with learning disabilities, cognitive training has demonstrated improvement in verbal and visuo-spatial working memory that sustained for up to eight months (Peijnenborgh et al., 2016). Lastly, Melby-Lervåg, Redick, & Hulme (2016) found that cognitive training yielded improvements across verbal and visuo-spatial working memory tasks. Consistently across meta-analyses of samples with both adults and children, with and without behavioral and learning impairments, cognitive training has yielded some context and content dependent, near-transfer effects for working memory improvements, but no far-transfer effects to other cognitive domains, or intelligence.

Despite the immense amount of research conducted recently, less work has examined the effectiveness of cognitive training in preschoolers, a crucial developmental period for self-regulation processes, such as EF (Garon, Bryson, & Smith, 2008). One of the only studies with a younger sample demonstrated some effectiveness for cognitive training improving working memory task performance compared to a control group, though these findings were not robust across measures of EF, nor did they examine behavioral or academic functioning (Thorell, Lindqvist, Bergman Nutley, Bohlin, & Klingberg, 2009). One of the other studies with preschoolers found that cognitive training improved symptoms of parent and clinician, but not teacher, rated inattention, but they also did not examine academic outcomes (Tamm, Nakonezny, & Hughes, 2014).

The impact of cognitive training is mostly limited to near-transfer improvements in similar cognitive tasks (i.e., working memory tasks), but not necessarily enhancements in core cognitive mechanisms, as evidenced by lack of academic or behavioral improvements (Melby-Lervåg et al., 2016; Soveri et al., 2017; Sala & Gobet, 2017). On the other hand, more traditional and evidence-based behavioral parent training programs demonstrate significant reductions in EBP (Kaminski, Valle, Filene, & Boyle, 2008). However, as reviewed by Chronis et al. (2004), there are some challenges to employing parent training models within school settings. Additionally, behavioral parent training programs do not specifically address EF deficits that are theoretically associated with EBP. Not surprisingly, an array of preschool curricula have been developed to promote self-regulation skills as a means of improving academic success. Broadly, these curricula aim to improve social-emotional skills, behavioral regulation, problem solving, and classroom engagement (see Domitrovich, Durlak, Goren, & Weissberg, 2013 for a list of programs; Ursache, Blair, & Raver, 2011). One easily transportable self-regulation classroom curriculum includes the use of 30-minute circle time EF games that require attention, working memory, inhibitory control, and behavioral regulation (Tominey & McClelland, 2011). Across several studies, these circle time EF games have been shown to improve preschoolers' self-regulation and academic achievement (Tominey & McClelland, 2011; Schmitt, McClelland, Tominey, & Acock, 2015). While such classroom curricula have empirical support for improving self-regulation and academics, they typically target children without behavior problems.

Adapted from the summer treatment program (STP; Pelham et al., 2010), the STP-PreK (Graziano et al., 2014) is a multimodal intervention which includes a parent training program along with an 8-week daily camp component that utilizes behavioral modification strategies to facilitate the transition to kindergarten for children with behavior problems. Compared to universal programs, such as the preschool curricula mentioned previously, the STP-PreK is unique in targeting children with elevated levels of EBP, who have greater EF deficits, at a critical time in development. Rimm-Kaufman and Pianta's Ecological and Dynamic Model of Transition (2000) highlights the importance of self-regulation during the transition from preschool to kindergarten especially for academic trajectories. Self-regulation plays a large role in adjusting to the increasing demands of independence and responsibility in kindergarten, making intervention during the transition period critically important (Rimm-Kaufman & Pianta, 2000). A previous open trial (Graziano et al., 2014) and randomized control trial (Graziano & Hart, 2016) demonstrated the initial efficacy of the STP-PreK in improving children's EBP and EF. However, it is important to note that the randomized control trial included a comprehensive social-emotional/self-regulation classroom curriculum, which included daily social skills lessons through the use of puppets, vignettes, and videos; a 30-minute self-regulation period consisting of various EF games adapted from Tominey & McClelland (2011) and most relevant to the current study, a computer period in which children participated in Cogmed JM working memory training (CWMT; http://cogmed.com; Graziano & Hart, 2016). Thus, it remains unclear which active social-emotional/self-regulation component contributed to improvements in EBP and EF. When implementing a classroom curriculum, it is important to examine which treatment components are actively providing benefits. Isolating the effect of working memory training is particularly important given emerging commercialization of computerized cognitive training programs and marketing to parents and academic personnel (Hambrick, 2014; Simons et al., 2016).

Current Study

Interest in technology interventions and cognitive training programs with high transportability targeting children's EF have received a great deal of attention over the last decade (Cortese et al., 2015). Despite some promising results as it relates to near transfer effects (i.e., EF), these programs have generally not yielded results relating to academic benefits or symptom/impairment reduction (Rapport, Orban, Kofler, & Friedman, 2013; Cortese et al., 2015). It may be the case that cognitive training programs are more effective if delivered during the preschool period, a crucial developmental period for EF (Garon, Bryson, & Smith, 2008). After an extensive literature review using the following key words, few studies to our knowledge have examined such programs within a preschool population, and despite some promising results, none of the studies examined academic outcomes, and only one examined symptom reduction: [cognitive training, preschool, social emotional curriculum, behavioral intervention] (Thorell et al., 2009; Rueda, Checa, & Cómbita, 2012; Tamm et al., 2014). Additionally, no study to our knowledge has examined the extent to which such computerized cognitive training programs provide incremental benefits to children above and beyond a classroom based behavioral and social-emotional/self-regulation curriculum. Using a randomized trial design, the current study assigned preschoolers with elevated EBP to receive the STP-PreK's behavioral and social-emotional/self-regulation classroom curriculum along with either a) the non-adaptive or b) the adaptive version of CWMT. We expected that children receiving the adaptive CWMT would outperform those receiving the non-adaptive version on EF measures. However, we hypothesized that there would be no additional benefits for the adaptive cognitive training over the non-adaptive group in terms of academic or behavioral functioning improvements.

Method

Participants and Recruitment

This study took place in a large urban university in the Southeastern United States with a large Hispanic/Latino population. Children and their families were recruited from local preschools and mental health agencies via brochures, radio advertisements, and open house/parent workshops. Participants were eligible if they (a) had an externalizing problems composite t-score of 60 or above on parent (M = 63.71, SD = 13.84) or teacher (M = 67.09, SD = 17.20) BASC-2 (Reynolds & Kamphaus, 1992), (b) were enrolled in preschool the previous year, (c) had an estimated IQ of 70 or above (M = 85.57, SD = 12.74), (d) had no reported Autism Spectrum or Psychotic Disorder, and (e) were able to participate in the 8-week STP Pre-K (Graziano et al., 2014).

The final sample consisted of 49 children (M_{age} = 4.52, SD = 0.63, 71% male), whose parents provided consent to participate in the study. In terms of ethnic makeup, 76% of the participants were Hispanic/Latino. All children's primary language was English, with 58% also being proficient in Spanish. All child assessments were administered in English. According to the C-DISC (Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000), 33% of children met DSM-IV criteria for both ADHD and

Oppositional Defiant Disorder (ODD), an additional 29% met criteria for ADHD alone, 20% met criteria for ODD alone, and 18% did not meet any diagnosis.

Study Design and Procedure

The university's Institutional Review Board approved this study. All families participated in a pre-treatment assessment prior to the start of the STP-PreK. As part of the pre-treatment assessment, children were individually administered the Wechsler Preschool and Primary Scale of Intelligence- 4th edition (WPPSI-IV; Wechsler, 2012) and six subtests of the Woodcock-Johnson Test of Achievement-Third Edition (WJ-III; Woodcock, McGrew, & Mather, 2001) while parents completed a diagnostic interview (C-DISC; Shaffer et al., 2000) in their preferred language (83% English). Parents and teachers also completed questionnaires about the child's behavior and self-regulation skills. Eligible participants were invited to attend a second laboratory visit, where children completed an EF battery which consisted of the Head-Toes-Knees-Shoulders (HTKS) Task (Ponitz, McClelland, Matthews, & Morrison, 2009; McClelland et al., 2014) and the Automated Working Memory Assessment (AWMA; Alloway, Gathercole, & Pickering, 2004). The same EF battery and academic achievement assessment was completed 1-2 weeks following the intervention.

Intervention

The STP-PreK (Graziano at al., 2014) is a multimodal intervention for preschoolers with ADHD and other behavior problems. Children in the STP-PreK receive an intensive academic, behavioral, social-emotional, and self-regulation training throughout the camp day (M-F 8 a.m. to 5 p.m.) across a variety of classroom and recreational enrichment activities. Embedded across activities is the use of a behavior modification program. Parents also attended a weekly school readiness parenting program (Graziano, Ros, Hart, & Slavec, 2017). A previous randomized trial showed that the addition of a social-emotional/self-regulation curriculum to the STP-PreK provided enhanced academic and self-regulation outcomes (Graziano & Hart, 2016). The social-emotional/self-regulation curriculum included an EF game period (30 minutes), adapted from Tominey & McClelland (2011), and CWMT (15 minutes; http://www.cogmed.com).

Given the current study's interest in examining the incremental benefits of computerized cognitive training, children in this study all received the same behavioral modification program and social-emotional curriculum from the STP-PreK, but were additionally randomized to receive either a) an adaptive version of CWMT (n = 24), or b) a non-adaptive version of CWMT (n = 25). CMWT is a computer program designed to improve working memory and behavior in preschoolers through a game-like interface with a theme park design (Roche & Johnson, 2014). The program consists of 10-15 minute sessions, five days a week across the course of 5 weeks (http://www.cogmed.com). The adaptive version is designed to increase in difficulty dependent on children's game performance. On the other hand, children in the non-adaptive version remain in the same easy introductory level they start out at regardless of performance. Consistent with prior research, children participated in the cognitive intervention for a maximum of 25 days. (Rapport et al., 2013). The two intervention groups were compared on all demographic (e.g., child age, child sex, SES, ethnicity) and screening variables (e.g., initial EBP symptom severity, ADHD diagnosis). Ethnicity was significantly associated with condition (r = -.30, p < .05), such that there were less

Hispanic/Latino children in the non-adaptive condition than in the adaptive condition. As seen in Table 1, there were no significant differences between the groups on any other demographic or screening measures.

Measures

Behavioral Functioning

ADHD symptoms. Parents and teachers completed the Disruptive Behavior Disorder (DBD) Rating scale (Pelham, Gnagy, Greenslade, & Milich, 1992). Each symptom of ADHD on the DBD Rating Scale is rated on a 4-point frequency scale (*not at all, just a little, pretty much, or very much*). The DBD Rating Scale was adapted to reflect the newest edition of the Diagnostic and Statistical Manual for Mental Disorders (DSM-5; American Psychiatric Association, 2013). For this study, the mean severity of ADHD symptoms (hyperactivity/impulsivity and inattention) were used for parent ($\alpha = .91$, $\alpha = .95$ pre and post, respectively) and teacher ($\alpha = .94$, $\alpha = .96$ pre and post, respectively).

Externalizing behavior problems. Parents and teachers completed the Behavior Assessment System for Children–Second Edition (BASC-2; Reynolds & Kamphaus, 1992). The BASC-2 is widely utilized tool that assesses emotional and behavioral domains. The scales include internalizing, externalizing, and behavior symptom domains, and adaptive/social functioning skills. The externalizing problems scale was used for the current study for parent ($\alpha = .90$, $\alpha = .91$ pre and post, respectively) and teacher ($\alpha = .97$, $\alpha = .97$ pre and post, respectively).

Executive Functioning

AWMA. Children were administered four subtests of the Automated Working Memory Assessment (AWMA; Alloway et al., 2004). Subtests included: (a) Word Recall (auditory short-term memory); (b) Listening Recall (auditory working memory); (c) Dot Matrix (visuospatial short-term memory); and (d) Mister X (visuospatial working memory). In the Word Recall task, children are required to remember a sequence of words and repeat them back to the examiner. The Listening Recall subtest requires children to indicate if a sentence is "true" or "false," then recall the last word of the sentence with increasing difficulty. In the Dot Matrix task, children must recall in order the location of a series of dots presented on a 4 X 5 grid. In the Mister X task, two similar figures are next to each other, each holding a ball in its hand. One of the figures is rotated between 45 to 315 degrees. The child is required to determine spatial orientation (i.e. "Are they holding the ball in the same hand or different hands?"), and recall the location of the ball from six different possibilities. Raw scores from the subtests are converted to standard scores according to gender and age norms. Scores from the AWMA show adequate test–retest reliability and has established convergent validity (Alloway et al., 2008). Due to the moderate to high correlation among the four subtests (*rs* = .31-.78), an average standardized score of the subtests was calculated and used for the analyses in the current study.

HTKS. Children were administered the head–toes–knees–shoulders task (HTKS; Ponitz et al., 2008). The HTKS is a widely-used task used with preschoolers to assess EF. The HTKS has well-established internal consistency, reliability and concurrent/predictive validity (McClelland et al., 2007; Ponitz, McClelland, Matthews, & Morrison, 2009). During HTKS, children are required to follow a set of behavioral rules paired with conflicting behavioral responses. There are three parts to the task with 10 trials each. Prior to each part, children are presented with a set of rules (i.e. head and toes) such that the child is required to do the opposite/different move from what is stated aloud. For example, when the examiner says, “touch your toes” the correct behavioral response would require the child to touch their head. In the second part, a new set of paired rules is added, touching shoulders and knees. In the third part, the examiner switches the rules, such that head pairs with knees, and shoulders pairs with toes. The child receives 0 points for an incorrect response, 2 points for an immediate correct response, and 1 point for self-corrections with a total possible score of 60. The current study used this total score with higher scores indicating better EF.

BRIEF. Parents and teachers completed the Behavior Rating Inventory of Executive Function Preschool Version (BRIEF-P; Gioia, Isquith, Guy, & Kenworthy, 2000). The BRIEF-P yields 5 non-overlapping scales clinical scales (inhibit, shift, emotional control, working memory, and plan-organize). Scores on these individual scales can be summed up to form composites of inhibitory self-control (inhibit + emotional control), flexibility (shift + emotional control), emergent metacognition (working memory + plan/organize), and an overall global executive composite. Higher scores on clinical scales/composites are indicative of poorer EF capacity. The emergent metacognition composite t-score was used as a measure of EF for parents (α = .92, α = .94 pre and post, respectively) and teachers (α = .94, α = .98 pre and post, respectively).

Academic Functioning

WJ-III. Children were administered six subsets of the Woodcock-Johnson Test of Achievement-Third Edition (WJ-III; Woodcock, McGrew, & Mather, 2001), a widely used, norm-referenced measure of academic achievement with excellent psychometric properties. The subsets administered were Applied Problems, Calculation, Writing

Samples, Letter-Word Identification, Passage Comprehension, and Spelling. This study examined derived composite scores: Brief Reading (Letter-Word Identification, Passage Comprehension), Brief Math (Applied Problems, Calculation), and Brief Writing (Spelling, Writing Samples). Given the high correlations among the brief scores, (r's = .56-.58 pre, and r's = .63-.67 post), a composite score was created for an overall academic achievement score at both assessment points.

Data Analytic Plan

All analyses were conducted using Statistical Package for the Social Sciences, version 20 (SPSS 20). There was less than 6% missing data for all child measures. Missing data for parent and teacher report ranged from 2-18% and 12-63% at pre and post-treatment, respectively. According to Little's Missing Completely at Random test, the missing data was missing completely at random (X^2 (605) = 17.2, $p > .05$). There were no significant differences between children with complete versus partial data in terms of any demographic variables or any outcomes examined in the current study. The full dataset is available from the authors upon request. Multiple imputation was conducted with 5 imputations, which is a sufficient estimate for the given sample size (Rubin, 1987). Preliminary analyses were conducted to examine the differences between adaptive ($n = 24$) and non-adaptive ($n = 25$) conditions, as well as associations between demographic variables and the study variables. Our sample size is above the minimum of 20 per group, and sufficient for detecting significant time effects for working memory training (Redick, Shipstead, Wiemers, Melby-Lervåg, & Hulme, 2015). Multiple repeated measures ANOVAs were conducted to compared children in the STP-PreK who were randomized to adaptive versus non-adaptive CWMT in terms of behavioral, academic, and EF outcomes. Bonferroni corrections to minimize Type 1 error were utilized while Cohen's *d* effect sizes were provided for all analyses.

Results

Preliminary Analyses

Preliminary analyses examined potential associations between demographic variables and the study's outcome variables. Ethnicity was significantly associated with pre-treatment scores of academic achievement ($r = .29$, $p < .05$), such that non-Hispanic/Latino children scored higher than Hispanic/Latino children. Children's age and IQ were significantly associated with HTKS ($r = .43$, $p < .001$; $r = .14$, $p < .05$ respectively) and AWMA ($r = .18$, $p < .01$; $r = .48$, $p < .001$ respectively) performance, indicating that older children, and children with higher IQs performed better on EF tasks. Additionally, IQ was significantly associated with WJ performance ($r = .63$, $p < .001$), such that children with higher IQs performed better academically. Given that IQ shares variance with EF and academic performance, and consistent with prior work (Rapport et al., 2009), IQ was not used as a covariate. Rather, a residual IQ score was derived by parceling out variance not accounted for by the outcome variable of interest on IQ. No other demographic variables were significantly associated with the study's variables of interest. Therefore, subsequent analyses included age, ethnicity, and residual IQ scores as covariates.

Intervention Outcomes

CWMT. As seen in Table 2.1, there were no significant differences between the adaptive to the non-adaptive condition in terms of number of days trained, $F(1, 47) = 3.02$, $p = .09$, active number of minutes played, $F(1, 47) = 0.09$, $p = .77$, or number of minutes not engaged in the activity, $F(1, 47) = 1.73$, $p = .20$. On the other hand, there were significant differences between the two conditions between the start index and maximum index, $F(1, 47) = 49.71$, $p < .001$. Thus, as expected children who received the adaptive condition experienced an increase in the level of difficulty of the training modules.

Behavioral functioning. As seen in Table 2.2, even after accounting for age, ethnicity, and residual IQ, there was a significant time effect such that children across both groups experienced a significant improvement in their ADHD symptoms as rated by both parents and teachers, $F(1, 44) = 32.96$, $p <.001$, $d = -.55$; $F(1, 44) = 11.58$, $p < .01$, $d = -.41$, respectively. However, there was no significant time X condition effect for parent rated ADHD symptoms, $F(1, 44) = 0.63$, $p = .43$, or teacher rated ADHD symptoms, $F(1, 44) = 0.41$, $p = .53$, suggesting that children across both groups experienced similar improvements in ADHD symptoms.

Additionally, there was a significant time effect for EBP such that children across both groups decreased in their behavior problems as rated by both parents and teachers on the BASC-2, $F(1, 44) = 32.14$, $p <.001$, $d = -.60$; $F(1, 44) = 46.03$, $p < .001$, $d = -.86$, respectively. There was no significant time X condition effect for parent, $F(1, 44) = 0.09$, $p = .76$, or teacher, $F(1, 44) = 0.64$, $p = .43$, rated behavior problems. These findings suggest that children in both the adaptive and non-adaptive conditions improved their behavior problems at a similar rate.

Executive functioning. Similarly and as seen in Table 2.3, there was a significant time effect for both observed EF measures, $F(1, 44) = 43.46$, $p < .001$, $d = .49$; $F(1, 44) = 51.93$, $p < .001$, $d = .60$, AWMA and HTKS respectively. However, there was no significant time X condition effect on either observed EF measure, $F(1, 44) = 0.70$, $p = .41$; $F(1, 44) = 0.10$, $p = .75$, AWMA and HTKS respectively. Additionally, there was a significant time effect for both parents and teachers reported EF deficits, $F(1, 44) = 72.69$, $p < .001$, $d = -.62$; $F(1, 44) = 7.17$, $p < .05$, $d = -.27$, respectively. However, there was no significant time X condition effect for either parent nor teacher rated impairment of EF, $F(1, 44) = 2.47$, $p = .12$; $F(1, 44) = 0.05$, $p = .82$ respectively. These results indicated that children across both groups improved similarly in terms of observed and parent/teacher reported EF.

Academic functioning. As seen in Table 2.3, there was a significant time effect for the WJ-III, $F(1, 44) = 11.06$, $p < .01$, $d = .23$. However, there was no significant time X condition effect, $F(1, 44) = 0.32$, $p = .57$. Regardless of condition, all children improved academically.

Discussion

This study was among the first to examine the extent to which CWMT provided incremental benefits to a classroom based EF curriculum for young children with EBP. The results from the current study demonstrated that children that were randomized to receive the non-adaptive cognitive training improved similarly across all domains (behavioral, academic, and EF) compared to children assigned to the adaptive cognitive training. However, all children who participated in the STP-PreK improved their behavioral, academic, and executive functioning as evident by parent, teacher, and observed/standardized measures. Implications of these findings are discussed below.

Prior research examining the efficacy of cognitive training programs in older children and adolescents have yielded mixed results (Rapport et al., 2009). Our findings with a younger sample were more consistent with emerging meta-analyses and reviews (Simons et al., 2016; Cortese et al., 2015), such that the effects of cognitive training did not generalize to academic or behavioral improvements (van der Donk et al., 2015). Furthermore, we did not even find near transfer effects of CWMT to working memory, or other aspects of EF. Transfer of learning theories, such as formal discipline, suggest that repeated practice generally improves performance, which is the guiding principle for cognitive training (Simons et al., 2016). However, transfer effects are largely content and context dependent, so the specificity of cognitive training limits generalizability to more complex processes such as EF (Stine-Morrow & Basak, 2011).

This study was among the first to systematically examine the potential for cognitive training to improve EF in a preschool sample with EBP. Our null near-transfer effects are consistent with Sala and Gobet (2017), who found that when controlling for placebo effects (i.e., similar to our active control condition), the near-transfer effects become quite small, especially within an atypical population. It may be the case that for preschoolers with ADHD, the content of CWMT does not facilitate generalization of EF skills (near- or far-transfer effects) or academic/behavioral improvements (far-transfer effects) more broadly. Similarly, as discussed in the review by Peijnenborgh et al. (2016), cognitive training is not a “one size fits all” model, such that focusing solely on working memory does not capture the core deficits across presentations and subtypes of ADHD. However, it is also important to note that such cognitive training was conducted within an intensive behavioral modification program that also included a brief EF classroom period. These EF games may more broadly address some of the deficits seen across presentations of ADHD, such as behavioral inhibition, motivation, and planning/sequencing, along with working memory (Peijnenborgh et al., 2016). Thus, it appears that CWMT simply does not add any incremental value to improving children with EBP's adaptive functioning when embedded within a more comprehensive psychosocial intervention such as the STP-PreK.

Consistent with our hypotheses, we found significant improvements in children's behavioral, academic, and executive functioning. These findings align with prior research examining the STP-PreK (Graziano et al., 2014; Graziano & Hart, 2016) demonstrating improvements across various domains, including a reduction in ADHD symptomology. Such improvements within the behavioral domain is not surprising given that the STP-PreK also includes a parent training component. Parent training is the first line of treatment for young children with ADHD and EBP with numerous studies supporting its effect on children's behavioral functioning (Chronis et al., 2004; Pelham & Fabiano, 2008; Kaminski et al., 2008; Comer, Chow, Chan, Cooper-Vince, & Wilson, 2014). On the other hand, the continued success of the STP-PreK in targeting children's academic and executive functioning is noteworthy as parent training programs have traditionally not been successful addressing academic and executive functioning impairments (Graziano & Hart, 2016; Kaminski et al., 2008). Thus, it appears that the inclusion of an academic and social-emotional/self-regulation classroom curriculum in a daily camp along with more traditional behavioral parent training contributes to the STP-PreK's success in targeting children's academic and executive functioning.

Strengths of this study include the randomized design where parents and teachers were unaware of the CWMT condition to which the child was assigned. Prior research did not include randomization, and even recently, reporters have typically been unblinded to treatment condition, such that parents/teachers knew the children were receiving training, leading to a possible illusory reported bias (Rapport et al., 2009). Furthermore, when controlling for blinded reporters, many of the previously significant effects became null findings (Cortese et al., 2015). The current study also examined the incremental effect of CWMT with a more comprehensive behavioral modification curriculum that includes classroom EF circle time games, which could potentially yield greater, more robust effects than cognitive training alone. Finally, the measurement of EF was multimodal utilizing multiple informants, as well as direct assessment. As discussed by Shipstead, Redick, and Engle (2012), using single tasks to define change in ability raises concern, and is an overrepresentation of what may be occurring with near- and far-transfer effects of cognitive training. Indeed, prior research was limited to task performance only (Thorell et al., 2008; Rueda et al., 2012), or failed to integrate measures of both near transfer effects (i.e. task performance) and far transfer effects (reported measures and academic achievement outcomes (Rapport et al., 2009). However, our study examined multiple measures of EF at both time points, which provide a stronger evaluation of cognitive training outcomes and the lack of near- or far-transfer effects.

There were also limitations to the current study. Most notably, there was no true control condition as all children received some version of the STP-PreK. Additionally, while we chose to randomize the CWMT, this randomization meant that the EF games period remained as part of both the non-adaptive and adaptive conditions. Alternatively, we could have randomized the EF games period and kept the CWMT as part of the standard STP-PreK's EF curriculum. However, we chose randomizing CWMT given the additional costs that it may yield for current clinical practices that are recommending for families to use at home (http://www.cogmed.com). It may also be more practical to implement free EF games rather than computerized training given the expensive costs associated per child. Additionally, the current study did not include a follow-up assessment period. Thus, it is possible that children in the adaptive CWMT experienced either additional improvements or better maintenance of the treatment effects across time. Future research should examine the potential sleeper effect of CWMT on children's school functioning. Furthermore, the sample for this study was homogenous, largely Hispanic (76%), limiting the generalizability of these results to other settings and populations. However, this limitation can also be viewed as a strength as Hispanic children are the fastest growing minority in the country, and are largely understudied in research (La Greca, Silverman, & Lochman, 2009). Lastly, our sample had relatively lower levels of general intelligence, albeit still within the low average range, compared to previous cognitive training trials with typically developing children (Peijnenborgh et al., 2016). However, the low average IQ in our sample may be representative of a community referred clinical sample, and is consistent with previous cognitive training research with children with disabilities (Peijnenborgh et al., 2016). The extent to which lower overall cognitive functioning impacts the lack of near- or far-transfer effects remain an important question for future work.

Despite the limitations of the current study, our findings have clinical implications. For preschool children with EBP, CWMT does not appear to provide any incremental benefits to children's EF, behavior, or academics when implemented within a comprehensive behavioral modification intervention that also included a brief EF classroom period. However, the results from this study provide continued support for the STP-PreK in improving school readiness outcomes. Given the expensive cost of cognitive training, this study, along with a larger body of literature (Cortese et al., 2015) suggests that CWMT should not be implemented as either a stand-alone intervention for children with EBP nor as an adjunctive intervention. Rather, it provides support for the implementation of an EF games period in classrooms, along with behavior modification.

The results of our study, in combination with many meta-analyses (Melby-Lervåg et al., 2016; Soveri et al., 2017; Sala & Gobet, 2017) demonstrates that cognitive training fails to provide strong evidence for far-transfer effects. Future research should move beyond the traditional cognitive training, and expand to more innovative technology, such as virtual reality. For example, virtual reality has been effective in treating phobias and Post Traumatic Stress Disorder by simulating real life situations (Botella, Serrano, Baños, & Garcia-Palacios, 2015). It will be important for future work to use virtual reality to create situations more analogous to the classroom setting, in which demands for self-regulation and advanced cognitive performance are necessary for school success. By expanding beyond the technologically outdated cognitive interventions and laboratory tasks, virtual reality could be an important next step in the realm of behavioral intervention.

Acknowledgements

The research reported here was supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R324A120136 as well as a local grant from The Children's Trust (1329-7290) to the third author. The opinions expressed are those of the authors and do not represent views of the Institute or the U.S. Department of Education or The Children’s Trust. We would also like to acknowledge the support of Miami-Dade County Public Schools and thank the families and dedicated staff who participated in the study.

Table 2.1. *Baseline Variables by Condition*

	Total Sample (n = 49)	Adaptive (n = 24)	Non-Adaptive (n = 25)
Demographic variables			
Child sex (% male)	71	63	80
Child age (Mean)	4.52 (0.63)	4.56 (0.62)	4.48 (0.66)
Hollingshead SES	39.81 (13.15)	40.13 (12.87)	39.50 (13.67)
Child Ethnicity (% Hispanic/Latino)	76	**63***	**88***
Child IQ	85.57 (12.74)	84.04 (13.51)	87.04 (12.05)
BASC-2 (P)	63.71 (13.84)	63.67 (17.26)	63.75 (9.66)
BASC-2 (T)	67.09 (17.20)	65.67 (16.25)	68.80 (19.01)
ADHD only diagnosis (%)	29	29	28
ODD only diagnosis (%)	20	25	16
ADHD + ODD diagnosis (%)	33	21	44
Cogmed JM variables			
Days trained	20.08 (5.37)	18.75 (6.04)	21.36 (4.38)
Active minutes played per day	15.80 (2.57)	15.69 (2.23)	15.91 (2.91)
Paused minutes per day	15.14 (10.75)	17.18 (12.28)	13.18 (8.84)
Start-max index	6.69 (9.63)	**13.67 (9.70)*****	**0.00 (0.00)*****

Note. Values in parenthesis represent standard deviations. SES = socioeconomic status, BASC-2 = Behavior Assessment System for Children, 2nd edition, ADHD = Attention-Deficit/Hyperactivity Disorder, ODD = Oppositional Defiant Disorder, P = parent report, T = teacher report. Paused minutes per day = number of minutes per day not engaged in the activity. Start-max index = difference between the maximum and the start index. *p<.05 significant group differences, ***p<.001 significant group differences.

Table 2.2. *Behavioral Functioning Outcomes*

	Pre *M* (*SE*)	Post *M* (*SE*)	Time x Group *F*	Time Effect *F*
Behavioral Functioning				
DBD—ADHD (P)			0.63	**32.96*** **
Adaptive	1.53 (.13)	0.92 (.17)	---	---
Non-adaptive	1.34 (.13)	0.87 (.13)	---	---
DBD—ADHD (T)			0.63	**11.58** **
Adaptive	1.31 (0.17)	0.80 (0.17)	---	---
Non-adaptive	1.59 (0.18)	1.07 (0.18)	---	---
BASC—Externalizing (P)			0.09	**32.14*** **
Adaptive	63.24 (3.03)	52.19 (2.11)	---	---
Non-adaptive	64.62 (3.24)	53.22 (2.08)	---	---
BASC—Externalizing (T)			0.64	**46.03*** **
Adaptive	66.52 (2.50)	51.68 (1.86)	---	---
Non-adaptive	68.04 (2.45)	56.57 (1.87)	---	---

Note. Means and SEs are marginal estimates after controlling for age and ethnicity. *p<.05, **p<.01, ***p<.001. P = Parent report, T = Teacher report, DBD—ADHD = Disruptive Behavior Disorder Rating Scale mean Attention-Deficit/Hyperactivity Disorder symptom severity, BASC Externalizing = Behavior Assessment System for Children, 2nd edition Externalizing Problems T-score.

Table 2.3. *Academic and Executive Functioning Outcomes*

	Pre *M* (*SE*)	Post *M* (*SE*)	Time x Group *F*	Time Effect *F*
Executive Functioning				
AWMA—average			0.70	**43.46*** **
Adaptive	82.60 (2.99)	91.35 (2.22)	---	---
Non-adaptive	85.06 (2.17)	92.85 (2.18)	---	---
HTKS—total			0.10	**51.93*** **
Adaptive	3.24 (1.32)	9.81 (2.57)	---	---
Non-adaptive	6.41 (1.29)	16.68 (2.52)	---	---
BRIEF—EMC (P)			2.47	**72.69*** **
Adaptive	74.18 (2.87)	55.40 (2.45)	---	---
Non-adaptive	69.88 (2.97)	58.55 (2.39)	---	---
BRIEF—EMC (T)			0.05	**7.17***
Adaptive	65.54 (2.90)	58.65 (2.50)	---	---
Non-adaptive	65.44 (2.83)	62.12 (2.42)	---	---
Academic Functioning				
WJ-III—average			0.32	**11.06** **
Adaptive	91.36 (3.19)	95.53 (3.25)	---	---
Non-adaptive	97.07 (3.12)	103.28 (3.20)	---	---

Note. Means and SEs are marginal estimates after controlling for age and ethnicity. **p*<.05, ***p*<.01, ****p*<.001. P = Parent report, T = Teacher report, AWMA—average = Automated Working Memory Assessment average standard score, HTKS—total = Head-Toes-Knees-Shoulders total score, BRIEF—EMC = Behavior Rating Inventory of Executive Function Preschool version Emergent Metacognition T-score, WJ-III = Woodcock-Johnson Test of Achievement-Third Edition average standard score.

III. STUDY III

Abstract

The purpose of this study was to longitudinally examine 1) the malleability of stress, parental executive functioning (EF), and parenting skills across an early behavioral parent training (BPT) intervention, 2) the association between stress and parental EF and parenting skills, and 3) the extent to which parental stress moderates the association between parental EF and parenting skills for parents of children with Attention-Deficit/Hyperactivity Disorder (ADHD). Participants included 112 parents (95% mothers, M_{age} = 36.25) of children (76% males, M_{age} = 5.51) with ADHD. Multilevel modeling found that parents generally improved parenting skills, parental stress, and EF (*d*'s = |.33-2.07|). While there were no significant findings regarding the impact of initial levels of parental stress or EF on parenting skills across intervention, there was a significant association between parental stress and reported negative parenting at baseline. Findings from this study suggest that parental stress, parenting skills, and parental EF are malleable over the course of BPT. Future work should examine the directional associations between parental EF, stress, and parenting skills across BPT.

Introduction

Attention-Deficit/Hyperactivity Disorder (ADHD) is a common neurodevelopmental disorder affecting an estimated 9-12% of children and adolescents with typical onset during the preschool years, and a pooled 2.4% prevalence specifically during the preschool years (Danielson et al., 2018), making it the most common referral for mental health centers (Avenevoli et al., 2013; Keenan & Wakschlag, 2000). ADHD is characterized by symptoms of inattention, and/or hyperactivity/impulsivity and associated with significant impairments across domains of functioning, including social, academic, and behavioral domains (American Psychological Association, 2013; Wehmeier et al., 2010). While hyperactivity, impulsivity, and inattention are developmentally more typical during the preschool years, high levels of symptoms during preschool are associated with poor outcomes, such as neuropsychological impairment, social functioning, and academic achievement (O'Neill et al., 2017). Furthermore, ADHD during the preschool years is associated with increased family dysfunction, such as parental distress, parental depressive symptoms and reactive parenting (Breaux & Harvey, 2019). Not surprisingly, researchers have developed and evaluated numerous treatments for children with ADHD (Pelham & Fabiano, 2008).

Behavioral Parent Training (BPT) and Current Limitations

BPT is the front-line intervention, specifically for young children with ADHD (American Academy of Pediatrics, 2011; Pelham & Fabiano, 2008). A plethora of research examining the effects of BPT demonstrate positive effects on children's behavioral functioning (Chronis et al., 2004). However, despite the large evidence base supporting BPT, the BPT literature has been reviewed and criticized for having low engagement, high attrition rates, and poor maintenance of gains overtime (Chacko et al., 2016). For example, BPT broadly has been found to have dropout rates ranging from 25-60% across treatment (Koerting et al., 2013; Scott & Dadds, 2009). Specifically, among young children with behavior problems, minority status and family structure (e.g., single-parent household) have been associated with higher dropout rates, and maternal minority status and education was associated with worse poorer treatment outcomes including child behavior problems and parenting skills (Bagner & Graziano, 2012).

Further examining effect sizes of BPT over time, a meta-analytical review by Lee et al., (2012) demonstrated that BPT during the preschool years has been associated with improvements in both child behavior and parenting, with either maintained intervention effect size from post-treatment to follow-up, or decreased magnitude in effect size at follow-up when compared to post-treatment effect sizes. Similarly, specific to preschoolers with behavior problems, studies have found either maintenance or regression at follow-up ranging from 1-week to 3-years post-treatment (Abikoff et al., 2015; Graziano et al., 2018; Nixon, 2000). Furthermore, there is little evidence demonstrating reductions in long-term risks associated with ADHD following BPT during preschool, especially when considering the possible contamination of effects by exposure to other treatments later in life (Daley et al., 2018; Polanczyk, 2018). Therefore, examining factors that potentially interfere with BPT interventions remains critical for understanding and maximizing treatment outcomes, particularly for children with ADHD.

Parent-Child Relationships

Positive parenting (e.g., use of praise, good listening skills) is important for children’s development across many domains of functioning (Belsky, 1984). Baumrind conceptualized four domains of parenting styles based on warmth and control: authoritative, authoritarian, permissive, and rejecting/neglecting (Baumrind, 1991). Broadly, authoritative parenting, characterized by high levels of nurturing and support, in addition to clear limit-setting and assertiveness, is associated with better parent-child relationships (Baumrind, 1991; Peterson et al., 1997), child academic achievement (Masud et al., 2015; Peterson et al., 1997; Steinberg et al., 1992), and decreased risk of child behavior problems and substance use across development (Baumrind, 1991). However, it is important to note that parent-child relationships are not unidirectional. Belky's (1984) process model of parenting suggests that parenting is influenced by both parents and children, in addition to other contextual factors. Furthermore, Taraban and Shaw (2018) updated the process of parenting model, suggesting that parents are influenced by factors such as personality, depression, cognitions and affect, and developmental history (e.g., higher parental depression associated with worse parenting). On the other hand, children are influenced by negative emotionality, stress, genetics, and emotion regulation (Taraban & Shaw, 2018). Furthermore, Sameroff's (2009) transactional model of development suggests that bidirectional relationships reinforce over time. One example of this within children with behavior problems, such as ADHD, is Patterson's coercive family process theory (Patterson, 1982). More specifically, parents and children bidirectionally influence each other over time in a coercive cycle of noncompliance and ineffective parenting. For example, if a child has a tantrum when a limit is placed and the parent then removes the limit/request placed to make the calm down, the child is negatively reinforced for having a tantrum to remove limits/requests, and the parent is negatively reinforced for either giving in or removing limits/requests by the child becoming calm (Patterson, 1982). Therefore, BPT for children with ADHD addresses the coercive cycle and promotes authoritative parenting by teaching strategies to both increase warmth and appropriate limit setting (Chronis et al., 2004). However, as mentioned previously, BPT has many limitations and is impacted by a number of parent and child factors. Therefore, understanding factors impeding treatment outcomes and/or exploring alternative interventions is critical. The purpose of the present study is to examine parental factors, including executive functioning and stress, related to behavioral parent training outcomes (e.g., parenting).

Parental Executive Functioning

Though the early years have been identified as a critical point for cognitive development, and neural plasticity (Fox et al., 1994), developmental neuroscience has found evidence for neural plasticity throughout adulthood (Freitas et al., 2011; Huttenlocher, 2009). Plasticity can be measured either through acquisition of new knowledge, or increased flexibility/efficient use of preexisting knowledge (Lövdén et al., 2010). Executive functioning (EF), a higher-order cognitive process involved in the planning and execution of goal-directed behaviors, has generally been conceptualized as a stable construct in adulthood (Ettenhofer et al., 2006). However, emerging work suggests that there are individual differences in stability and use of EF through adulthood (Biederman et al., 2007; Dahlin et al., 2008; Huttenlocher, 2009). Examining the potential malleability of EF is of significant clinical interest given the role of EF in parenting.

EF is crucial for parents in managing difficult child behavior. Specifically, parental EF, including inhibitory control, working memory, and cognitive flexibility, facilitate the regulation of thoughts and emotions to meet the demands of parenting (Barrett & Flemming, 2011). For example, in order to effectively reduce problem behaviors in their child, parents must appraise the situation, regulate their own emotional and cognitive responses to the situation, and determine possible responses to the situation (Lorber et al., 2003). Furthermore, research has demonstrated that parents with poor working memory respond more negatively to a child with behavior problems, compared to a sibling without behavior problems (Deater-Deckard et al., 2010). Another study found that for children with conduct problems, maternal EF was predictive of harsh parenting for mothers with poor EF, but only when there were low levels of environmental uncertainty and stress (Deater-Deckard et al., 2012). These highlight the importance of parental EF in the context of parenting and demonstrate a need to examine the potential malleability of parental cognition in early intervention. To date, research examining parental EF in the context of parenting has focused primarily on typically developing children (Cuevas et al., 2014), and children with conduct problems (Deater-Deckard et al., 2012). However, very little is known about the link between parental EF and parenting skills among children with ADHD, or the impact of BPT on parental EF.

Prior work has demonstrated the malleability of EF in children with behavior problems across a behavioral intervention (Graziano & Hart, 2016; Landis et al., 2019; see Chapter II). One possible explanation for improvements in young children's EF based theoretically in neuroscience, highlights the possibility of both anatomical and functional neural modification through practice (i.e., self-regulation curriculum), in combination with the remarkable development of the frontal lobe and changes in cognitive functioning during early childhood (Peijnenborgh et al., 2016; Vinogradov et al., 2012). Consistent with emerging research demonstrating individual differences in the stability and use of EF through adulthood (Biederman et al., 2007; Dahlin et al., 2008; Huttenlocher, 2009), some literature has demonstrated that cognitive training can improve EF task performance in adults (Soveri et al., 2017). However, this study would be among the first to examine the impact of BPT on parental EF. Though BPT is not intended to improve parental EF, it is possible that improvements in child behavior and/or parenting, or reductions in parental stress, may alleviate cognitive resources for improved efficiency of already existing EF, or new learning across the course of intervention. Examining the link between BPT and parental EF is particularly important given that BPT is the front-line treatment for preschoolers with ADHD. Identifying the malleability of parental EF in the context of early intervention BPT is important given the impact of EF on parenting skills that are critical for the management of child behavior problems (Barrett & Flemming, 2011).

Parental Stress

According to the yearly Stress in America™ survey conducted by the APA prior to the COVID-19 pandemic, the percentage of Americans experiencing symptoms of stress has risen over the past few years to an astonishing 75% (APA, 2017). Chronic stress has been significantly associated with both physiological and psychological deficits (McEwen, 2004). In addition to the everyday stressors of life, children with behavior problems, including ADHD, elicit stress from their parents (Deater-Deckard & Panneton, 2017; Theule et al., 2013). However, the association between stress and parenting is not unidirectional, and may be explained by multiple child and parent factors, including child behavior problems and both child and parental EF (Joyner et al., 2009).

Parental stress has negative impacts on parent-child relationships (Crnic & Greenberg, 1990; Mills-Koonce et al., 2009). Deater-Deckard (1998) hypothesized three pathways regarding the association between stress, parenting, and child behavior: 1) parenting stress causes poor parenting behavior, 2) poor parenting causes child behavioral and social/emotional problems, and 3) parenting mediates the association between stress and child outcomes. Relatedly, the effectiveness of BPT is affected by a myriad of factors including parental stress (Theule et al., 2013). Given the important role of parents in frontline treatment of behavior problems, it is not surprising that high levels of parental stress are associated with weaker parent training treatment outcomes (Reyno & McGrath, 2006). Understanding the role of stress across a BPT intervention may have prognostic value in predicting treatment response, and targeting parental treatment targets, such as parental stress, prior to BPT may improve BPT outcomes for both parents and children.

Stress and EF

Stress triggers neuroendocrine responses through the hypothalamic-pituitary-axis, and glucocorticoids released during stress responses impact learning and memory (Joëls et al., 2006; Ramey & Goldstein, 1957). Some research suggests there may be a tradeoff of EF when under stress, demonstrated by improvements in some aspects of EF, but impairments in others (Goldfarb et al., 2017). While generally stress is thought to enhance memory consolidation in particular, it has also been associated with a variety of impaired cognitive performance (Wolf et al., 2015). Stress impairs prefrontal cortical functions, such as EF, memory, and learning (Arnsten, 2000; Lupien et al., 2007; McEwen & Sapolsky, 1995). Furthermore, effects of stress on cognition have been reviewed to be both task and context dependent (Plieger & Reuter, 2020). Alternatively, factors such as perceived control of the stressor and task complexity, were associated with poorer EF (Gabrys et al., 2019; Oei et al., 2006). Overall, tasks that require more elaborate cognitive processing, such as tasks that require reasoning, and higher cognitive processing, such as those requiring multiple cognitive functions, are particularly impaired at high levels of stress (Plieger & Reuter, 2020). As discussed above, parenting, for example, requires both elaborate processing, and multiple EFs, which may be one explanation for poorer EF in parents of children with behavior problems. Thus, it is possible that if stress improves across intervention, EF may also improve as a result of stress reduction across BPT. It may also be that deficits in EF and/or parenting skills only occur for parents with higher initial levels of stress, given that less low stress levels have not been associated with negative impacts on cognitive functioning. Therefore, EF would not be expected to impact parenting skills for parents with low levels of stress, compared to those with high levels of stress. However, no studies to date have examined the impact of parental stress and EF across BPT or in the context of children with ADHD.

Current Study

While parental EF is important for parenting and child outcomes (Barrett & Fleming, 2011; Cuevas et al., 2014), and stress is associated with deficits in parents' cognitive functioning (Arnsten, 2000; Lupien et al., 2007; McEwen & Sapolsky, 1995), prior research has been unable to disentangle the directionality of the association between stress and cognition, and how they relate to parenting. The current study would be among the first to examine the effects of stress on parental EF and parenting skills longitudinally and examine directionality of the unclear association between parental EF, stress, and parenting skills. Lastly, little is known about the impact of parental EF on outcomes of parenting interventions, especially in the context of stress. This study would be the first to examine the role of parental EF in the acquisition of parenting skills, and how stress may moderate the association between parental EF and parenting skills over the course of a BPT intervention. Given the potentially deleterious effects of stress on cognition, it would be crucial to examine the influence of stress on parental EF and the acquisition of parenting skills in early interventions for children with ADHD.

As parental stress generally accumulates throughout the child's preschool years and is a risk factor for parent and child functioning without intervention (Holzman & Bridgett, 2017), this study has critical implications for intervention. Examining the directionality of the associations between parental stress, parental EF, and parenting skills would identify which parental factor(s) BPT interventions should target first. Maximizing treatment outcomes by targeting the causal factor(s) may yield greater intervention response or more rapid response to treatment.

This study utilized a longitudinal design to examine the interplay between parental EF, stress, and parenting skills for young children with ADHD in the context of a parenting intervention. This study examined 1) the malleability of stress (1a), parental EF (1b), and parenting skills (1c) across an early BPT intervention, 2) the association between stress (2a) and parental EF (2b) and parenting skills, and 3) the extent to which parental stress moderates the association between parental EF and parenting skills. I expected that stress, executive functioning, and parenting skills would significantly improve over the course of BPT intervention. Additionally, it was hypothesized that initial levels of both stress and parental EF would predict changes in parenting skills. More specifically, it was expected that higher initial levels of parental EF would predict greater increases in positive parenting skills, and greater decreases in negative parenting skills, and that higher initial levels of stress would predict fewer increases in positive parenting skills, and fewer decreases in negative parenting skills across intervention. Lastly, it was predicted that parental stress would moderate the association between parental EF and parenting skills, such that association between EF and parenting skills would be stronger among parents with lower levels of stress.

Method

Participants and Recruitment

The study was conducted at a large urban university in the Southeastern United States with a large Hispanic/Latinx population. Children and their families were recruited from local preschools and mental health agencies through brochures, radio ads, and open houses/parent workshops to participate in an intensive summer treatment program for children transitioning to kindergarten, first, or second grade (STP-PreK+; Graziano et al., 2014). All families in the current study consented to participate in the ADHD Heterogeneity of Executive Function and Emotion Regulation Across Development study (AHEAD; Graziano et al., 2022). For the ADHD sample, the parent and child were invited to participate in an assessment to determine study eligibility. Inclusion criteria consisted of: (1) endorsed clinically significant levels of ADHD symptoms (six or more symptoms of either Inattention and/or Hyperactivity/Impulsivity according to the DSM-5 OR a previous diagnosis of ADHD), (2) indicated that the child is currently displaying clinically significant academic, behavioral, or social impairments as measured by a score of 3 or higher on a seven-point impairment rating scale (Fabiano et al., 2006), (3) were not taking any psychotropic medication, and (4) were able to attend an eight-week summer program with weekly parent training. For the typically developing sample, inclusion criteria consisted of: (1) endorsed less than 4 ADHD symptoms, (2) less than 4 Oppositional Defiant Disorder (ODD) symptoms, and (3) indicated no clinically significant impairment. Participants in both the ADHD and typically developing samples were also required to be enrolled in preschool, kindergarten, or first grade during the previous year, have an estimated IQ of 70 or higher, have no confirmed history of an Autism Spectrum Disorder.

During intake, ADHD diagnosis (and comorbid disruptive behavior disorders) was assessed through a combination of parent structured interview (Computerized-Diagnostic Interview Schedule for Children; Shaffer et al., 2000) and parent and teacher ratings of symptoms and impairment (Disruptive Behavior Disorders Rating Scale, Impairment Rating Scale; Fabiano et al., 2006) as is recommended practice (Pelham et al., 2005). Dual Ph.D. level clinician review was used to determine diagnosis and eligibility.

For the current study, only AHEAD families with ADHD were included. Furthermore, families were excluded if they did not complete the summer treatment program (n = 4 dropped prior to the start of treatment). Additionally, one dyad was removed from all analyses as the parent was a certified Parent-Child Interaction Therapy (PCIT) therapist, on which the intervention was largely based. The final study sample consisted of 112 parents (95% mothers) of children (76% males) with ADHD and provided consent to participate in the study. The mean age of the participating children was 5.51 years, *SD* = .75 years, and the mean age of the participating parents was 36.25 years, *SD* = 6.22 years. In terms of the ethnic makeup, 83% of the children were

Hispanic, and 81% of parents identified as Hispanic. Regarding racial makeup, 88% of children were white, 8% Black or African American, 1% Asian, 3% mixed (1 Asian and White, 3 Black or African American and White), while 89% of parents identified as White, 8% Black or African American, 2% mixed (Black or African American and White), and 1% Asian. Linguistically, 76% of parents identified as being bilingual English/Spanish-speaking, 21% monolingual English-speaking, and 3% monolingual Spanish-speaking. Regarding highest level of education completed, 33% of parents reported having an advanced degree (master's, MD, PhD, JD), 32% bachelor's degree, 12% associate's degree, 16% some college, 6% high school graduate, and 1% some high school. Diagnostic information was obtained through parent structured interviews in conjunction with parent and teacher ratings of symptoms and impairment. There were no significant differences in demographic variables between the current subsample and the larger study sample.

Study Design and Procedures

The university's Institutional Review Board approved this study. As part of the initial assessment for this study, parents completed several questionnaires in their preferred language (English or Spanish) about the child's behavior and self-regulation skills as well as the self-report measures about parental stress and parenting skills, discussed in further detail below, prior to the start of treatment, immediately following treatment completion (or about 6 months after intake; $M = 4.47$, $SD = 1.09$), and 6 months after the completion of treatment (or about 1 year after intake; $M = 12.49$, $SD = 2.90$). See Appendix A for table of measures administered at each time-point.

Intervention

As part of the STP-PreK+ (Graziano et al., 2014; Graziano & Hart, 2016), parents attend a parenting program (School Readiness Parenting Program; SRPP; Graziano et al., 2018). Parents are assigned to group according to the child's grade, such that some classes contain children transitioning to kindergarten, while others contain children transitioning into 1st or 2nd grade. Parents attend a group BPT program each week for two hours in the language of choice (English or Spanish), for a total of eight sessions. The first half of each session focuses on traditional parent training strategies (e.g., fostering positive parent-child interactions, use of reinforcement, time-out). Behavior management content is based on PCIT (Zisser & Eyberg, 2010). As such, the first four sessions focusing on child-directed skills (e.g., improving "do skills" of labeled praises, behavioral descriptions, and reflections while minimizing "don't skills" of criticisms, questions, and commands) and four sessions focusing on parent-directed skills (e.g., effective commands, time out). The second half of each session focuses on aspects of school readiness (e.g., appropriately managing difficult child behavior during homework, promoting children's social-emotional functioning, fostering early literacy and math skills). Parents contribute to the didactic group discussion via a Community Parent Education Program (COPE; Thorell, 2009) style, which involves active engagement and participation to guide the group discussion. Parents practice the skills in subgroups (behavior management strategies with their own child while other parents observe; school readiness topics role played with other parents), while therapists rotate to provide direct coaching to each parent. Parent training fidelity was completed for 6 of 8 sessions by a licensed psychologist or doctoral/master's level graduate students, with weekly group supervision a licensed psychologist. Consistent with prior work demonstrating high treatment fidelity (Graziano & Hart, 2016; Hare et al., 2021), the current study found fidelity ranging from 88% to 100% (M = 98%) content delivery across sessions for two of the three cohorts, indicating that across both English and Spanish groups SRPP was implemented with high fidelity.

Measures

Screening Measures

To measure externalizing behavior problems (EBP), parents completed the Behavior Assessment System for Children–Third Edition (BASC-3; Reynolds & Kamphaus, 2015). The BASC-3 is widely utilized tool that assesses emotional and behavioral domains. The externalizing problems scale at pre-treatment was used for the current study ($\alpha = .87$).

Parental Executive Functioning

To measure EF parents were administered two tests from the NIH Toolbox for the Assessment of Neurological and Behavioral Function (NIH Toolbox) via the NIH Toolbox iPad App at pre-treatment, 6-month follow-up, and 1-year follow-up (Weinstraub, 2013). *The Flanker Inhibitory Control and Attention Test* assess inhibitory control and selective attention. *The Dimensional Change Card Sort Test* measures cognitive flexibility or set shifting. Due to high correlation between the tasks (rs = .66 - .83, ps < .01), EF composite age corrected scaled scores were calculated (averaged) and used at each time point.

Parenting Skills

Parents were observed during a 5-minute child directed play situation using the *Dyadic Parent-Child Interaction Coding System*—Fourth Edition (DPICS; Eyberg, 1981) at pre-treatment, 6-month follow-up, and 1-year follow-up. For this study, the coding categories for positive and negative parenting skills, proportion “do skills” and proportion “don’t skills” were used respectively. “Do skills” includes praises, behavioral descriptions, and reflections, while “don’t skills” include questions, commands, and negative talk. Coding was masked to time point and completed by graduate and undergraduate students trained with 80% reliability to criterion videos. Observations (20%) were coded a second time for reliability (*k*s = .87-1.0). Additionally, parents completed the *Alabama Parenting Questionnaire* (APQ; Shelton et al., 1996) at all three time points, which is a 5-point Likert scale (ranging from 1 = *Never* to 5 = *Always*), 42-item self-report measure that assesses five dimensions of parenting: involvement, positive parenting, poor monitoring/supervision, inconsistent discipline, and corporal punishment. Given that prior research has demonstrated that for young children, the corporal punishment and poor monitoring/supervision subscales of the APQ demonstrate weak reliability and internal consistency (Dadds et al., 2003), the negative parenting factor was not used. Rather, this study utilized the positive parenting factor (α = .79-.83), and inconsistent discipline scale (α = .69-.75). Possible scores range from 16-80 (positive parenting) and 6-30 (inconsistent discipline).

Parental Stress

Parents completed the *Parenting Stress Index*, Fourth Edition Short Form (PSI; Abdin, 1995) prior to the completion of treatment, as well as at 6-month and 1-year follow-up. The PSI is a 5-point Likert scale (ranging from 1 = *Strongly Agree* to 5 = *Strongly Disagree*), 36-item self-report measure that yields three subscales: parental distress, parent-child dysfunctional interaction, and difficult child. The PSI is reliable and valid for parents with young children (Reitman et al., 2002). The current study used the total combined stress score as a measurement of parental stress (α = .92-.94). Possible scores range from 36-180.

Data Analytic Plan

All analyses were conducted using Statistical Package for the Social Sciences, version 25 (SPSS 25). Missing data for parental stress, parental executive functioning, and parenting skills ranged from 0-5%, 0-4%, and 11-39% at pre-treatment, 6-month follow-up, and 1-year follow-up, respectively. Of note, three separate cohorts were recruited and completed the summer program in 2017, 2018, and 2019, respectively. Therefore, a large portion of the data was collected prior to the COVID-19 pandemic; however, follow-up data for 32 families occurred virtually, or were unable to be collected due to the pandemic. According to Little's Missing Completely at Random test, the missing data were missing completely at random (X^2 (247) = 254.03, $p > .05$). There were no significant differences between children with complete versus partial data, or in-person versus virtual completion of measures in terms of any demographic variables or any outcomes examined in the current study. To account for missing data, Restricted Maximum Likelihood (REML) was utilized.

Multilevel models were conducted to examine how outcome variables change over time, modeled in both a linear and quadratic fashion. Time, the Level-1 (L1) predictor, was defined as pre-treatment = 0, 6-Month Follow-Up = 1, and 1-Year Follow-up = 2. The L1 and Level-2 (L2) equations for the quadratic models are presented below:

Level 1: $\text{Parenting/EF/Stress}_{ij} = \beta_{0j} + \beta_{1j}\,\text{time}_{ij} + \beta_{2j}\,\text{time}_{ij} * \text{time}_{ij} + e_{ij}$

Level 2: $\beta_{0j} = \gamma_{00} + \gamma_{01}$ (child age/EBP/education/language where appropriate)$_{1j}$ +

μ_{0j}

$\beta_{1j} = \gamma_{10}$

$\beta_{2j} = \gamma_{20}$

Combined: Parenting/EF/Stress$_{ij} = \gamma_{00} + \gamma_{01}$ (child age/EBP/education/language where appropriate)$_{1j} + \gamma_{10}$ time$_{ij}$ + γ20 timeij * time$_{ij} + \mu_{0j} + e_{ij}$

To probe model results, and consistent with prior work examining effect sizes across the STP-PreK (Graziano & Hart, 2016), Cohen's *d* effect sizes were calculated using estimated means and standard deviations, and confidence intervals for all effect sizes were included (Thompson, 2002).

Additional multilevel models were conducted to examine the impact of stress or executive functioning on parenting over time, modeled in both a linear and quadratic fashion. Time, the L1 predictor, was defined as pre-treatment = 0, 6-Month Follow-Up = 1, and 1-Year Follow-up = 2.

Lastly, hierarchical regression analyses were conducted to examine possible interaction between parental stress, parental executive functioning, and parenting skills. It was anticipated that the sample size of 112 would be sufficient to detect the proposed moderate to large moderation effects, with power between .95 and .99 based on G*Power.

Results

Preliminary Analyses

Preliminary analyses examined any potential associations between demographic variables and any of the study's outcomes (see Tables 3.1-3.3). Children's age was significantly associated with reported positive parenting at pre-treatment, $r = -.26$, $p < .01$, and 6-month follow-up, $r = -.29$, $p < .01$, indicating that parents of older children reported less positive parenting strategies. Age was also significantly associated with parent EF at follow-up, $r = -.26$, $p < .05$, such that parents of older children performed worse on EF. Child sex was significantly associated with parent executive functioning, $r = .27$, $p < .05$, such that parents of males scored higher on executive functioning than parents of females. Additionally, child ethnicity was significantly associated with parental stress at 6-month follow-up, $r = -.23$, $p < .05$, and 1-year follow-up, $r = -.26$, $p < .05$. Parents of Hispanic children reported having lower parental stress at 6-month (M = 62.56, SD =17.47) and 1-year follow-up (M = 67.96, SD = 18.69) compared to parents of non-Hispanic children (M = 74.50, SD = 22.86, M = 82.00; SD = 27.14, respectively). Lastly, initial severity of children's EBP was significantly associated with parental stress at all timepoints, $r = .40$, $p < .01$; $r = .32$, $p <.01$; $r = .40$, $p < .01$, respectively, such that higher levels of reported behavior problems were associated with greater levels of reported parental stress. Additionally, initial severity of children's externalizing behavior problems was significantly associated with observed negative parenting at follow-up, $r = -.22$, $p < .05$, and reported negative parenting at follow-up, $r = .21$, $p < .05$, such that parents of children with higher levels of behavior problems were observed to use less negative parenting skills at 6-month follow-up and reported using more negative parenting strategies at 1-year follow-up.

Parent ethnicity was significantly associated with parental stress at intake, $r = -.24$ $p < .01$, and 6-month follow-up, $r = -.24$ $p < .001$. Parents who identified as Hispanic reported having lower levels of parental stress at pre-treatment (M = 75.10, SD = 19.95) and 6-month follow-up (M = 62.15, SD = 17.29), compared to non-Hispanic parents (M = 87.52, SD = 16.39; M = 73.76, SD = 22.63, respectively). Given that both child and parent ethnicity were significantly associated with outcome variables, only parent ethnicity was used as a covariate in subsequent analyses due to high correlation between parent and child ethnicity, $r = .74$, $p < .001$. Parent level of education was significantly associated with EF at pre-treatment, $r = .36$, $p < .01$, 6-month follow-up, $r = .29$ $p < .01$, and 1-year follow-up, $r = .36$ $p < .01$. Parents with higher levels of education performed better on the EF composite. Education was also significantly associated with reported positive parenting at pre-treatment, $r = .19$ $p < .05$, and 1-year follow-up, $r = .22$ $p < .05$, such that parents with higher levels of education reported using more positive parenting strategies. Parent education was significantly associated with observed negative parenting strategies, $r = -.22$ $p < .05$, such that parents with higher levels of education used less negative parenting skills prior to treatment. Parent language accounted for differences in observed positive and negative parenting at 6-month follow-up, F = 3.73, $p < .05$; F = 6.33, $p < .01$. Bilingual English/Spanish-speaking parents were observed to use more positive parenting skills (M = 0.31, SE = 0.02) compared to monolingual Spanish-speaking parents (M = 0.10, SE = 0.08; $p < .05$). There was no significant difference in positive parenting skills between Bilingual English/Spanish-speaking parents and monolingual English-speaking parents (M = 0.28, SE = 0.03; $p > .05$), or between monolingual Spanish-speaking parents and monolingual English-speaking parents ($p > .05$). Monolingual Spanish-speaking parents were observed to use more negative parenting skills (M = .44, SE = 0.07) than bilingual English/Spanish-speaking parents (M = 0.20, SE = 0.01; $p < .01$) and monolingual English-speaking parents (M = 0.22, SE = 0.02; $p < .01$). There was no significant difference between bilingual English/Spanish-speaking parents and monolingual English-speaking parents ($p > .05$). Lastly, parent age was significantly associated with executive functioning at pre-treatment, $r = .39$, $p < .01$, 6-month follow-up, $r = .31$, $p < .01$, and 1-year follow-up, $r = .41$, $p < .01$. Older parents performed better on executive functioning. Of note, given that executive functioning scores were age corrected, parent age was not controlled for in subsequent analyses. No other demographic variables were associated with positive or negative parenting, parental EF, or parental stress. Therefore, subsequent analyses included pre-treatment child age, child externalizing behavior problems, parent language, and parent education as covariates where appropriate.

Intervention Outcomes

Correlation analyses were conducted to examine the association between observed and reported positive and negative parenting. There was no significant correlation between reported and observed positive or negative parenting measures at any time point, all *p*s > .05. Therefore, separate models were examined for each outcome rather than examining latent constructs over time.

Multilevel models were conducted to examine how outcome variables changed over time, modeled in both a linear and quadratic fashion. For analyses with a significant covariate fixed effect, covariate by time interaction effects were probed. There were no significant covariate by time interaction effects across analyses, such that intervention effects did not differ based on differences in the covariate (e.g., child age, child EBP, parent education level, parent language) at pre-treatment.

Positive Parenting

As seen in Table 3.4 and Figure 1, when controlling for child age the fixed quadratic effect for time for reported positive parenting was significant, $B = -1.45$, $p < .01$. While the overall quadratic effect was significant, effect sizes indicated no significant difference between reported positive parenting skills across treatment, see Table 3.4.

As seen in Table 3.5 and Figure 1, when controlling for parent language, the fixed quadratic effect for time for observed positive parenting was significant, $B = 0.15$, $p < .001$. Effect sizes indicated significant large increase in positive parenting skills from pre-treatment to 6-month follow-up and pre-treatment to 1-year follow-up, see Table 3.5. Additionally, there was a significant moderate decrease in positive parenting skills used from 6-month follow-up to 1-year follow-up. Parents use of positive parenting skills improved over the course of intervention, with regression from 6-month follow-up to 1-year follow-up.

Negative Parenting

As seen in Table 3.6 and Figure 2, the fixed quadratic effect for time for reported negative parenting was significant, $B = 2.81$, $p < .001$. Effect sizes indicated a significant large decrease in negative parenting skills from pre-treatment to 6-month follow-up and small decrease from pre-treatment to 1-year follow-up, see Table 3.6. Additionally, there was a significant moderate increase in negative parenting skills used from 6-month follow-up to 1-year follow-up. Parents use of negative parenting skills improved (lessened) over the course of intervention, with regression from 6-month follow-up to 1-year follow-up.

As seen in Table 3.7 and Figure 2, when controlling for parent language, the fixed quadratic effect for time for observed negative parenting was significant, $B = 0.15$, $p < .001$. Effect sizes indicated a significant large decrease in negative parenting skills from pre-treatment to 6-month follow-up and a small decrease from pre-treatment to 1-year follow-up, see Table 3.7. Additionally, there was a significant moderate increase in negative parenting skills used from 6-month follow-up to 1-year follow-up. Parents use of negative parenting skills improved over the course of intervention, with regression from 6-month follow-up to 1-year follow-up.

Executive Functioning

As seen in Table 3.8 and Figure 3, when controlling for parent education, the fixed quadratic effect for time for parental EF was significant, $B = -2.57$, $p < .01$. Effect sizes indicated a significant small increase in EF from pre-treatment to 6-month follow-up, see Table 3.8. However, there was poor maintenance of gains, as there was no significant difference from pre-treatment to 1-year follow-up or from 6-month follow-up to 1-year follow-up. Parents EF improved over the course of intervention but was not maintained after the intervention at 1-year follow-up.

Stress

As seen in Table 3.9 and Figure 4, the fixed quadratic effect for time for parental stress was significant, $B = 9.60$, $p < .001$. Effect sizes indicated a significant moderate decrease in parental stress from pre-treatment to 6-month follow-up and a small decrease from pre-treatment to 1-year follow-up, see Table 3.9. Additionally, there was a significant small increase in parental stress from 6-month follow-up to 1-year follow-up. Parent stress levels improved over the course of intervention, with regression from 6-month follow-up to 1-year follow-up.

EF and Parenting

As seen in Tables 3.10 and 3.11, the interaction effect between the quadratic effect for time and pre-treatment parental EF, for reported and observed positive parenting was not significant, $B = 0.03$, $p > .05$; $B = 0.00$, $p > .05$. While there was a significant quadratic time effect, there was no difference in the acquisition of positive parenting skills based on parents' pre-treatment EF.

Similarly, as seen in Tables 3.12 and 3.13, the interaction effect between the quadratic effect for time and pre-treatment parental EF, for reported and observed negative parenting was not significant, $B = -0.05$, $p > .05$; $B = 0.00$, $p > .05$. While there was a significant quadratic time effect, there was no difference in negative parenting skills across intervention based on parents' pre-treatment EF.

Stress and Parenting

As seen in Tables 3.14 and 3.15, the interaction effect between the quadratic effect for time and pre-treatment parental tress, for reported and observed positive parenting was not significant, $B = -0.01$, $p > .05$; $B = 0.00$, $p > .05$. While there was a significant quadratic time effect, there was no difference in the acquisition of positive parenting skills based on parents' pre-treatment stress.

Similarly, as seen in Tables 3.16 and 3.17, the interaction effect between the quadratic effect for time and pre-treatment parental stress, for reported and observed negative parenting was not significant, $B = 0.02$, $p > .05$; $B = 0.00$, $p > .05$. While there was a significant quadratic time effect, there was no difference in negative parenting skills across intervention based on parents' pre-treatment stress.

EF, Stress, and Parenting

Hierarchical regression analyses were conducted to examine the unique associations between stress and EF and parenting. As seen in Table 3.18, education was significantly associated with reported positive parenting, $\beta = .28$, $p < .01$, but not observed positive parenting $p > .05$. Parents with higher levels of education reported using more positive parenting strategies, but not observed parenting strategies, at pre-treatment. Additionally, EBP, EF, and PSI were not significantly associated with either reported or observed positive parenting, *ps* > .05. There was no significant interaction between EF and stress for either reported or observed positive parenting. When controlling for EBP and education levels, neither pre-treatment differences in parental stress or EF, nor the interaction between parental stress and EF, had an impact on reported or observed positive parenting skills pre-treatment.

As seen in Table 3.19, education was significantly associated with observed negative parenting, $\beta = -.21$, $p < .05$, but not reported negative parenting $p > .05$. Parents with higher levels of education were observed to use less negative parenting strategies, but not reported negative parenting strategies, at pre-treatment. Additionally, stress was significantly associated with reported negative parenting, $\beta = .34$, $p < .01$, but not observed negative parenting $p > .05$. When controlling for EBP and education level, parents who reported higher levels of parental stress reported also using more negative parenting strategies at pre-treatment. EBP and EF were not significantly associated with either reported or observed negative parenting, *ps* > .05. EF had no impact on reported or observed negative parenting pre-treatment. Lastly, there was no significant interaction between EF and stress for either reported or observed negative parenting. When controlling for EBP and education levels, there was no moderation between pre-treatment parental stress, EF and reported or observed negative parenting.

Discussion

This is one of the first studies to examine the effects of stress on parental EF and parenting skills longitudinally, and examine unclear associations between parental EF, stress, and parenting skills. Additionally, very little is known about the impact of parental EF on outcomes of parenting interventions, especially in the context of stress. This study is the first to examine the role of parental EF in the acquisition of parenting skills, and how stress may moderate the association between parental EF and parenting skills over the course of a BPT intervention with a predominately Hispanic sample. Findings from this study suggest that self-reported parental stress, observed and reported parenting skills, and observed parental EF are malleable over the course of a parenting intervention for parents of children with EBP. While there were no significant findings regarding the impact of initial levels of parental stress or EF on parenting skills across intervention, there was a significant association between parental stress and reported negative parenting at baseline. These findings are discussed in further detail below.

The increase in positive parenting skills and reduction in negative parenting skills found in this study are consistent with prior literature demonstrating the effectiveness of

BPT on parenting skills (Kaminski et al., 2008; Lee et al., 2012). Additionally, our findings regarding improvements in self-reported parental stress aligns with prior work demonstrating effectiveness of BPT on parent functioning (Chronis et al, 2004). Specifically, compared to prior studies examining parent outcomes of SRPP, findings from this study are consistent in demonstrating improvements across SRPP for observed positive and negative parenting, as well as reported negative parenting skills, and parental stress (Graziano et al., 2018). Additionally, the current study found significant increases in reported negative parenting and parental stress, and decreases in observed positive parenting, from 6-month follow-up to 1-year follow-up. These findings may indicate poor maintenance of parent related BPT outcomes, which mirrors prior literature demonstrating poor maintenance of gains over time (Lundahl et al., 2006). However, when compared to the literature examining child and parent effect sizes of BPT, the effect sizes found in the current study are larger than the generally small effect sizes (*d*s = |0.07-0.66|) at follow-up (Lee et al., 2012; Reyno & McGrath, 2008). This may be a function of treatment intensity, severity level of children's ADHD (e.g., all meeting diagnosis), and/or high levels of treatment implementation fidelity. Furthermore, when only examining parent outcomes, the effect sizes found in the current study are similar or larger than most prior work specific to parent outcomes (*d*s = |0.01-1.23|; Kaminski et al., 2008; Lundahl et al., 2006). Thus, while the current study demonstrated some regression of gains, it is important to note that improvements in observed positive parenting, observed and reported negative parenting, and parental stress were significant from pre-treatment to 1-year follow-up, with small (parental stress) to large (observed parenting) effect sizes. Overall, parents improved in parenting skills and reduced parental stress over the course of intervention.

Additional benefits of BPT novel to the current study include observed improvements in parental EF from pre-treatment to 6-month follow-up. These findings not only highlight neural plasticity through adulthood, but also reflect the ability for parents to acquire new knowledge across a parent training intervention, as mirrored by the overall findings of improved parenting skills. Additionally, improvements in parental EF across BPT may indicate the possibility for parents to more efficiently use preexisting knowledge or increased cognitive flexibility beyond the context of parenting. The findings from the current study align with prior work demonstrating the malleability of EF through adulthood and ability for parents to demonstrate new learning (Biederman et al., 2007; Dahlin et al., 2008; Huttenlocher, 2009). However, it is important to note that SRPP does not directly target parental EF or teach parent strategies specific to EF. This may also partially explain the small effect size found in this study compared to the literature examining effect sizes of cognitive training on older adults' EF (Hedge's gs = |0.05-1.52; Mowszowski et al., 2016). Therefore, it is possible that slight improvements in parental EF could be a secondary gain to improvements in parental stress, which has been noted to negatively impact EF (Arnsten, 2000; Lupien et al., 2007; McEwen & Sapolsky, 1995). Broadly, improvements in EF found in this study align with literature demonstrating the importance of parental EF in parenting (Mazursky-Horowitz et al., 2018). Additionally, these findings contribute to the existing literature by demonstrating the ability to possibly improve parental EF across a parenting intervention. However, these findings should be interpreted with caution given poor transfer of gains in EF among adults in the literature (Dahlin et al., 2008), and no evidence to support directional associations between stress, EF, and parenting skills. Despite the poor maintenance of gains in parental EF at 1-year follow-up, these findings illuminate the promise of targeting and further improving parental EF across BPT.

One possible explanation for improvements in parental EF include “practice effects.” However, the construction of the assessment overall was designed to minimize practice effects (Gershon et al., 2013). Nonetheless, significant practice effects were found for the NIH Toolbox composite domains over a two-week span, as well as some of the subtests in adults (Heaton et al., 2014; Zelazo et al., 2014). Ultimately, prior studies have not examined practice effects over a longer duration, such as 6 months, which was the lapse between each timepoint in the current study. Additionally, it is important to consider that there was no significant difference from 6-month follow-up to 1-year follow-up, which may indicate the findings of the current study as treatment effects, a ceiling in practice effects, or simply regression to the mean.

The current study was among the first to examine the potential impacts of parental stress and parental EF on the acquisition of parenting skills, and the extent to which stress may moderate the impacts of EF on parenting skills. While the current study did not find significant effects for either parental EF or stress at pre-treatment predicting changes in observed or reported positive or negative parenting, it is entirely plausible that stress and cognitive functioning are indeed associated with parenting. For EF in particular, it may also be more nuanced, such that some EFs (e.g., “hot” EF, which includes motivational or affective conditions), but not others (e.g., “cool” EF, associated with more affectively neutral situations), are more relevant to parenting (Zelazo & Cunningham, 2007; Zelazo

& Müller, 2011). The EF tasks administered in the present study did not include an affective or motivational component by design, and likely represent "cool" EF. Prior work in a high-risk sample (e.g., families experiencing homelessness) found that "hot" EF, was associated with positive parenting, whereas "cool" EF was only associated with harsh parenting for mothers who reported high levels of stress (Monn et al., 2017). The null findings in this study may be due to other factors unique to the sample, that contributed to these surprising findings. For example, mean age-corrected scores on the EF composite in the current sample ranged from 53-134 across time points. In contrast, age-corrected NIH toolbox scores have a mean of 50 and standard deviation of 10 (National Institutes of Health & Northwestern University, 2021), indicating the sample as a whole performed above average, and is not representative of the broader range of EF in the population. Furthermore, prior literature has demonstrated positive associations between cognitive function and education level (Cerhan et al., 1998; Van Hooren et al., 2007), which aligns with the current sample mostly comprised of parents with a college degree or higher level of education. Similarly, mean scores for parental stress for the current sample ranged from 64.33 to 77.43, which is lower and more restricted in range compared to some other samples (Graziano et al., 2018) which ranged from 66.89 to 83.96. The current sample likely represents a sample of parents with higher EF and lower stress than the general population or other parents of children with behavior problems broadly.

Alternatively, one possible explanation is that parents benefit from parenting intervention regardless of initial stress levels and EF. This would be an important contribution to the literature, and in contrast with prior literature suggesting that parents with poorer working memory are more reactive to difficult behavior (Deater-Deckard et al., 2010). These findings suggest that for parents of children with ADHD, parental EF was not associated with parenting skills at pre-treatment or across treatment, such that parents did not engage in more or less positive or negative parenting depending on their initial EF levels. The current study did find a significant association between stress and parenting, such that parents reporting higher levels of stress also reported using more negative parenting skills at pre-treatment. However, observation did not support these findings, and stress did not predict changes in parenting across intervention. Similarly, parents did not engage in different levels of positive (observed or reported) or negative (observed) parenting depending on their reported stress, despite prior literature demonstrating parents of children with behavior problems generally demonstrate higher stress levels (Theule et al., 2010) and is associated with more harsh parenting, specifically in low stress environments (Deater-Deckard et al., 2012). While this finding is unexpected, it is also important to acknowledge the strong publication bias in psychological research broadly examining effect sizes (Kuhberger et al., 2014), which highlights the importance for null findings in the literature as well. This is particularly relevant given the dearth in the literature examining the impact of parent outcomes across BPT compared to the literature examining child outcomes.

Limitations & Future Directions

Major strengths of this study include the examination of parent outcomes across BPT, a longitudinal design to examine complex dynamics between stress and cognition with parenting, the novelty of examining the malleability of parental EF across BPT intervention, and a multi-method approach to assessing parenting skills. Yet, some limitations should be addressed. First, it is important to note that the all parents participated in the SRPP intervention, and children of parents in the current study engaged in an intensive behavior modification intervention over the course of the 8-week parenting intervention. Thus, it is possible that the improvements noted in parenting skills, as well as parental stress and EF may be a secondary gain or reflection of the improvements in child behavior as a function of participation in intervention. However, it is important to note that prior work examining child outcomes of the STP-PreK demonstrated no differences in child behavior between families who participated in the full STP-PreK with SRPP, and those who only participated in the SRPP program alone (Graziano & Hart, 2014). It would be important for future work to examine the effects of SRPP as a stand-alone intervention.

Additionally, the current study focused solely on parents of children with behavior problems and did not examine differences between parents of children in the ADHD group and children in the control/reference group from the larger study, or parents of children with ADHD not receiving intervention. Thus, it may be possible that parenting skills, stress, and EF improve over time regardless of intervention. However, this is unlikely given the well documented prior literature demonstrating the stability and even decline of parenting skills (Dallaire & Weintraub, 2005; Ettinger et al., 2018), parental stress (Crnic et al., 2005; Winstone et al., 2021), and parental EF through adulthood (Best et al., 2009; Fox et al., 1994). Nonetheless, future work should examine the effects of SRPP in comparison to typically developing sample and/or control group of children with ADHD not receiving intervention to determine intervention effects unique to the parenting program.

Other limitations include possible measurement and methodological errors. It is likely that the current study did not find significant changes in reported positive parenting over time due to ceiling effects, such that across timepoints, parents rated themselves highly on the scale of positive parenting, which may be inherent to the APQ positive parenting scale (Elgar er al., 2007). Additionally, it is important to note that self-report bias may have impacted results across measures of parenting and stress (Meyer et al., 2001; Morsbach & Prinz, 2006), especially given the discrepancy between self-report and observation of parenting skills. To account for this potential limitation the current study utilized multimodal assessment of parenting, which is an inherent strength. However, reporter bias limitations, in combination with the aforementioned limitations regarding the NIH Toolbox, highlight that future work should utilize multimodal assessment, such as physiological measurement of parental stress. For example, research has identified that stress is related to increased sympathetic and/or decreased parasympathetic nervous system activity (Thayer et al., 2012; Willcutt et al., 2005). Prior research has primarily examined stress in the context of parenting through self-report measures; namely the Parenting Stress Index (Reyno & McGrath, 2006; Theule et al., 2013). Future work should examine parental stress comprehensively using both self-report, and physiological measurement of the sympathetic and parasympathetic nervous systems (Porges, 1992; Porges, 1995). More specifically, respiratory sinus arrhythmia is a non-invasive measurement of cardiac vagal tone, used as an indicator of parasympathetic nervous system activity (Katona & Jih, 1975; Porges, 2007). Additionally, cardiac pre-ejection period can be measured non-invasively as an indicator of sympathetic nervous system activity (Berntson et al., 1996). By examining both respiratory sinus arrhythmia and pre-ejection period, future work would be able to examine measure both stress reactivity (pre-ejection period) as well as its regulatory component (respiratory sinus arrhythmia).

In addition to measurement error, the sample size of the current study should also be noted. The current sample may be underpowered regarding statistical approaches to determine a small moderation effect or predictive effects of parental EF and stress and for the longitudinal analyses conducted in this study (Hertzog et al., 2006; Hertzog et al., 2008; Shieh & Jan, 2015). Thus, it will be important for future research to examine the directional associations between parental cognition, stress, and parenting with a larger sample (e.g., N > 200).

Lastly, the demographics of the current study limit generalizability of these findings to other samples. For example, primarily Hispanic sample in this study limits the interpretations of the results to parents of preschoolers of other racial/ethnic backgrounds. However, previous work has been limited in generalizability beyond Caucasian populations, highlighting a strength of the current study. The present study expanded upon the population for which results from previous research may apply. Given that Hispanic children are the fastest growing minority in the United States (La Greca et al., 2009), it is important to examine self-regulation processes in this population. Additionally, it is important to note that parents in the current sample likely represent a portion of the population with higher than average EF and education, and potentially lower stress levels than expected. Thus, future work should explore similar research questions with more diverse and high-risk samples, including those of varying household structures, education levels, and SES.

Conclusions

Despite the limitations, the current study provides initial evidence that not only parenting skills and parental stress, but also parental EF, are malleable across a BPT intervention. This study is among the first to potentially demonstrate improvements in parental EF across a parenting intervention, which have significant impacts for future interventions. As SRPP does not target parental EF, it may be that additional components and/or adjunct session content, such as stress management or parent coping skills, to BPT may provide additive benefits to parents' EF, which has been demonstrated with children (Graziano & Hart, 2016; Landis et al., 2019). This would be especially important in alignment with prior research having demonstrated the negative impacts of stress on EF (Lupien et al., 2007). Additional components or sessions would not only provide benefits to parent's cognitive functioning, but may also have additional benefits regarding parenting skills and maximizing child outcomes as well.

Furthermore, this study is among the first to examine directional associations between parental stress, parental EF, and parenting skills. While prior literature has demonstrated the importance of EF in parenting (Deater-Deckard et al., 2010), and the impacts of stress on cognition (Lupien et al, 2007), this study was among the first to examine these constructs across an intervention. This study addresses a gap in the literature by examining the complex associations between parental stress, parental EF, and parenting skills in the context of BPT, and has clinical implications to identify which parental factor(s) BPT interventions should target first. Maximizing treatment outcomes by targeting the causal factor(s) may yield greater intervention response or more rapid response to treatment. Future research should examine the directional associations between parental EF, parent stress, and parenting skills with a) multi-method (report and observation/direct assessment) measures of outcome variables, b) neurobiological measures (e.g., respiratory sinus arrhythmia, pre-ejection period) to examine biological underpinnings of parental stress, and c) most importantly, longitudinal studies with larger, more diverse (e.g., race, ethnicity, SES, education, high-risk) samples to better understand if changes in stress/EF predict changes in parenting, cross-lagged models to explore directionality over time, and explore any potential moderators or mediators.

Table 3.1. *Baseline Variables with Pre-Treatment Outcomes*

	Mean (SD)	Pre-Treatment					
		APQ: PosPar	DPICS: Do	APQ: NegPar	DPICS: Don't	NIH: EF	PSI
Child							
Age	5.51 (0.75)	-0.26**	-0.04	0.03	0.02	-0.04	-0.10
Sex	76% males	0.18	0.04	-0.08	-0.01	0.16	-0.04
Ethnicity	83% Hispanic	0.06	0.13	0.04	0.04	0.08	-0.18
EBP	61.80 (9.85)	-0.13	-0.06	0.00	-0.03	-0.10	**0.30****
Parent							
Age	36.25 (6.22)	0.02	-0.05	-0.02	0.06	**0.39****	-0.02
Ethnicity	81% Hispanic	0.18	0.05	0.01	0.05	-0.05	-0.24**
Relation	95% mothers	0.06	-0.16	0.02	-0.08	0.23*	-0.18
Education	-	0.19*	0.10	-0.08	-0.22*	**0.26****	0.12

Note. APQ = Alabama Parenting Questionnaire; PosPar = Positive Parenting Factor; NegPar = Inconsistent Discipline Scale; DPICS = Dyadic Parent-Child Interaction Coding System, 4th Edition; Do = Proportion "do skills;" Don't = Proportion "don't skills;" NIH: EF = NIH Toolbox for the Assessment of Neurological and Behavioral Function, Executive Functioning age corrected composite score; PSI = *Parenting Stress Index*, 4th Edition Short Form, total score; SD = standard deviation; EBP = Behavior Assessment System for Children, 3rd edition Externalizing Problems T-score, parent report. **p*<.05, ***p*<.01, ****p*<.001. Bolded p values indicate significant values as survived Benjamini-Hochberg correction.

Table 3.2. *Baseline Variables with 6-Month Follow-Up Outcomes*

	6-Month Follow-Up					
	APQ: PosPar	DPICS: Do	APQ: NegPar	DPICS: Don't	NIH: EF	PSI
Child						
Age	**-0.29****	-0.06	-0.07	-0.09	-0.13	0.01
Sex	0.09	-0.04	0.00	0.05	0.12	-0.04
Ethnicity	0.02	0.05	0.02	0.02	0.15	-0.23*
EBP	-0.13	0.12	0.07	-0.22*	0.03	**0.32****
Parent						
Age	-0.07	-0.16	0.15	0.13	**0.31****	0.07
Ethnicity	0.09	0.10	0.06	-0.01	0.03	-0.24*
Relation	-0.14	-0.12	0.05	0.03	0.22*	-0.05
Education	-0.02	0.09	0.00	-0.11	**0.29****	0.14

Note. APQ = Alabama Parenting Questionnaire; PosPar = Positive Parenting Factor; NegPar = Inconsistent Discipline Scale; DPICS = Dyadic Parent-Child Interaction Coding System, 4th Edition; Do = Proportion "do skills;" Don't = Proportion "don't skills;" NIH: EF = NIH Toolbox for the Assessment of Neurological and Behavioral Function, Executive Functioning age corrected composite score; PSI = *Parenting Stress Index*, 4th Edition Short Form, total score; EBP = Behavior Assessment System for Children, 3rd edition Externalizing Problems T-score, parent report. *p<.05, **p<.01, ***p<.001. Bolded p values indicate significant values as survived Benjamini-Hochberg correction.

Table 3.3. *Baseline Variables with 1-Year Follow-Up Outcomes*

	1-Year Follow-Up					
	APQ: PosPar	DPICS: Do	APQ: NegPar	DPICS: Don't	NIH: EF	PSI
Child						
Age	-0.17	-0.16	-0.07	0.08	-0.27*	0.02
Sex	0.05	0.01	-0.10	-0.08	0.27*	-0.01
Ethnicity	0.07	0.04	-0.01	-0.01	-0.03	-0.26*
EBP	-0.13	0.02	0.21*	-0.05	0.13	**0.40****
Parent						
Age	-0.01	-0.01	0.08	-0.08	**0.41****	0.11
Ethnicity	0.11	-0.33*	0.06	0.19	-0.21	-0.16
Relation	0.01	0.18	-0.02	-0.23	-0.13	-0.07
Education	0.22*	0.30	0.02	-0.26	**0.36****	0.15

Note. APQ = Alabama Parenting Questionnaire; PosPar = Positive Parenting Factor; NegPar = Inconsistent Discipline Scale; DPICS = Dyadic Parent-Child Interaction Coding System, 4th Edition; Do = Proportion "do skills;" Don't = Proportion "don't skills;" NIH: EF = NIH Toolbox for the Assessment of Neurological and Behavioral Function, Executive Functioning age corrected composite score; PSI = *Parenting Stress Index*, 4th Edition Short Form, total score; EBP = Behavior Assessment System for Children, 3rd edition Externalizing Problems T-score, parent report. *p<.05, **p<.01, ***p<.001. Bolded p values indicate significant values as survived Benjamini-Hochberg correction.

Table 3.4. *Reported Positive Parenting Outcomes*

Quadratic Model			
Predictor	B	SE	p-value
		Fixed Effects	
Intercept	68.62	0.58	<.001
Time*Time	-1.45	0.52	.006
Time	3.08	1.07	.004
Child Age	-2.04	0.64	.002
		Random Effects	
Intercept	18.71	3.52	<.001
Residual	19.52	1.91	<.001
	F	p-value	
Quadratic Time Effect	7.82	.006	
	Estimate	SD	
Pre-Treatment	68.62	6.82	
6-Month Follow-Up	70.25	5.89	
1-Year Follow-Up	68.98	6.27	
	Cohen's *d*	95% CI	
Pre to 6-Month	0.26	[-0.02, 0.51]	
Pre to 1-Year	0.05	[-0.22, 0.32]	
6-Month to 1-Year	-0.21	[-0.47, 0.07]	

Note. Mean centered results are presented. Bolded effect sizes indicate a significant difference ($p < .05$) in the effect size between time points.

Table 3.5. *Observed Positive Parenting Outcomes*

	Quadratic Model		
Predictor	B	SE	p-value
		Fixed Effects	
Intercept	0.08	0.01	<.001
Time*Time	-0.16	0.01	<.001
Time	0.38	0.02	<.001
L1	-0.13	0.05	.012
L2	-0.01	0.02	.559
		Random Effects	
Intercept	0.00	0.00	.001
Residual	0.01	0.00	<.001
	F	p-value	
Quadratic Time Effect	158.76	<.001	
	Estimate	SD	
Pre-Treatment	0.08	0.05	
6-Month Follow-Up	0.30	0.14	
1-Year Follow-Up	0.20	0.14	
	Cohen's *d*	95% CI	
Pre to 6-Month	**2.07**	[1.65, 2.30]	
Pre to 1-Year	**1.24**	[0.86, 1.52]	
6-Month to 1-Year	**-0.71**	[-0.99, 0.37]	

Note. Mean centered results are presented. L1 and L2 = dummy coded parent language with bilingual English/Spanish as reference group. Bolded effect sizes indicate a significant difference (p <.05) in the effect size between time points.

Table 3.6. *Reported Negative Parenting Outcomes*

	Quadratic Model		
Predictor	B	SE	p-value
	Fixed Effects		
Intercept	13.41	0.36	<.001
Time*Time	2.81	0.33	<.001
Time	-6.47	0.69	<.001
	Random Effects		
Intercept	6.69	1.32	<.001
Residual	7.98	0.79	<.001
	F	p-value	
Quadratic Time Effect	71.41	<.001	
	Estimate	SD	
Pre-Treatment	13.41	4.44	
6-Month Follow-Up	9.75	3.04	
1-Year Follow-Up	11.71	3.84	
	Cohen's *d*	95% CI	
Pre to 6-Month	**-0.96**	[-1.19, -0.64]	
Pre to 1-Year	**-0.41**	[-0.66, -0.12]	
6-Month to 1-Year	**0.57**	[0.27, 0.82]	

Note. Mean centered results are presented. Bolded effect sizes indicate a significant difference ($p < .05$) in the effect size between time points.

Table 3.7. *Observed Negative Parenting Outcomes*

Quadratic Model			
Predictor	B	SE	p-value
	Fixed Effects		
Intercept	0.46	0.01	<.001
Time*Time	0.15	0.01	<.001
Time	-0.4	0.03	<.001
L1	0.16	0.06	.013
L2	-0.01	0.02	.622
	Random Effects		
Intercept	0.01	0	<.001
Residual	0.01	0	<.001
	F	p-value	
Quadratic Time Effect	129.38	<.001	
	Estimate	SD	
Pre-Treatment	0.46	0.14	
6-Month Follow-Up	0.21	0.12	
1-Year Follow-Up	0.26	0.13	
	Cohen's *d*	95% CI	
Pre to 6-Month	**-1.92**	[-2.15, -1.52]	
Pre to 1-Year	**-1.47**	[-1.74, -1.07]	
6-Month to 1-Year	**0.40**	[0.08, 0.69]	

Note. Mean centered results are presented. L1 and L2 = dummy coded parent language with bilingual English/Spanish as reference group. Bolded effect sizes indicate a significant difference (p <.05) in the effect size between time points.

Table 3.8. *Parental Executive Functioning Outcomes*

Quadratic Model			
Predictor	B	SE	p-value
	Fixed Effects		
Intercept	90.44	1.22	<.001
Time*Time	-2.57	0.95	.008
Time	6.92	1.9	<.001
Education	3.29	0.82	<.001
	Random Effects		
Intercept	106.93	17.87	<.001
Residual	59.1	6.21	<.001
	F	p-value	
Quadratic Time Effect	7.28	.008	
	Estimate	SD	
Pre-Treatment	90.44	12.61	
6-Month Follow-Up	94.79	13.73	
1-Year Follow-Up	94.00	14.21	
	Cohen's *d*	95% CI	
Pre to 6-Month	**0.33**	[0.05, 0.58]	
Pre to 1-Year	0.27	[-0.04, 0.55]	
6-Month to 1-Year	-0.06	[-0.35, 0.24]	

Note. Mean centered results are presented. Bolded effect sizes indicate a significant difference ($p < .05$) in the effect size between time points.

Table 3.9. *Parental Stress Outcomes*

	Quadratic Model		
Predictor	B	SE	p-value
		Fixed Effects	
Intercept	77.4	1.76	<.001
Time*Time	9.6	1.42	<.001
Time	-22.89	2.93	<.001
EBP	0.75	0.15	<.001
		Random Effects	
Intercept	199.21	34.38	<.001
Residual	145.18	14.29	<.001
	F	p-value	
Quadratic Time Effect	45.62	<.001	
	Estimate	SD	
Pre-Treatment	77.40	19.95	
6-Month Follow-Up	64.11	18.85	
1-Year Follow-Up	70.02	20.82	
	Cohen's *d*	95% CI	
Pre to 6-Month	**-0.68**	[-0.92, -0.39]	
Pre to 1-Year	**-0.36**	[-0.62, -0.07]	
6-Month to 1-Year	**0.3**	[0.01, 0.56]	

Note. Mean centered results are presented. Bolded effect sizes indicate a significant difference (p <.05) in the effect size between time points. EBP = Behavior Assessment System for Children, 3rd edition Externalizing Problems T-score, parent report.

Table 3.10. *Pre-Treatment EF and Reported Positive Parenting Outcomes*

Quadratic Model			
Predictor	B	SE	p-value
	Fixed Effects		
Intercept	68.69	0.58	<.001
Time*Time*EF	0.03	0.04	.521
Time*EF	-0.03	0.09	.712
Time	3.27	1.07	.003
Time*Time	-1.56	0.52	.003
EF	-0.07	0.05	.133
Child Age	-2.09	0.63	.001
Education	0.60	0.39	.123
	Random Effects		
Intercept	17.57	3.42	<.001
Residual	19.45	1.92	<.001
	F	p-value	
Quadratic Time*EF Effect	0.41	.520	

Note. Mean centered results are presented. EF = Executive Functioning at Pre-treatment.

Table 3.11. *Pre-Treatment EF and Observed Positive Parenting Outcomes*

Quadratic Model			
Predictor	B	SE	p-value
	Fixed Effects		
Intercept	0.08	0.01	<.001
Time*Time*EF	0.00	0.00	.596
Time*EF	0.00	0.00	.460
Time	0.38	0.02	<.001
Time*Time	-0.16	0.01	<.001
EF	0.00	0.00	.667
Education	0.01	0.01	.120
L1	-0.12	0.05	.024
L2	-0.01	0.02	.736
	Random Effects		
Intercept	0.00	0.00	<.001
Residual	0.01	0.00	.001
	F	p-value	
Quadratic Time*EF Effect	0.28	.596	

Note. Mean centered results are presented. EF = Executive Functioning at Pre-treatment; L1 and L2 = dummy coded parent language with bilingual English/Spanish as reference group.

Table 3.12. *Pre-Treatment EF and Reported Negative Parenting Outcomes*

Quadratic Model			
Predictor	B	SE	p-value
	Fixed Effects		
Intercept	13.34	0.36	<.001
Time*Time*EF	-0.05	0.03	.080
Time*EF	0.08	0.05	.129
Time	-6.57	0.68	<.001
Time*Time	2.88	0.33	<.001
EF	-0.03	0.03	.306
Education	0.02	0.24	.932
	Random Effects		
Intercept	6.37	1.29	<.001
Residual	7.84	0.78	<.001
	F	p-value	
Quadratic Time*EF Effect	3.09	.080	

Note. Mean centered results are presented. EF = Executive Functioning at Pre-treatment.

Table 3.13. *Pre-Treatment EF and Observed Negative Parenting Outcomes*

Quadratic Model			
Predictor	B	SE	p-value
	Fixed Effects		
Intercept	0.47	0.01	<.001
Time*Time*EF	0.00	0.00	.613
Time*EF	0.00	0.00	.804
Time	-0.40	0.03	<.001
Time*Time	0.15	0.01	<.001
EF	0.00	0.00	.996
Education	-0.02	0.01	.064
L1	0.14	0.06	.030
L2	-0.02	0.02	.461
	Random Effects		
Intercept	0.01	0.00	<.001
Residual	0.01	0.00	<.001
	F	p-value	
Quadratic Time*EF Effect	0.26	.613	

Note. Mean centered results are presented. EF = Executive Functioning at Pre-treatment. L1 and L2 = dummy coded parent language with bilingual English/Spanish as reference group.

Table 3.14. *Pre-Treatment Parental Stress and Reported Positive Parenting Outcomes*

Quadratic Model			
Predictor	B	SE	p-value
	Fixed Effects		
Intercept	68.60	0.58	<.001
Time*Time*PSI	-0.01	0.03	.649
Time*PSI	0.04	0.05	.436
Time	3.13	1.08	.004
Time*Time	-1.47	0.52	.005
PSI	-0.04	0.03	.160
Child Age	-2.37	0.65	<.001
EBP	-0.10	0.05	.057
	Random Effects		
Intercept	17.82	3.46	<.001
Residual	19.70	1.95	<.001
	F	p-value	
Quadratic Time*PSI Effect	0.21	.649	

Note. Mean centered results are presented. PSI = Parenting Stress Index, 4th Edition Short Form, total score at Pre-Treatment; EBP = Behavior Assessment System for Children, 3rd edition Externalizing Problems T-score, parent report.

Table 3.15. *Pre-Treatment Parental Stress and Observed Positive Parenting Outcomes*

Quadratic Model

Predictor	B	SE	p-value
	Fixed Effects		
Intercept	0.08	0.01	<.001
Time*Time*PSI	0.00	0.00	.149
Time*PSI	0.00	0.00	.083
Time	0.39	0.02	<.001
Time*Time	-0.16	0.01	<.001
PSI	0.00	0.00	.777
EBP	0.00	0.00	.825
L1	-0.14	0.05	.007
L2	-0.02	0.02	.456
	Random Effects		
Intercept	0.00	0.00	<.001
Residual	0.01	0.00	.001
	F	p-value	
Quadratic Time*PSI Effect	2.10	.149	

Note. Mean centered results are presented. PSI = Parenting Stress Index, 4th Edition Short Form, total score at Pre-Treatment; EBP = Behavior Assessment System for Children, 3rd edition Externalizing Problems T-score, parent report; L1 and L2 = dummy coded parent language with bilingual English/Spanish as reference group.

Table 3.16. *Pre-Treatment Parental Stress and Reported Negative Parenting Outcomes*

Quadratic Model

Predictor	B	SE	p-value
	Fixed Effects		
Intercept	13.43	0.36	<.001
Time*Time*PSI	0.02	0.02	.237
Time*PSI	-0.05	0.03	.140
Time	-6.55	0.69	<.001
Time*Time	2.85	0.33	<.001
PSI	0.07	0.02	.001
EBP	-0.01	0.03	.659
	Random Effects		
Intercept	6.11	1.25	<.001
Residual	7.96	0.79	<.001
	F	p-value	
Quadratic Time*PSI Effect	1.41	.237	

Note. Mean centered results are presented. PSI = Parenting Stress Index, 4th Edition Short Form, total score at Pre-Treatment; EBP = Behavior Assessment System for Children, 3rd edition Externalizing Problems T-score, parent report. *p<.05, **p<.01, ***p<.001.

Table 3.17. *Pre-Treatment Parental Stress and Observed Negative Parenting Outcomes*

Quadratic Model

Predictor	B	SE	p-value
	Fixed Effects		
Intercept	0.46	0.01	<.001
Time*Time*PSI	0.00	0.00	.702
Time*PSI	0.00	0.00	.766
Time	-0.40	0.03	<.001
Time*Time	0.15	0.01	<.001
PSI	0.00	0.00	.211
EBP	0.00	0.00	.504
L1	0.17	0.06	.008
L2	0.00	0.02	.849
	Random Effects		
Intercept	0.01	0.00	<.001
Residual	0.01	0.00	<.001
	F	p-value	
Quadratic Time*PSI Effect	0.15	.702	

Note. Mean centered results are presented. PSI = Parenting Stress Index, 4th Edition Short Form, total score at Pre-Treatment; EBP = Behavior Assessment System for Children, 3rd edition Externalizing Problems T-score, parent report; L1 and L2 = dummy coded parent language with bilingual English/Spanish as reference group.

Table 3.18. *Stress and Executive Functioning on Positive Parenting at Pre-Treatment*

	β	T-value	Model R^2	R^2 Change	F Change
Reported Positive Parenting					
Step 1. EBP	-0.08	-0.76	0.1	0.1	2.94*
Education	0.28**	2.76			
EF	-0.18	-1.85			
PSI	-0.15	-1.47			
Step 2. EF x PSI	0.08	0.84	0.11	0.01	0.7
Observed Positive Parenting					
Step 1. EBP	-0.02	-0.22	0.01	0.01	0.2
Education	0.07	0.71			
EF	-0.07	-0.70			
PSI	0.00	0.01			
Step 2. EF x PSI	0.14	1.37	0.03	0.02	1.88

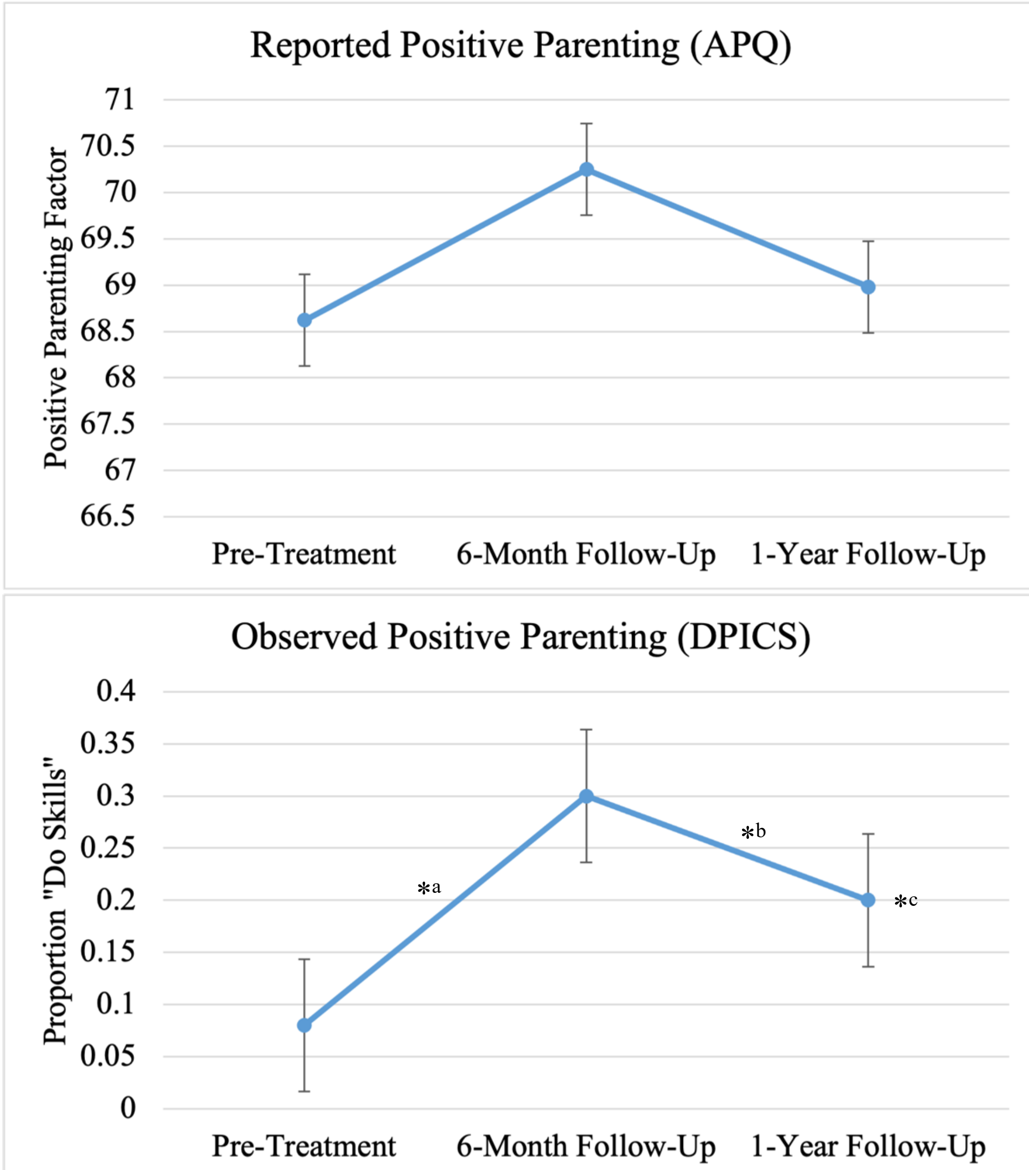
Note. ***p <.001, **p <.01, * p < .05. EF = Executive Functioning at Pre-treatment; PSI = Parenting Stress Index, 4th Edition Short Form, total score at pre-treatment; EBP = Behavior Assessment System for Children, 3rd edition Externalizing Problems T-score, parent report.

Table 3.19. *Stress and Executive Functioning on Negative Parenting at Pre-Treatment*

	β	T-value	Model R^2	R^2 Change	F Change
Reported Negative Parenting					
Step 1. EBP	-0.14	-1.41	0.1	0.1	2.99*
Education	-0.10	-0.96			
EF	-0.07	-0.68			
PSI	0.34**	3.29			
Step 2. EF x PSI	0	0.04	0.1	0	0
Observed Negative Parenting					
Step 1. EBP	0.02	0.16	0.06	0.06	1.56
Education	-0.21*	-2.1			
EF	0.02	0.22			
PSI	-0.1	-0.98			
Step 2. EF x PSI	-0.04	-0.46	0.06	0	0.21

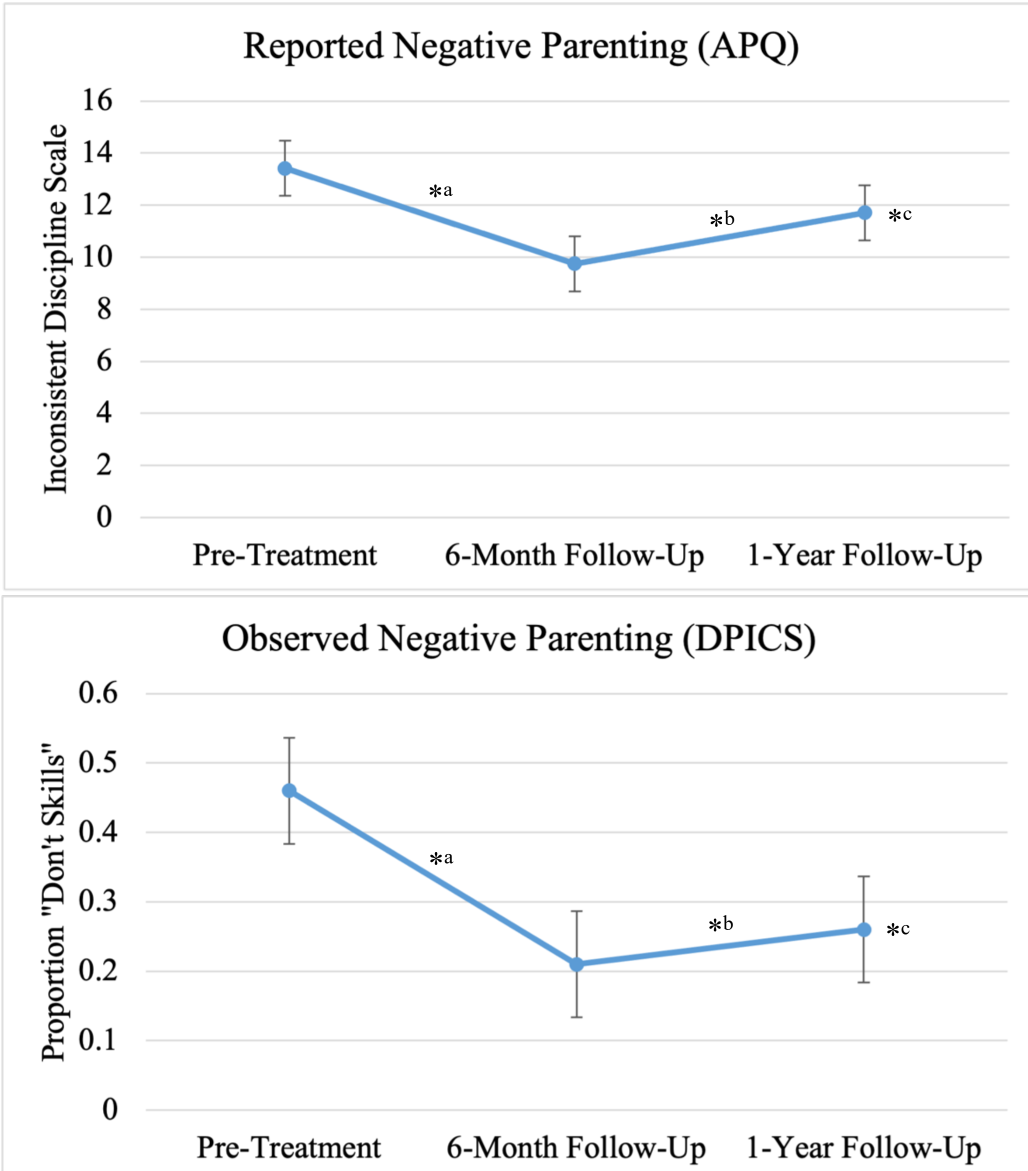
Note. ***p <.001, **p <.01, * p < .05. EF = Executive Functioning at Pre-treatment; PSI = Parenting Stress Index, 4th Edition Short Form, total score at pre-treatment; EBP = Behavior Assessment System for Children, 3rd edition Externalizing Problems T-score, parent report.

Figure 1. *Positive Parenting Intervention Effects*



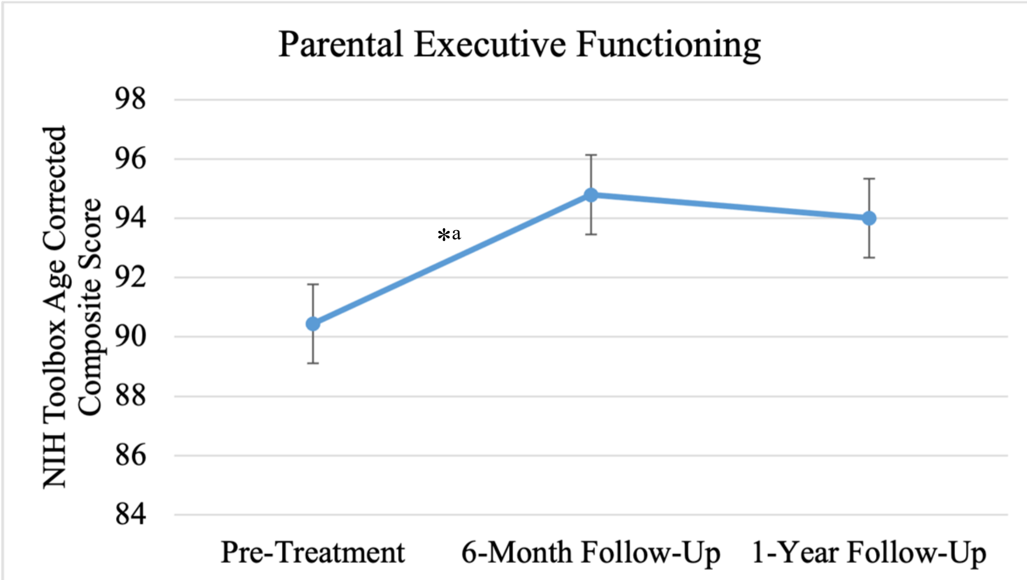
Note. Analyses controlled for child age (Reported) and dummy coded parent language (Observed). For convenience the largest group (bilingual English/Spanish) is shown as there were no significant differences between groups. APQ = Alabama Parenting Questionnaire; DPICS = Dyadic Parent-Child Interaction Coding System, 4th Edition; * = significant Cohen's d effect size, [a] = pre-treatment to 6-month follow-up, [b] = 6-month follow-up to 1-year follow-up, [c] = pre-treatment to 1-year follow-up.

Figure 2. *Negative Parenting Intervention Effects*



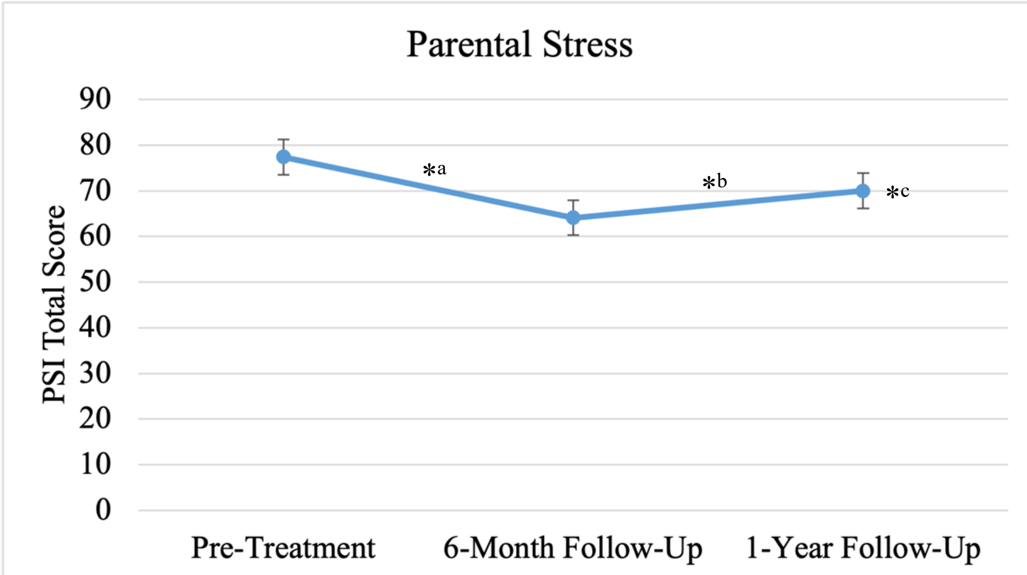
Note. Analyses controlled for dummy coded parent language (Observed). For convenience the largest group (bilingual English/Spanish) is shown as there were no significant differences between groups. APQ = Alabama Parenting Questionnaire; DPICS = Dyadic Parent-Child Interaction Coding System, 4th Edition; * = significant Cohen's d effect size, [a] = pre-treatment to 6-month follow-up, [b] = 6-month follow-up to 1-year follow-up, [c] = pre-treatment to 1-year follow-up.

Figure 3. *Executive Functioning Intervention Effects*



Note. Analyses controlled for parent education. NIH = NIH Toolbox for the Assessment of Neurological and Behavioral Function; * = significant Cohen's d effect size, [a] = pre-treatment to 6-month follow-up.

Figure 4. *Parental Stress Intervention Effects*



Note. Analyses controlled for child externalizing behavior problems. PSI = *Parenting Stress Index*, 4th Edition Short Form; * = significant Cohen's d effect size, [a] = pre-treatment to 6-month follow-up, [b] = 6-month follow-up to 1-year follow-up, [c] = pre-treatment to 1-year follow-up.

V. CONCLUSION

The three manuscripts presented examine both child and parent factors across behavioral parent training (BPT) for preschoolers with externalizing behavior problems (EBP). More specifically, this work examines self-regulation processes, especially EF. Understanding predictors of treatment response are of utmost importance for maximizing intervention outcomes for both children and parents.

Study I examines the extent to which individual differences in executive function (EF) and emotion regulation (ER) are uniquely associated with inattention and hyperactivity symptoms of Attention-Deficit/Hyperactivity Disorder (ADHD), respectively, among preschoolers with at-risk or clinically elevated EBP (N = 249). Although more longitudinal work is needed, findings suggest that as early as the preschool period, underlying deficits in EF and ER do differentially relate to ADHD symptoms. More specifically, deficits in EF differentially relate to symptoms of inattention, while both deficits in EF and ER predict symptoms of hyperactivity. One proposed suggestion given the results is for interventions to target EF deficits in preschoolers.

The second study examines interventions targeting self-regulation among preschoolers with EBP. Children participated in an 8-week summer treatment program for Pre-Kindergarteners (STP-PreK), where they were randomly assigned to either adaptive CWMT (n = 24), or non-adaptive CWMT (n = 25). Findings suggest that all children who participated in the STP-PreK improved their behavioral, academic, and executive functioning as evident by parent, teacher, and observed/standardized measures (d's = .23-.86). However, CWMT does not provide any incremental benefits to children's

EF, behavior, or academics beyond STP-PreK. Results from this study provides support for the implementation of an EF games period in classrooms, along with behavior modification.

Lastly, to examine parent factors, study III utilized a longitudinal design to examine 1) the malleability of stress, parental executive functioning (EF), and parenting skills across an early BPT intervention, 2) the association between stress and parental EF and parenting skills, and 3) the extent to which parental stress moderates the association between parental EF and parenting skills for parents of children with ADHD. Parents (N = 112) of children with ADHD participated in School Readiness Parenting Program (SRPP). Findings from this study suggest that parental stress, parenting skills, and possibly parental EF are malleable over the course of BPT (*d*'s = |.33-2.07|). Future work should examine the directional associations between parental EF, stress, and parenting skills across BPT. As SRPP does not target parental EF, it may be that additional components and/or adjunct session content, such as stress management or parent coping skills, to BPT may provide additive benefits to parents' EF, similar to improvements demonstrated in children's EF in study II.

Combined, this collection of work contributes to the existing literature on interventions for children with EBP by examining both child and parent factors. Findings across the studies presented critically inform intervention science. It will be important for future work to not only continue to examine child and parent factors across intervention longitudinally, but also the relatedness of parent and child factors over time in order to best optimize intervention outcomes.

LIST OF REFERENCES

Abidin, R. R. (1990). *Parenting stress index-short form* (p. 118). Charlottesville, VA: Pediatric Psychology Press.

Abikoff, H. B., Thompson, M., Laver-Bradbury, C., Long, N., Forehand, R. L., Miller Brotman, L., ... & Sonuga-Barke, E. (2015). Parent training for preschool ADHD: a randomized controlled trial of specialized and generic programs. *Journal of Child Psychology and Psychiatry*, *56*(6), 618-631.

Alloway, T. P., Gathercole, S. E., & Pickering, S. J. (2006). Verbal and visuospatial short-term and working memory in children: Are they separable?. *Child development*, *77*(6), 1698-1716.

Alvarez, J. A., & Emory, E. (2006). Executive function and the frontal lobes: a meta-analytic review. *Neuropsychology review*, *16*(1), 17-42.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: American Psychiatric Association.

American Psychological Association (2017). Stress in America™: The State of our Nation.

Ardila, A., Pineda, D., & Rosselli, M. (2000). Correlation between intelligence test scores and executive function measures. *Archives of clinical neuropsychology*, *15*(1), 31-36.

Arnsten, A. F. (2000). Through the looking glass: differential noradenergic modulation of prefrontal cortical function. *Neural plasticity*, *7*(1-2), 133-146.

Avenevoli, S., Baio, J., Bitsko, R. H., Blumberg, S. J., Brody, D. J., Crosby, A., ... & Visser, S. N. (2013). Mental health surveillance among children--United States, 2005-2011.

Bagner, D. M., & Graziano, P. A. (2013). Barriers to success in parent training for young children with developmental delay: The role of cumulative risk. *Behavior modification*, *37*(3), 356-377.

Bandura, A. (1991). Social cognitive theory of self-regulation. *Organizational Behavior and Human Decision Processes, 50*(2), 248-287.

Barkley, R. A. (1997). Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD. *Psychological Bulletin, 121*(1), 65-94.

Barkley, R. A. (2015). Executive functioning and self-regulation viewed as an extended phenotype: Implications of the theory for ADHD and its treatment.

Barkley, R. A. (2016). Recent longitudinal studies of childhood attention-deficit/hyperactivity disorder: Important themes and questions for further research.

Barrett, J., & Fleming, A. S. (2011). Annual research review: All mothers are not created equal: Neural and psychobiological perspectives on mothering and the importance of individual differences. *Journal of Child Psychology and Psychiatry*, *52*(4), 368-397.

Baumrind, D. (1991). The influence of parenting style on adolescent competence and substance use. *The journal of early adolescence*, *11*(1), 56-95.

Belsky, J. (1984). The determinants of parenting: A process model. *Child development*, 83-96.

Berg, D. H. (2007). *The role of processing speed and working memory in children's mental addition* (Order No. AAINR22131). Available from PsycINFO. (622020868; 2007-99013-040).

Berntson, G. G., Cacioppo, J. T., & Fieldstone, A. (1996). Illusions, arithmetic, and the bidirectional modulation of vagal control of the heart. *Biological psychology*, *44*(1), 1-17.

Best, J. R., Miller, P. H., & Jones, L. L. (2009). Executive functions after age 5: Changes and correlates. *Developmental review*, *29*(3), 180-200.

Biederman, J. (2005). Attention-Deficit/Hyperactivity disorder: A selective overview. *Biological Psychiatry, 57*(11), 1215-1220.

Biederman, J., Monuteaux, M. C., Doyle, A. E., Seidman, L. J., Wilens, T. E., Ferrero, F., . . . Faraone, S. V. (2004). Impact of executive function deficits and attention-Deficit/Hyperactivity disorder (ADHD) on academic outcomes in children. *Journal of Consulting and Clinical Psychology, 72*(5), 757-766.

Biederman, J., Petty, C. R., Fried, R., Doyle, A. E., Spencer, T., Seidman, L. J., ... & Faraone, S. V. (2007). Stability of executive function deficits into young adult years: a prospective longitudinal follow-up study of grown up males with ADHD. *Acta Psychiatrica Scandinavica*, *116*(2), 129-136.

Bird, H. R., Gould, M. S., & Staghezza, B. (1992). Aggregating data from multiple informants in child psychiatry epidemiological research. *Journal of the American Academy of Child & Adolescent Psychiatry, 31*(1), 78-85.

Blair, C., & Diamond, A. (2008). Biological processes in prevention and intervention: The promotion of self-regulation as a means of preventing school failure. *Development and psychopathology*, *20*(3), 899-911.

Blair, C., & Razza, R. P. (2007). Relating effortful control, executive function, and false belief understanding to emerging math and literacy ability in kindergarten. *Child Development, 78*(2), 647-663.

Blair, C., & Ursache, A. (2011). A bidirectional model of executive functions and self-regulation. *Handbook of self-regulation: Research, theory, and applications*, *2*, 300-320.

Botella, C., Serrano, B., Baños, R. M., & Garcia-Palacios, A. (2015). Virtual reality exposure-based therapy for the treatment of post-traumatic stress disorder: a review of its efficacy, the adequacy of the treatment protocol, and its acceptability. *Neuropsychiatric disease and treatment*, *11*, 2533.

Breaux, R. P., & Harvey, E. A. (2019). A longitudinal study of the relation between family functioning and preschool ADHD symptoms. *Journal of Clinical Child & Adolescent Psychology*, *48*(5), 749-764.

Bunford, N., Evans, S. W., & Wymbs, F. (2015). ADHD and emotion dysregulation among children and adolescents. *Clinical Child and Family Psychology Review, 18*(3), 185-217.

Calkins, S. D. (2007). The emergence of self-regulation: Biological and behavioral control mechanisms supporting toddler competencies. In C. A. Brownell, & C. B. Kopp (Eds.), *Socioemotional development in the toddler years: Transitions and transformations.* (pp. 261-284) Guilford Press, New York, NY.

Cerhan, J. R., Folsom, A. R., Mortimer, J. A., Shahar, E., Knopman, D. S., McGovern, P. G., ... & Heiss, G. (1998). Correlates of cognitive function in middle-aged adults. *Gerontology*, *44*(2), 95-105.

Chacko, A., Jensen, S. A., Lowry, L. S., Cornwell, M., Chimklis, A., Chan, E., ... & Pulgarin, B. (2016). Engagement in behavioral parent training: Review of the literature and implications for practice. *Clinical child and family psychology review*, *19*(3), 204-215.

Chhabildas, N., Pennington, B. F., & Willcutt, E. G. (2001). A comparison of the neuropsychological profiles of the DSM-IV subtypes of ADHD. *Journal of Abnormal Child Psychology, 29*(6), 529-540.

Chronis, A. M., Chacko, A., Fabiano, G. A., Wymbs, B. T., & Pelham, W. E. (2004). Enhancements to the behavioral parent training paradigm for families of children with ADHD: Review and future directions. *Clinical child and family psychology review*, *7*(1), 1-27.

Cole, P. M. (1986). Children's spontaneous control of facial expression. *Child Development, 57*(6), 1309-1321.

Cole, P. M., Zahn-Waxler, C., Fox, N. A., Usher, B. A., & Welsh, J. D. (1996). Individual differences in emotion regulation and behavior problems in preschool children. *Journal of Abnormal Psychology, 105*(4), 518-529.

Comer, J. S., Chow, C., Chan, P. T., Cooper-Vince, C., & Wilson, L. A. (2013). Psychosocial treatment efficacy for disruptive behavior problems in very young children: A meta-analytic examination. *Journal of the American Academy of Child & Adolescent Psychiatry*, *52*(1), 26-36.

Connor, D. F. (2002). Preschool attention deficit hyperactivity disorder: A review of prevalence, diagnosis, neurobiology, and stimulant treatment. *Journal of Developmental and Behavioral Pediatrics, 23*, S1-S9.

Cortese, S., Ferrin, M., Brandeis, D., Buitelaar, J., Daley, D., Dittmann, R. W., ... & Zuddas, A. (2015). Cognitive training for attention-deficit/hyperactivity disorder: meta-analysis of clinical and neuropsychological outcomes from randomized controlled trials. *Journal of the American Academy of Child & Adolescent Psychiatry*, *54*(3), 164-174.

Crnic, K. A., & Greenberg, M. T. (1990). Minor parenting stresses with young children. *Child development*, *61*(5), 1628-1637.

Crnic, K. A., Gaze, C., & Hoffman, C. (2005). Cumulative parenting stress across the preschool period: Relations to maternal parenting and child behaviour at age 5. *Infant and Child Development: An International Journal of Research and Practice*, *14*(2), 117-132.

Cuevas, K., Deater-Deckard, K., Kim-Spoon, J., Watson, A. J., Morasch, K. C., & Bell, M. A. (2014). What's mom got to do with it? Contributions of maternal executive function and caregiving to the development of executive function across early childhood. *Developmental Science*, *17*(2), 224-238.

Dadds, M. R., Maujean, A., & Fraser, J. A. (2003). Parenting and conduct problems in children: Australian data and psychometric properties of the Alabama Parenting Questionnaire. *Australian Psychologist*, *38*(3), 238-241.

Dahlin, E., Nyberg, L., Bäckman, L., & Neely, A. S. (2008). Plasticity of executive functioning in young and older adults: immediate training gains, transfer, and long-term maintenance. *Psychology and aging*, *23*(4), 720.

Daley, D., Van der Oord, S., Ferrin, M., Cortese, S., Danckaerts, M., Doepfner, M., ... & Sonuga-Barke, E. J. (2018). Practitioner review: current best practice in the use of parent training and other behavioural interventions in the treatment of children and adolescents with attention deficit hyperactivity disorder. *Journal of Child Psychology and Psychiatry*, *59*(9), 932-947.

Dallaire, D. H., & Weinraub, M. (2005). The stability of parenting behaviors over the first 6 years of life. *Early Childhood Research Quarterly*, *20*(2), 201-219.

Danielson, M. L., Bitsko, R. H., Ghandour, R. M., Holbrook, J. R., Kogan, M. D., & Blumberg, S. J. (2018). Prevalence of parent-reported ADHD diagnosis and associated treatment among US children and adolescents, 2016. *Journal of Clinical Child & Adolescent Psychology*, *47*(2), 199-212.

Deater-Deckard, K. (1998). Parenting stress and child adjustment: Some old hypotheses and new questions. *Clinical psychology: Science and practice*, *5*(3), 314.

Deater-Deckard, K. D., & Panneton, R. (2017). *Parental Stress and Early Child Development*. Springer.

Deater-Deckard, K., Sewell, M. D., Petrill, S. A., & Thompson, L. A. (2010). Maternal working memory and reactive negativity in parenting. *Psychological science*, *21*(1), 75-79.

Deater-Deckard, K., Wang, Z., Chen, N., & Bell, M. A. (2012). Maternal executive function, harsh parenting, and child conduct problems. *Journal of Child Psychology and Psychiatry*, *53*(10), 1084-1091.

Denham, S. A. (2006). Emotional competence: Implications for social functioning. In J. L. Luby (Ed.), *Handbook of preschool mental health: Development, disorders, and treatment.* (pp. 23-44) Guilford Press, New York, NY.

Diamond, A., & Lee, K. (2011). Interventions shown to aid executive function development in children 4 to 12 years old. *Science*, *333*(6045), 959-964.

Domitrovich, C., Durlak, J., Goren, P., &Weissberg, R. (2013). *Effective social and emotional learning programs: Preschool and elementary school edition*. Chicago, IL: CASEL.

Douglas, V. I. (2005). Cognitive Deficits in Children with Attention Deficit Hyperactivity Disorder: A Long-Term Follow-Up. *Canadian Psychology/Psychologie canadienne*, *46*(1), 23.

Egger, H. L., & Angold, A. (2006). Common emotional and behavioral disorders in preschool children: presentation, nosology, and epidemiology. *Journal of child psychology and psychiatry*, *47*(3-4), 313-337.

Elgar, F. J., Waschbusch, D. A., Dadds, M. R., & Sigvaldason, N. (2007). Development and validation of a short form of the Alabama Parenting Questionnaire. *Journal of Child and Family Studies*, *16*(2), 243-259.

Ettenhofer, M. L., Hambrick, D. Z., & Abeles, N. (2006). Reliability and stability of executive functioning in older adults. *Neuropsychology*, *20*(5), 607.

Ettinger, A. K., Riley, A. W., Colantuoni, E., & Mendelson, T. (2018). Trajectories of early parenting practices among low-income ethnically diverse women. *Journal of Child and Family Studies*, *27*(2), 615-628.

Eyberg, S. M., & Robinson, E. A. (1981). *Dyadic parent-child interaction coding system: A manual*. American Psychological Association.

Fabiano, G. A., Pelham, Jr, W. E., Waschbusch, D. A., Gnagy, E. M., Lahey, B. B., Chronis, A. M., ... & Burrows-MacLean, L. (2006). A practical measure of impairment: Psychometric properties of the impairment rating scale in samples of children with attention deficit hyperactivity disorder and two school-based samples. *Journal of Clinical Child and Adolescent Psychology*, *35*(3), 369-385.

Fox, N. A., Calkins, S. D., & Bell, M. A. (1994). Neural plasticity and development in the first two years of life: Evidence from cognitive and socioemotional domains of research. *Development and Psychopathology*, *6*(4), 677-696.

Freitas, C., Perez, J., Knobel, M., Tormos, J. M., Oberman, L. M., Eldaief, M., ... & Pascual-Leone, A. (2011). Changes in cortical plasticity across the lifespan. *Frontiers in aging neuroscience*, *3*, 5.

Gabrys, R. L., Howell, J. W., Cebulski, S. F., Anisman, H., & Matheson, K. (2019). Acute stressor effects on cognitive flexibility: Mediating role of stressor appraisals and cortisol. *Stress*, *22*(2), 182-189.

Garon, N., Bryson, S. E., & Smith, I. M. (2008). Executive function in preschoolers: A review using an integrative framework. *Psychological Bulletin, 134*(1), 31-60.

Gazzaley, A., & Nobre, A. C. (2012). Top-down modulation: bridging selective attention and working memory. *Trends in cognitive sciences*, *16*(2), 129-135.

Gershon, R. C., Wagster, M. V., Hendrie, H. C., Fox, N. A., Cook, K. F., & Nowinski, C. J. (2013). NIH toolbox for assessment of neurological and behavioral function. *Neurology*, *80*(11 Supplement 3), S2-S6.

Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. (2000). *Behavior Rating Inventory of Executive Function: BRIEF*. Odessa, FL: Psychological Assessment Resources.

Goldfarb, E. V., Froböse, M. I., Cools, R., & Phelps, E. A. (2017). Stress and cognitive flexibility: cortisol increases are associated with enhanced updating but impaired switching. *Journal of Cognitive Neuroscience*, *29*(1), 14-24.

Goldsmith, H. H., & Rothbart, M. K. (1996). *The Laboratory Temperament Assessment Battery (Lab-TAB): Locomotor Version 3.0. Technical manual*. Madison: Department of Psychology, University of Wisconsin.

Graziano, P. A., & Garcia, A. (2016). Attention-deficit hyperactivity disorder and children's emotion dysregulation: A meta-analysis. *Clinical Psychology Review, 46*, 106-123.

Graziano, P. A., & Hart, K. (2016). Beyond behavior modification: benefits of social–emotional/self-regulation training for preschoolers with behavior problems. *Journal of school psychology*, *58*, 91-111.

Graziano, P. A., Garb, L. R., Ros, R., Hart, K., & Garcia, A. (2016). Executive functioning and school readiness among preschoolers with externalizing problems: The moderating role of the student–teacher relationship. *Early Education and Development, 27*(5), 573-589.

Graziano, P. A., Garic, D., & Dick, A. S. (2022). Individual differences in white matter of the uncinate fasciculus and inferior fronto-occipital fasciculus: possible early biomarkers for callous-unemotional behaviors in young children with disruptive behavior problems. *Journal of Child Psychology and Psychiatry*, *63*(1), 19-33.

Graziano, P. A., Reavis, R. D., Keane, S. P., & Calkins, S. D. (2007). The role of emotion regulation in children's early academic success. *Journal of School Psychology, 45*(1), 3-19.

Graziano, P. A., Ros, R., Hart, K. C., & Slavec, J. (2018). Summer treatment program for preschoolers with externalizing behavior problems: A preliminary examination of parenting outcomes. *Journal of Abnormal Child Psychology*, *46*(6), 1253-1265.

Graziano, P. A., Slavec, J., Hart, K., Garcia, A., & Pelham, W. E. (2014). Improving school readiness in preschoolers with behavior problems: Results from a summer treatment program. *Journal of Psychopathology and Behavioral Assessment*, *36*(4), 555-569.

Graziano, P. A., Slavec, J., Ros, R., Garb, L., Hart, K., & Garcia, A. (2015). Self-regulation assessment among preschoolers with externalizing behavior problems. *Psychological Assessment, 27*(4), 1337-1348.

Grizenko, N., Paci, M., & Joober, R. (2010). Is the inattentive subtype of ADHD different from the combined/hyperactive subtype? *Journal of Attention Disorders, 13*(6), 649-657.

Gross, J. J. (1998). The emerging field of emotion regulation: An integrative review. *Review of General Psychology, 2*(3), 271-299.

Gross, J. J. (1999). Emotion regulation: Past, present, future. *Cognition & Emotion*, *13*(5), 551-573.

Hambrick, D. Z. (2014). Brain Training Doesn't Make You Smarter. Retrieved from https://www.scientificamerican.com/article/brain-training-doesn-t-make-you-smarter/

Hare, M. M., Garcia, A. M., Hart, K. C., & Graziano, P. A. (2021). Intervention response among preschoolers with ADHD: The role of emotion understanding. *Journal of School Psychology*, *84*, 19-31.

Heaton, R. K., Akshoomoff, N., Tulsky, D., Mungas, D., Weintraub, S., Dikmen, S., ... & Gershon, R. (2014). Reliability and validity of composite scores from the NIH Toolbox Cognition Battery in adults. *Journal of the International Neuropsychological Society*, *20*(6), 588-598.

Hertzog, C., Lindenberger, U., Ghisletta, P., & von Oertzen, T. (2006). On the power of multivariate latent growth curve models to detect correlated change. *Psychological methods*, *11*(3), 244.

Hertzog, C., von Oertzen, T., Ghisletta, P., & Lindenberger, U. (2008). Evaluating the power of latent growth curve models to detect individual differences in change. *Structural Equation Modeling: A Multidisciplinary Journal*, *15*(4), 541-563.

Holzman, J. B., & Bridgett, D. J. (2017). Heart rate variability indices as bio-markers of top-down self-regulatory mechanisms: A meta-analytic review. *Neuroscience & biobehavioral reviews*, *74*, 233-255.

Hugdahl, K. (2000). Lateralization of cognitive processes in the brain. *Acta Psychologica, 105*(2-3), 211-235.

Huttenlocher, P. R. (2009). *Neural plasticity: The effects of environment on the development of the cerebral cortex*. Harvard University Press.

Joëls, M., Pu, Z., Wiegert, O., Oitzl, M. S., & Krugers, H. J. (2006). Learning under stress: how does it work?. *Trends in cognitive sciences*, *10*(4), 152-158.

Joyner, K. B., Silver, C. H., & Stavinoha, P. L. (2009). Relationship between parenting stress and ratings of executive functioning in children with ADHD. *Journal of Psychoeducational Assessment*, *27*(6), 452-464.

Kaminski, J.W., Valle, L. A., Filene, J. H., & Boyle, C. L. (2008). A meta-analytic review of components associated with parent training program effectiveness. *Journal of abnormal child psychology*, *36*(4), 567-589.

Katona, P. G., & Jih, F. E. L. I. X. (1975). Respiratory sinus arrhythmia: noninvasive measure of parasympathetic cardiac control. *Journal of applied physiology*, *39*(5), 801-805.

Keenan, K., & Wakschlag, L. S. (2000). More than the terrible twos: The nature and severity of behavior problems in clinic-referred preschool children. *Journal of abnormal child psychology*, *28*(1), 33-46.

Keenan, K., Wakschlag, L. S., Danis, B., Hill, C., Humphries, M., Duax, J., & Donald, R. (2007). Further evidence of the reliability and validity of DSM-IV ODD and CD in preschool children. *Journal of the American Academy of Child & Adolescent Psychiatry*, *46*(4), 457-468.

Koerting, J., Smith, E., Knowles, M. M., Latter, S., Elsey, H., McCann, D. C., ... & Sonuga-Barke, E. J. (2013). Barriers to, and facilitators of, parenting programmes for childhood behaviour problems: a qualitative synthesis of studies of parents' and professionals' perceptions. *European child & adolescent psychiatry*, *22*(11), 653-670.

Kofler, M. J., Raiker, J. S., Sarver, D. E., Wells, E. L., & Soto, E. F. (2016). Is hyperactivity ubiquitous in ADHD or dependent on environmental demands? Evidence from meta-analysis. *Clinical Psychology Review, 46*, 12-24.

Kopp, C. B. (1989). Regulation of distress and negative emotions: A developmental view. *Developmental psychology*, *25*(3), 343.

Kühberger, A., Fritz, A., & Scherndl, T. (2014). Publication bias in psychology: A diagnosis based on the correlation between effect size and sample size. *PloS one*, *9*(9), e105825.

La Greca, A. M., Silverman, W. K., & Lochman, J. E. (2009). Moving beyond efficacy and effectiveness in child and adolescent intervention research. *Journal of consulting and clinical psychology*, *77*(3), 373.

Lahey, B. B., Pelham, W. E., Loney, J., Lee, S. S., & Willcutt, E. (2005). Instability of the DSM-IV subtypes of ADHD from preschool through elementary school. *Archives of General Psychiatry, 62*(8), 896-902. Lonigan, C. J., Bloomfield, B. G., Anthony, J. L., Bacon, K. D., Phillips, B. M., & Samwel, C. S. (1999). Relations among emergent literacy skills, behavior problems, and social competence in preschool children from low- and middle-income backgrounds. *Topics in Early Childhood Special Education, 19*(1), 40-53.

Landis, T. D., Hart, K. C., & Graziano, P. A. (2019). Targeting self-regulation and academic functioning among preschoolers with behavior problems: Are there incremental benefits to including cognitive training as part of a classroom curriculum?. *Child Neuropsychology*, *25*(5), 688-704.

Lavigne, J. V., LeBailly, S. A., Hopkins, J., Gouze, K. R., & Binns, H. J. (2009). The prevalence of ADHD, ODD, depression, and anxiety in a community sample of 4-year-olds. *Journal of Clinical Child & Adolescent Psychology*, *38*(3), 315-328.

Lee, P. C., Niew, W. I., Yang, H. J., Chen, V. C. H., & Lin, K. C. (2012). A meta-analysis of behavioral parent training for children with attention deficit hyperactivity disorder. *Research in developmental disabilities*, *33*(6), 2040-2049.

Lorber, M. F., O'Leary, S. G., & Kendziora, K. T. (2003). Mothers' overreactive discipline and their encoding and appraisals of toddler behavior. *Journal of Abnormal Child Psychology*, *31*(5), 485-494.

Lövdén, M., Bäckman, L., Lindenberger, U., Schaefer, S., & Schmiedek, F. (2010). A theoretical framework for the study of adult cognitive plasticity. *Psychological bulletin*, *136*(4), 659.

Luby, J. L., Heffelfinger, A., Measelle, J. R., Ablow, J. C., Essex, M. J., Dierker, L., et al. (2002). Differential performance of the MacArthur HBQ and DISC-IV in identifying DSM-IV internalizing psychopathology in young children. *Journal of the American Academy of Child & Adolescent Psychiatry*, *41*(4), 458–466.

Lundahl, B., Risser, H. J., & Lovejoy, M. C. (2006). A meta-analysis of parent training: Moderators and follow-up effects. *Clinical psychology review*, *26*(1), 86-104.

Lupien, S. J., Maheu, F., Tu, M., Fiocco, A., & Schramek, T. E. (2007). The effects of stress and stress hormones on human cognition: Implications for the field of brain and cognition. *Brain and cognition*, *65*(3), 209-237.

Mahone, E. M., & Hoffman, J. (2007). Behavior rating of executive function among preschoolers with ADHD. *The Clinical Neuropsychologist, 21*(4), 569-586.

Mahone, E. M., Hagelthorn, K. M., Cutting, L. E., Schuerholz, L. J., Pelletier, S. F., Rawlins, C., ... & Denckla, M. B. (2002). Effects of IQ on executive function measures in children with ADHD. *Child Neuropsychology*, *8*(1), 52-65.

Martel, M. M., Nigg, J. T., & Lucas, R. E. (2008). Trait mechanisms in youth with and without attention-deficit/hyperactivity disorder. *Journal of Research in Personality, 42*(4), 895-913.

Martel, M. M., Nigg, J. T., & Von Eye, A. (2009). How do trait dimensions map onto ADHD symptom domains? *Journal of Abnormal Child Psychology, 37*(3), 337-348.

Mash, J., & Barkley, R. (2003). *Child psychopathology* (2nd ed.).New York, NY: Guilford.

Masud, H., Thurasamy, R., & Ahmad, M. S. (2015). Parenting styles and academic achievement of young adolescents: A systematic literature review. *Quality & quantity*, *49*(6), 2411-2433.

Mazursky-Horowitz, H., Thomas, S. R., Woods, K. E., Chrabaszcz, J. S., Deater-Deckard, K., & Chronis-Tuscano, A. (2018). Maternal executive functioning and scaffolding in families of children with and without parent-reported ADHD. *Journal of abnormal child psychology*, *46*(3), 463-475.

McClelland, M. M., Cameron, C. E., Duncan, R., Bowles, R. P., Acock, A. C., Miao, A., & Pratt, M. E. (2014). Predictors of early growth in academic achievement: The head-toes-knees-shoulders task. *Frontiers in psychology*, *5*, 599.

McEwen, B. S. (2004). Protection and damage from acute and chronic stress: allostasis and allostatic overload and relevance to the pathophysiology of psychiatric disorders. *Annals of the New York Academy of Sciences*, *1032*(1), 1-7.

McEwen, B. S., & Sapolsky, R. M. (1995). Stress and cognitive function. *Current opinion in neurobiology*, *5*(2), 205-216.

McRae, K., Misra, S., Prasad, A. K., Pereira, S. C., & Gross, J. J. (2012). Bottom-up and top-down emotion generation: Implications for emotion regulation. *Social Cognitive and Affective Neuroscience, 7*(3), 253-262.

Melby-Lervåg, M., Redick, T. S., & Hulme, C. (2016). Working memory training does not improve performance on measures of intelligence or other measures of "far transfer" evidence from a meta-analytic review. *Perspectives on Psychological Science*, *11*(4), 512-534.

Meyer, G. J., Finn, S. E., Eyde, L. D., Kay, G. G., Moreland, K. L., Dies, R. R., ... & Reed, G. M. (2001). Psychological testing and psychological assessment: A review of evidence and issues. *American psychologist*, *56*(2), 128.

Mills-Koonce, W. R., Propper, C., Gariepy, J. L., Barnett, M., Moore, G. A., Calkins, S., & Cox, M. J. (2009). Psychophysiological correlates of parenting behavior in mothers of young children. *Developmental psychobiology*, *51*(8), 650-661.

Monn, A. R., Narayan, A. J., Kalstabakken, A. W., Schubert, E. C., & Masten, A. S. (2017). Executive function and parenting in the context of homelessness. *Journal of Family Psychology*, *31*(1), 61.

Morsbach, S. K., & Prinz, R. J. (2006). Understanding and improving the validity of self-report of parenting. *Clinical Child and Family Psychology Review*, *9*(1), 1-21.

Mowszowski, L., Lampit, A., Walton, C. C., & Naismith, S. L. (2016). Strategy-based cognitive training for improving executive functions in older adults: a systematic review. *Neuropsychology review*, *26*(3), 252-270.

Musser, E. D., Backs, R. W., Schmitt, C. F., Ablow, J. C., Measelle, J. R., & Nigg, J. T. (2011). Emotion regulation via the autonomic nervous system in children with attention-deficit/hyperactivity disorder (ADHD). *Journal of Abnormal Child Psychology, 39*(6), 841-852.

National Institutes of Health, & Northwestern University (2021, May 25). *NIH Toolbox® Scoring and Interpretation Guide for the iPad*. NIH Toolbox. Retrieved from https://nihtoolbox.my.salesforce.com/sfc/p/#2E000001H4ee/a/2E0000004yR3/Ckb_AKw1oFUC56tgf6tdxcGDYaYbu8rsmBSFOX2Ec4g

Nevo, E., & Breznitz, Z. (2013). The development of working memory from kindergarten to first grade in children with different decoding skills. *Journal of Experimental Child Psychology, 114*(2), 217-228.

Nigg, J. T., Willcutt, E. G., Doyle, A. E., & Sonuga-Barke, E. (2005). Causal heterogeneity in attention-deficit/ hyperactivity disorder: Do we need neuropsychologically impaired subtypes? *Biological Psychiatry, 57*(11), 1224-1230.

Nixon, R. D. (2002). Treatment of behavior problems in preschoolers: A review of parent training programs. *Clinical psychology review*, *22*(4), 525-546.

O'Neill, S., Rajendran, K., Mahbubani, S. M., & Halperin, J. M. (2017). Preschool predictors of ADHD symptoms and impairment during childhood and adolescence. *Current psychiatry reports*, *19*(12), 1-15.

Oei, N. Y., Everaerd, W. T., Elzinga, B. M., van Well, S., & Bermond, B. (2006). Psychosocial stress impairs working memory at high loads: an association with cortisol levels and memory retrieval. *Stress*, *9*(3), 133-141.

Patterson, G. R. (1982). *Coercive family process* (Vol. 3). Castalia publishing company.

Peijnenborgh, J. C., Hurks, P. M., Aldenkamp, A. P., Vles, J. S., & Hendriksen, J. G. (2016). Efficacy of working memory training in children and adolescents with learning disabilities: A review study and meta-analysis. *Neuropsychological rehabilitation*, *26*(5-6), 645-672.

Pelham Jr, W. E., & Fabiano, G. A. (2008). Evidence-based psychosocial treatments for attention-deficit/hyperactivity disorder. *Journal of Clinical Child & Adolescent Psychology*, *37*(1), 184-214.

Pelham Jr, W. E., Gnagy, E. M., Greenslade, K. E., & Milich, R. (1992). Teacher ratings of DSM-III-R symptoms for the disruptive behavior disorders. *Journal of the American Academy of Child & Adolescent Psychiatry*, *31*(2), 210-218.

Pelham, Jr, W. E., Fabiano, G. A., & Massetti, G. M. (2005). Evidence-based assessment of attention deficit hyperactivity disorder in children and adolescents. *Journal of clinical child and adolescent psychology*, *34*(3), 449-476.

Pelham, W. E., Gnagy, E. M., Greiner, A. R., Waschbusch, D. A., Fabiano, G. A., & Burrows-Maclean, L. (2010). Summer treatment programs for attention-deficit/hyperactivity disorder. *Evidence-based psychotherapies for children and adolescents*, *2*, 277-292.

Pennington, B. F., & Ozonoff, S. (1996). Executive functions and developmental psychopathology. *Journal of child psychology and psychiatry*, *37*(1), 51-87.

Peterson, B. E., Smirles, K. A., & Wentworth, P. A. (1997). Generativity and authoritarianism: Implications for personality, political involvement, and parenting. *Journal of Personality and Social Psychology*, *72*(5), 1202.

Piacentini, J. C., Cohen, P., & Cohen, J. (1992). Combining discrepant diagnostic information from multiple sources: Are complex algorithms better than simple ones? *Journal of Abnormal Child Psychology, 20*(1), 51-63.

Plieger, T., & Reuter, M. (2020). Stress & executive functioning: A review considering moderating factors. *Neurobiology of Learning and Memory*, *173*, 107254.

Polanczyk, G. V. (2018). Building the Evidence to Treat Preschoolers With ADHD in Real-Life Settings. *Journal of the American Academy of Child and Adolescent Psychiatry*, *57*(8), 544-546.

Polanczyk, G. V., Willcutt, E. G., Salum, G. A., Kieling, C., & Rohde, L. A. (2014). ADHD prevalence estimates across three decades: an updated systematic review and meta-regression analysis. *International journal of epidemiology*, *43*(2), 434-442.

Ponitz, C. C., McClelland, M. M., Matthews, J. S., & Morrison, F. J. (2009). A structured observation of behavioral self-regulation and its contribution to kindergarten outcomes. *Developmental Psychology, 45,* 605–619.

Ponitz, C. E. C., McClelland, M. M., Jewkes, A. M., Connor, C. M., Farris, C. L., & Morrison, F. J. (2008). Touch your toes! Developing a direct measure of behavioral regulation in early childhood. *Early Childhood Research Quarterly, 23*(2), 141-158.

Porges, S. W. (1992). Vagal tone: a physiologic marker of stress vulnerability. *Pediatrics*, *90*(3), 498-504.

Porges, S. W. (1995). Orienting in a defensive world: Mammalian modifications of our evolutionary heritage. A polyvagal theory. *Psychophysiology*, *32*(4), 301-318.

Porges, S. W. (2007). The polyvagal perspective. *Biological psychology*, *74*(2), 116-143.

Ramey, E. R., & Goldstein, M. S. (1957). The adrenal cortex and the sympathetic nervous system. *Physiological Reviews*, *37*(2), 155-195.

Ramsden, S. R., & Hubbard, J. A. (2002). Family expressiveness and parental emotion coaching: Their role in children's emotion regulation and aggression. Journal of Abnormal Child Psychology, 30(6), 657-667.

Rapport, M. D., Bolden, J., Kofler, M. J., Sarver, D. E., Raiker, J. S., & Alderson, R. M. (2009). Hyperactivity in boys with attention-deficit/hyperactivity disorder (ADHD): a ubiquitous core symptom or manifestation of working memory deficits?. *Journal of Abnormal Child Psychology*, *37*(4), 521-534.

Rapport, M. D., Orban, S. A., Kofler, M. J., & Friedmxan, L. M. (2013). Do programs designed to train working memory, other executive functions, and attention benefit children with ADHD? A meta-analytic review of cognitive, academic, and behavioral outcomes. *Clinical psychology review*, *33*(8), 1237-1252.

Redick, T. S., Shipstead, Z., Wiemers, E. A., Melby-Lervåg, M., & Hulme, C. (2015). What's working in working memory training? An educational perspective. *Educational Psychology Review*, *27*(4), 617-633.

Reid, R., Trout, A. L., & Schartz, M. (2005). Self-regulation interventions for children with attention Deficit/Hyperactivity disorder. *Exceptional Children, 71*(4), 361-377.

Reitman, D., Currier, R. O., & Stickle, T. R. (2002). A critical evaluation of the Parenting Stress Index-Short Form (PSI-SF) in a Head Start population. *Journal of Clinical Child and Adolescent Psychology*, *31*(3), 384-392.

Reyno, S. M., & McGrath, P. J. (2006). Predictors of parent training efficacy for child externalizing behavior problems–a meta-analytic review. *Journal of Child Psychology and Psychiatry*, *47*(1), 99-111.

Reynolds, C. R., & Kamphaus, R. W. (1992). *BASC: Behavior Assessment System for Children Manual*. Circle Pines, MN: American Guidance Service.

Reynolds, C. R., & Kamphaus, R. W. (2015). Behavior assessment system for children–Third Edition (BASC-3). *Bloomington, MN: Pearson*.

Reynolds, C. R., & Kamphaus, R. W. (2015). Behavior assessment system for children–Third Edition (BASC-3). *Bloomington, MN: Pearson*.

Rimm-Kaufman, S. E., & Pianta, R. C. (2000). An ecological perspective on the transition to kindergarten: A theoretical framework to guide empirical research. *Journal of applied developmental psychology*, *21*(5), 491-511.

Roche, J. D., & Johnson, B. D. (2014). Cogmed working memory training product review. *Journal of attention disorders*, *18*(4), 379-384.

Rubin, D. B. (1987). Comment. *Journal of the American Statistical Association*, 82, 543–546.

Rubin, K. H., Coplan, R. J., Fox, N. A., & Calkins, S. D. (1995). Emotionality, emotion regulation, and preschoolers' social adaptation. *Development and Psychopathology, 7*(1), 49-62.

Rueda, M. R., Checa, P., & Cómbita, L. M. (2012). Enhanced efficiency of the executive attention network after training in preschool children: immediate changes and effects after two months. *Developmental cognitive neuroscience*, *2*, S192-S204.

Sala, G., & Gobet, F. (2017). Working memory training in typically developing children: A meta-analysis of the available evidence. *Developmental Psychology*, *53*(4), 671.

Sameroff, A. (2009). *The transactional model*. American Psychological Association.

Sarver, D. E., Rapport, M. D., Kofler, M. J., Raiker, J. S., & Friedman, L. M. (2015). Hyperactivity in attention-deficit/hyperactivity disorder (ADHD): Impairing deficit or compensatory behavior? *Journal of Abnormal Child Psychology, 43*(7), 1219-1232.

Schmitt, S. A., McClelland, M. M., Tominey, S. L., & Acock, A. C. (2015). Strengthening school readiness for Head Start children: Evaluation of a self-regulation intervention. *Early Childhood Research Quarterly*, *30*, 20-31.

Schoemaker, K., Mulder, H., Deković, M., & Matthys, W. (2013). Executive functions in preschool children with externalizing behavior problems: A meta-analysis. *Journal of abnormal child psychology*, *41*(3), 457-471.

Scott, S., & Dadds, M. R. (2009). Practitioner review: when parent training doesn’t work: theory-driven clinical strategies. *Journal of Child Psychology and Psychiatry*, *50*(12), 1441-1450.

Sergeant, J. A., Geurts, H., Huijbregts, S., Scheres, A., & Oosterlaan, J. (2003). The top and the bottom of ADHD: A neuropsychological perspective. *Neuroscience and Biobehavioral Reviews, 27*(7), 583-592.

Shaffer, D., Fisher, P., Lucas, C. P., Dulcan, M. K., & Schwab-Stone, M. (2000). NIMH diagnostic interview schedule for children version IV (NIMH DISC-IV): Description, differences from previous versions, and reliability of some common diagnoses. *Journal of the American Academy of Child & Adolescent Psychiatry, 39*(1), 28-38.

Shelton, K. K., Frick, P. J., & Wootton, J. (1996). Assessment of parenting practices in families of elementary school-age children. *Journal of clinical child psychology*, *25*(3), 317-329.

Shieh, G., & Jan, S. L. (2015). Power and sample size calculations for testing linear combinations of group means under variance heterogeneity with applications to meta and moderation analyses. *Psicologica: International Journal of Methodology and Experimental Psychology*, *36*(2), 367-390.

Shields, A., & Cicchetti, D. (1997). Emotion regulation among school-age children: The development and validation of a new criterion Q-sort scale. *Developmental Psychology, 33*(6), 906-916.

Shipstead, Z., Redick, T. S., & Engle, R. W. (2012). Is working memory training effective?. *Psychological bulletin*, *138*(4), 628.

Simons, D. J., Boot, W. R., Charness, N., Gathercole, S. E., Chabris, C. F., Hambrick, D. Z., & Stine-Morrow, E. A. (2016). Do "brain-training" programs work?. *Psychological Science in the Public Interest*, *17*(3), 103-186.

Sonuga-Barke, E. (2003). The dual pathway model of AD/HD: An elaboration of neuro-developmental characteristics. *Neuroscience and Biobehavioral Reviews, 27*(7), 593-604.

Southam-Gerow, M., & Kendall, P. C. (2002). Emotion regulation and understanding: Implications for child psychopathology and therapy. *Clinical Psychology Review, 22*(2), 189-222.

Soveri, A., Antfolk, J., Karlsson, L., Salo, B., & Laine, M. (2017). Working memory training revisited: A multi-level meta-analysis of n-back training studies. *Psychonomic Bulletin & Review*, *24*(4), 1077-1096.

Steinberg, L., Lamborn, S. D., Dornbusch, S. M., & Darling, N. (1992). Impact of parenting practices on adolescent achievement: Authoritative parenting, school involvement, and encouragement to succeed. *Child development*, *63*(5), 1266-1281.

Stine-Morrow, E. A., & Basak, C. (2011). Cognitive interventions. In *Handbook of the Psychology of Aging (Seventh Edition)* (pp. 153-171).

Subcommittee on Attention-Deficit/Hyperactivity Disorder, Steering Committee on Quality Improvement and Management. (2011). ADHD: clinical practice guideline for the diagnosis, evaluation, and treatment of attention-deficit/hyperactivity disorder in children and adolescents. *Pediatrics*, *128*(5), 1007-1022.

Tamm, L., Nakonezny, P. A., & Hughes, C. W. (2014). An open trial of a metacognitive executive function training for young children with ADHD. *Journal of Attention Disorders*, *18*(6), 551-559.

Taraban, L., & Shaw, D. S. (2018). Parenting in context: Revisiting Belsky's classic process of parenting model in early childhood. *Developmental Review*, *48*, 55-81.

Thayer, J. F., Åhs, F., Fredrikson, M., Sollers III, J. J., & Wager, T. D. (2012). A meta-analysis of heart rate variability and neuroimaging studies: implications for heart rate variability as a marker of stress and health. *Neuroscience & Biobehavioral Reviews*, *36*(2), 747-756.

Theule, J., Wiener, J., Tannock, R., & Jenkins, J. M. (2013). Parenting stress in families of children with ADHD: A meta-analysis. *Journal of Emotional and Behavioral Disorders*, *21*(1), 3-17.

Thompson, B. (2002). What future quantitative social science research could look like: Confidence intervals for effect sizes. *Educational Researcher*, *31*(3), 25-32.

Thorell, L. B. (2009). The Community Parent Education Program (COPE): Treatment effects in a clinical and a community-based sample. *Clinical Child Psychology and Psychiatry*, *14*(3), 373-387.

Thorell, L. B., & Wåhlstedt, C. (2006). Executive functioning deficits in relation to symptoms of ADHD and/or ODD in preschool children. *Infant and Child Development, 15*(5), 503-518.

Tominey, S. L., & McClelland, M. M. (2011). Red light, purple light: Findings from a randomized trial using circle time games to improve behavioral self-regulation in preschool. *Early Education & Development*, *22*(3), 489-519.

Toplak, M. E., West, R. F., & Stanovich, K. E. (2013). Practitioner Review: Do performance-based measures and ratings of executive function assess the same construct?. *Journal of Child Psychology and Psychiatry*, *54*(2), 131-143.

Ursache, A., Blair, C., & Raver, C. C. (2012). The promotion of self-regulation as a means of enhancing school readiness and early achievement in children at risk for school failure. *Child Development Perspectives*, *6*(2), 122-128.

van der Donk, M., Hiemstra-Beernink, A. C., Tjeenk-Kalff, A., Van Der Leij, A., & Lindauer, R. (2015). Cognitive training for children with ADHD: a randomized controlled trial of cogmed working memory training and 'paying attention in class'. *Frontiers in psychology*, *6*, 1081.

Van Hooren, S. A. H., Valentijn, A. M., Bosma, H., Ponds, R. W. H. M., Van Boxtel, M. P. J., & Jolles, J. (2007). Cognitive functioning in healthy older adults aged 64–81: A cohort study into the effects of age, sex, and education. *Aging, Neuropsychology, and Cognition*, *14*(1), 40-54.

Vinogradov, S., Fisher, M., & de Villers-Sidani, E. (2012). Cognitive training for impaired neural systems in neuropsychiatric illness. *Neuropsychopharmacology*, *37*(1), 43.

Wåhlstedt, C., Thorell, L. B., & Bohlin, G. (2008). ADHD symptoms and executive function impairment: Early predictors of later behavioral problems. *Developmental Neuropsychology, 33*(2), 160-178.

Waschbusch, D. A., King, S., & Gregus, A. (2007). Age of onset of ADHD in a sample of elementary school students. *Journal of Psychopathology and Behavioral Assessment, 29*(1), 9-16.

Wechsler, D. (2002). *Wechsler Preschool and Primary Scale of Intelligence–Third Edition*. San Antonio, TX: Psychological Corporation.

Wechsler, D. (2012). *Wechsler Preschool and Primary Scale of Intelligence–Fourth Edition*. San Antonio, TX: Psychological Corporation.

Wehmeier, P. M., Schacht, A., & Barkley, R. A. (2010). Social and emotional impairment in children and adolescents with ADHD and the impact on quality of life. *Journal of Adolescent health*, *46*(3), 209-217.

Weintraub, S., Dikmen, S. S., Heaton, R. K., Tulsky, D. S., Zelazo, P. D., Bauer, P. J., ... & Fox, N. A. (2013). Cognition assessment using the NIH Toolbox. *Neurology*, *80*(11 Supplement 3), S54-S64.

Welsh, J. A., Nix, R. L., Blair, C., Bierman, K. L., & Nelson, K. E. (2010). The development of cognitive skills and gains in academic school readiness for children from low-income families. *Journal of Educational Psychology, 102*(1), 43-53.

Welsh, M. C. (2002). Developmental and clinical variations in executive functions. In D. L. Molfese, & V. J. Molfese (Eds.), *Developmental variations in learning: Applications to social, executive function, language, and reading skills.* (pp. 139-185) Lawrence Erlbaum Associates Publishers, Mahwah, NJ.

Wichstrøm, L., Berg-Nielsen, T. S., Angold, A., Egger, H. L., Solheim, E., & Sveen, T. H. (2012). Prevalence of psychiatric disorders in preschoolers. *Journal of Child Psychology and Psychiatry*, *53*(6), 695-705.

Willcutt, E. G., Doyle, A. E., Nigg, J. T., Faraone, S. V., & Pennington, B. F. (2005). Validity of the executive function theory of attention-deficit/hyperactivity disorder: a meta-analytic review. *Biological psychiatry*, *57*(11), 1336-1346.

Winstone, L. K., Curci, S. G., & Crnic, K. A. (2021). Pathways to maternal and child well-being: Stability and transaction across toddlerhood. *Parenting*, *21*(2), 118-140.

Wolf, O. T., Atsak, P., De Quervain, D. J., Roozendaal, B., & Wingenfeld, K. (2016). Stress and memory: a selective review on recent developments in the understanding of stress hormone effects on memory and their clinical relevance. *Journal of neuroendocrinology*, *28*(8).

Woodcock, R. W., McGrew, K. S., & Mather, N. (2001). *Woodcock-Johnson tests of achievement*. Itasca, IL: Riverside Publishing.

Zelazo, P. D., & Cunningham, W. A. (2007). Executive function: Mechanisms underlying emotion regulation.

Zelazo, P. D., & Müller, U. (2011). Executive function in typical and atypical development.

Zelazo, P. D., Anderson, J. E., Richler, J., Wallner-Allen, K., Beaumont, J. L., Conway, K. P., ... & Weintraub, S. (2014). NIH Toolbox Cognition Battery (CB): validation of executive function measures in adults. *Journal of the International Neuropsychological Society*, *20*(6), 620-629.

Zisser, A., & Eyberg, S. M. (2010). Parent-child interaction therapy and the treatment of disruptive behavior disorders.

APPENDICES

Measures Collected at Each Time Point

Measure	**Pre-Treatment**	**6-Month Follow-Up**	**1-Year Follow-Up**
Child Externalizing Behavior Problems			
Behavior Assessment System for Children, 3rd edition	X		
Parental Executive Functioning			
NIH Toolbox for the Assessment of Neurological and Behavioral Function: *Flanker Inhibitory Control and Attention Test*	X	X	X
NIH Toolbox for the Assessment of Neurological and Behavioral Function: *The Dimensional Change Card Sort Test*	X	X	X
Parenting Skills			
Dyadic Parent-Child Interaction Coding System—Fourth Edition	X	X	X
Alabama Parenting Questionnaire	X	X	X
Parental Stress			
Parenting Stress Index, Fourth Edition Short Form	X	X	X

VITA

TAYLOR DANIELLE LANDIS

2012-2015	B.S., Psychology The Pennsylvania State University State College, Pennsylvania
2016-2018	M.S., Psychology Florida International University Miami, Florida
2018-Present	Doctoral Candidate in Psychology Florida International University Miami, Florida
2021-Present	Child Clinical/Pediatric Psychology Intern Baylor College of Medicine/Texas Children's Hospital Houston, Texas

PUBLICATIONS AND PRESENTATIONS

Tobias, V., Landis, T., & Graziano, P. (2021). Examining Temporal Cognition in Preschoolers With Attention Deficit Hyperactivity Disorder: Insights From Parent–Child Interactions. *Journal of Child and Family Studies*, *30*(9), 2315-2327.

Landis, T., Garcia, A., Hart, K., & Graziano, P. (2020). Differentiating symptoms of ADHD in preschoolers: The role of emotion regulation and executive function. *Journal of Attention Disorders*, 1087054719896858.

Graziano, P., Landis, T., Maharaj, A., Ros-Demarize, R., Hart, K., & Garcia, A. (2019). The association between callous-unemotional (CU) traits and preschoolers with externalizing behavior problems' self-regulation functioning. *Journal of Clinical Child and Adolescent Psychology*, 1-13.

Landis, T., Hart, K., & Graziano, P. (2019). Targeting self-regulation and academic functioning among preschoolers with behavior problems: Are there incremental benefits to including cognitive training as part of a classroom curriculum? *Child Neuropsychology*, *25*(5), 688-704.

Graziano, P., Landis, T., & Maharaj, A. (2019). Children with ADHD's reward and punishment sensitivity prior to and during a multimodal behavioral intervention. Poster presented at the Society for Research in Child Development Biannual Meeting, Baltimore, MD.

Tobias, V., Landis, T., & Graziano, P. (2019). Examining time processing impairment in children with ADHD: The role of parent-child interaction. Poster presented at the Society for Research in Child Development Biannual Meeting, Baltimore, MD.

Landis, T., Coto, J., Hart, K., & Graziano, P. (2019). The effects of a school readiness parenting program on preschoolers' sleep problems. Poster presented at the Society for Research in Child Development Biannual Meeting, Baltimore, MD.

Graziano, P., Garcia, A., & Landis, T. (2018). To fidget or not to fidget, that is the question: A systematic classroom evaluation of fidget spinners among young children with ADHD. *Journal of Attention Disorders*, *24*(1), 163-171.

Landis, T., Coto, J., Hart, K., & Graziano, P. (2018). The effects of a school readiness parenting program on preschoolers' sleep problems. In LaCount, P. & Hartung, C. (co-chairs), Healthy Lifestyles Interventions for ADHD Across the Lifespan. Symposium presented to the Association for Behavioral and Cognitive Therapies Annual Convention, Washington D.C.

Landis, T., Hart, K., & Graziano, P. (2018). Targeting self-regulation and academic functioning among preschoolers with behavior problems: Are there incremental benefits to including cognitive training as part of a classroom curriculum? Poster presented at the Association for Behavioral and Cognitive Therapies Annual Convention, Washington D.C.

Garcia, A., Landis, T., Melo, J., Lim, C., & Graziano, P. (2017). The summer healthy-lifestyle intervention program (HIP) for young children who are overweight: Results from an open trial. Poster presented at the Society for Pediatric Psychology Annual Conference, Portland, OR.

Graziano, P., Garcia, A., Hart, K., & Landis, T. (2017). Self-regulation profile of preschoolers with externalizing behavior problems with and without callous-unemotional traits. In P. Graziano (Chair), Underlying Neurocognitive and Emotional Processes in Youth with Callous-Unemotional Traits. Symposium presented to the Society for Research in Child Development Biannual Meeting, Austin, TX.

Landis, T., Garcia, A., Hart, K., & Graziano, P. (2017). How do symptoms of ADHD in preschool relate to executive function and emotion regulation. Poster presented to the Society for Research in Child Development Biennial Meeting in Austin, Texas.

Landis, T. & Huang-Pollock, C. (2015). The degree to which internalizing and externalizing symptomology account for the relationship between inattention, peer neglect, and peer rejection. Poster presented at Association for Psychological Science. New York, NY.