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Intervention Response Among Preschoolers with ADHD: The Role of Emotion Understanding

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Abstract

Emotion recognition/understanding (ERU), which is the ability to correctly identify emotional states in others as well as one's self, plays a key role in children's social-emotional development and is often targeted in early intervention programs. Yet the extent to which young children's ERU predicts their intervention response remains unclear. The current study examined the extent to which initial levels of ERU and changes in ERU predicted intervention response to a multimodal early intervention program (Summer Treatment Program for Pre-Kindergarteners; STP-PreK). Participants included 230 young children (M_{age} = 4.90, 80.0% male) with attention-deficit/hyperactivity disorder (ADHD) who participated in the 8-week STP-PreK. Children's ERU was measured via a standardized behavioral task. Similarly, standardized measures of academic achievement (Woodcock-Johnson-IV), executive functioning (Head-Toes-Knees-Shoulders-Task), and social-emotional functioning (Challenging Situation Task) were obtained pre- and post-intervention. Parents and teachers also reported on children's behavioral functioning pre- and post-intervention. Children with better initial ERU made greater improvements in academic, executive functioning (EF), and social-emotional domains, along with decreases in inattention symptom severity. However, pre-intervention levels of ERU were not associated with improvements in parent/teacher report of hyperactivity, oppositional defiant disorder, and overall behavioral impairment. Lastly, *changes* in ERU only predicted improvement in EF, but not any other school readiness outcomes. We provide preliminary evidence that initial levels of ERU predict intervention response across school readiness domains in a sample of preschoolers with ADHD.

Keywords

Attention-deficit/hyperactivity disorder (ADHD); emotion recognition; emotion understanding; school readiness; intervention

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School readiness is a multidimensional construct that involves children's behavioral, cognitive, academic, and social-emotional abilities (High, 2008; Rimm-Kaufman, 2004). Children not adequately equipped with these skills are at a greater risk for low academic achievement (McClelland, Morrison, & Holmes, 2000) and negative long term-outcomes (La Paro & Pianta, 2000). One key contributor to successful school readiness is emotion recognition/understanding (ERU; Denham et al., 2012). As outlined by Gross's (1998) emotion generation model, ERU is the ability to correctly identify emotional states in others as well as one's self (Castro, Cheng, Halberstadt, & Grühn, 2016; Denham et al., 2003; Izard et al., 2001). In the preschool years, ERU is related to the ability to accurately identify and label the basic emotions (sadness, happiness, fear, and anger) and to comprehend their external causes (Bassett, Denham, Mincic, & Graling, 2012; Pons, Harris, & de Rosnay, 2004). Given the important role ERU plays in children's social-emotional development, it is not surprising that school readiness intervention research has focused on targeting such skills (Izard et al., 2008). However, it is unclear how initial levels or improvements in ERU contribute to a better intervention response. The current paper looks to fill this gap by focusing on the extent to which children's initial levels of ERU and their change in ERU impacts their response to intervention within multiple domains of school readiness in a sample of preschoolers with attention-deficit/hyperactivity disorder (ADHD).

ERU and School Readiness

Both direct and indirect links between ERU and academic success have been proposed (Voltmer & von Salisch, 2017). For example, preschoolers' ERU predicted later school adjustment after controlling for age, verbal ability, and other emotion regulation domains (Shields et al., 2001). Further, ERU ability at five years old predicted skills in reading, math, and motivation to succeed academically at age nine, also controlling for verbal ability and temperament, indicating ERU's unique predictive ability of future academic success. Within the cognitive domain of school readiness, ERU has been linked to better executive functioning (EF; Denham et al., 2012; Voltmer & von Salisch, 2017). In young children, the link between EF and ERU has been consistently found, yet the direction of the association remains unclear (Martins, Osório, Veríssimo, & Martins, 2016). Some studies point to EF being the foundation for ERU, as EF helps children to control their behavior, which can promote the development of positive social interactions that are important for ERU development (Denham et al., 2012). Alternatively, ERU may aid in the development of cognitive processes related to self-regulation, such as EF (Blankson, O'Brien, Leerkes, Marcovitch, & Calkins, 2013; Leerkes, Paradise, O'Brien, Calkins, & Lange, 2008).

In addition to EF processes, another mechanism linking ERU to academic success is better social-emotional abilities, which consists of children's emotional functioning, social behavior, cognitive development, and regulation capabilities (Brownell & Kopp, 2010). As learning within a school setting has been shown to be a social endeavor, ERU, which is only the recognition of emotions, represents the first basic step in children's ability to use that emotional information to guide their behavior in the classroom. Greater ERU aids children in having better social-emotional abilities, which has been linked to higher productivity in the classroom, better relationships with teachers and peers, and better overall academic outcomes (Haynes, Ben-Avie & Ensign, 2003; Wilson, Gottfredson & Najaka, 2001). These social-emotional abilities form the basis for early success in school, given that it facilitates interactions with teachers and peers, allowing children the opportunity to acquire more information in the classroom and model peers' learning skills (Denham, et al., 2012; Voltmer & von Salisch, 2017). Conversely, children with low ERU may view the classroom as overwhelming and confusing (von Salisch, Denham, & Koch, 2017), thereby affecting their attitudes and behaviors towards school, which in turn, interferes with their social and academic success. Given the link between ERU and academic success it is important to examine how the two aforementioned mechanisms relate to intervention.

Within the social domain of school readiness, ERU plays a vital role in children's social competence (Ensor, Spencer, & Hughes, 2011). Being able to correctly interpret emotions in themselves and others gives preschoolers the foundation for successful social information processing, leading to better regulation of emotions (Gross, 1998) and more positive social interactions. Due to their ability to correctly interpret the emotions of their peers, children with greater ERU are more likely to work cooperatively with other children, allowing them to gain more skills than if they were working alone (Curby et al., 2015). Further, children with better ERU have the ability to correctly recognize fear and sadness which has been linked to higher levels of prosocial behavior (Marsh & Blair, 2008). Conversely, children with ERU deficits inappropriately respond to their peers as indexed by aggressive or withdrawn behaviors (Izard et al., 2001), leaving them at a significant disadvantage in successfully navigating the social and academic worlds of early schooling. Although aggression in children does not predict worse ERU, the reverse relationship has been found. Poor ERU predicts the development of later aggressive behaviors, indicating that worse ERU drives the development of aggression. Further, failure to recognize and understand other's distress can potentially impede the development of empathy (Schuberth et al., 2019), with deficits in recognizing fear and sadness linked to later antisocial behavior (Marsh & Blair, 2008). Consequently, children with worse ERU are at risk for developing inadequate social skills, as well as internalizing and externalizing disorders (Trentacosta & Fine, 2010).

ERU and ADHD

Given the significant links between ERU and multiple domains of school readiness, research has focused on identifying subgroups of children with particular deficits in those domains. Although it is well established that children with Autism Spectrum Disorder (ASD) experience significant deficits in ERU (Harms, Martin, & Wallace, 2010), more recent work has also identified children with ADHD as having worse ERU relative to typically developing children (Graziano & Garcia, 2016). ADHD, characterized by symptoms of hyperactivity, inattention, and impulsivity, represents one of the most common mental health referrals (Danielson et al., 2018). Children with ADHD experience significant academic, EF, and behavioral problems (DuPaul et al., 2004; Hinshaw, 1992; McQuade et al., 2011), as well as social-emotional difficulties (Ros & Graziano, 2018). Given these deficits, children with ADHD tend to experience a host of negative outcomes related to school, such as lower academic achievement and school dropout, independent of comorbid conditions (Fleming et al., 2017). More specifically, children with ADHD score worse on math and reading achievement tests, require more special educational services, and experience higher rates of grade retention when compared to typically developing peers (Biederman et al., 1996; Jensen et al., 2004).

One important mechanism that may explain why children with ADHD have difficulties in school readiness is their ERU capabilities (Graziano & Garcia, 2016). For example, children with ADHD and comorbid oppositional defiant disorder (ODD) performed worse on a measure of ERU compared to typically developing children and those with ASD (Downs & Smith, 2004). In ERU tasks, children with ADHD have deficits in correctly recognizing sadness and happiness (Kats-Gold, Besser & Priel, 2007), while other work has shown they have a harder time accurately detecting fear and anger (Singh et al., 1998; Williams et al., 2008). These ERU deficits may also be partially responsible for the significant social difficulties found among children with ADHD (Gardner & Gerdes, 2015). Given that poor social ability is related to worse long-term outcomes, emerging interventions for children with ADHD have started to incorporate social-emotional functioning targets (Havighurst et al., 2015). For example, Incredible Years which addresses emotion regulation as part of their social-emotional curriculum, has shown to be helpful in children with ADHD (Jones, Daley, Hutchings, Bywater & Eames, 2007; Webster-Stratton, Jamila Reid, & Stoolmiller, 2008). However, the extent to which children's initial levels or improvements in ERU influence their intervention response is unknown.

Although children's initial levels of ERU may have less of a direct impact on strictly behavioral interventions, such as parent training, ERU may be especially important for interventions that directly target children via a social-emotional and academic curriculum. ERU is particularly relevant to understanding children with ADHD's response to a classroom-based intervention due to its link to school readiness and academic functioning. It may be the case that better ERU facilitates children's ability to not only learn and engage in a more complex social-emotional curriculum that includes self-regulation strategies, but also acquire new academic knowledge. For example, children with better ERU are less likely to get frustrated during school and have better relationships with their teachers and peers (Denham et al., 2015). These links are particularly important for children with ADHD who are more likely to have higher levels of dysregulation and behavioral difficulties in a classroom environment. Understanding how initial levels of ERU impact intervention is important to individualize and optimize treatment options for children with ADHD. Additionally, given that some of these programs have shown changes in ERU (Graziano & Hart, 2016; Pons et al., 2019), it would be important to determine if those changes impact intervention outcomes in general or are only specific to certain domains of functioning.

The Current Study

Given the aforementioned links between school readiness and ERU, particularly in susceptible groups such as children with ADHD, the goal of the current study was to examine the extent to which initial levels of ERU and changes in ERU predict response to a multimodal school readiness intervention within a sample of preschoolers with ADHD. Of interest to the current study is the Summer Treatment Program for Pre-Kindergarteners (STP-PreK; Graziano et al., 2014), which is a multimodal intervention that has been shown to improve school readiness, social-emotional abilities, and behavioral impairments associated with ADHD (Graziano & Hart, 2016). An advantage of examining the role of ERU in predicting intervention response within the STP-PreK is the historically moderate to high rates of comorbidity with ODD (Wichstrøm et al., 2012), thus increasing our chances of capturing a wide range of ERU deficits. Considering previous research linking ERU to multiple school readiness domains (Denham et al., 2012), we hypothesized that better initial levels of ERU and improvements in ERU would be positively associated with greater intervention gains across academic, EF, prosocial, and behavior outcomes.

Methods

Participants and Recruitment

The current study was conducted at a large urban university in the Southeastern United States with a large Latinx population. Children and their families were recruited from local preschools and mental health agencies through parent workshops, brochures, and radio ads to participate in an intensive summer treatment program from years 2012–2018. Participants in the current study met eligibility criteria if they (a) had a diagnosis of ADHD, which was obtained through a parent structured interview (Diagnostic Interview Schedule for Children Version IV, C-DISC; Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000) and parent and teacher ratings of symptom severity (Pelham et al., 1992) and impairment (Fabiano et al., 2006) based on standard practice recommendations (Pelham, Fabiano, & Massetti, 2005); (b) were enrolled in preschool the previous school-year; (c) had an estimated IQ of 70 or higher on the Wechsler Preschool and Primary Scale of Intelligence-3rd or 4th edition (WPPSI-III; Wechsler, 2002; WPPSI-IV; Wechsler, 2012); (d) had no history of ASD; (e) had the ability to attend the STP-PreK; and (f) were fluent in English. The final sample consisted of 230 preschoolers (M_{age} = 4.90, 80.0% male; 83.5% Latinx), whose parents provided informed consent to participate in the research study and took part in the intervention. All children met diagnostic criteria for ADHD: 76.96% of children met diagnostic criteria for combined type, 14.54% for hyperactive/impulsive type, and 8.5% for inattentive type. Additionally, 69.6% of children also met diagnostic criteria for ODD. The primary caregivers reported mean age was 36.44 (*SD* = 6.40), with 59.4% married, 14.4% single (never married), 10.9% divorced, 8.7% living with a partner, and 6.6% separated. In terms of educational background, 32.2 % of the primary caregivers had at least a college degree, 28.3 % had an advanced degree, and 17.4 % had some college with a reported average Hollingshead socioeconomic score in the low- to middle-class range of 43.48 (*SD* = 13.02). According to parent report at intake, only 8.7% of children were on any psychotropic medication. Medication status was not associated with any predictors or outcomes. The children's doses were maintained throughout the intervention and results were the same with and without the inclusion of these children.

Procedure

This study was approved by the university's Institutional Review Board. All families were consented and participated in a pre-intervention assessment scheduled prior to the start of the intervention (STP-PreK). At the pre-intervention assessment, children underwent IQ and academic achievement testing, a standardized EF battery, and tasks to assess social functioning. Families also participated in post-intervention assessments one week following the completion of the STP-PreK where they were re-administered all study measures, with the exception of IQ testing. Doctoral or masters level students who were previously trained in academic and achievement testing and/or had completed a doctoral level psychological assessment course administered the IQ and WJ testing under the supervision of a licensed psychologist (last author). All other tasks (i.e., social-emotional, EF) were administered by undergraduate or doctoral students who underwent rigorous training in each assessment (e.g., didactics, observed a senior assessor, had to test out with senior assessor, and completed an assessment under live supervision prior to independently completing assessments). Questionnaires assessing children's behavioral functioning were also administered to the child's parent and teachers pre- and post-intervention. As part of their compensation, all families received the intervention at either no cost via a federal grant or at a subsidized cost via a local grant.

Intervention.—The STP-PreK is an 8-week multimodal intervention consisting of a behavior modification program that includes an academic and social-emotional curriculum (see Graziano et al., 2014). The behavior modification component of the program was modeled after a previously successful evidence-based intervention, the STP-Elementary (Fabiano et al. 2007; Pelham et al. 2010). Every day, parents were given daily written feedback on their child's behavior and academic progress in the form of a daily report card. Based on their progress that day, parents were instructed on how to provide contingent rewards at home. The social-emotional curriculum consisted of daily social skills and emotional awareness training via in-vivo training, the use of puppets, and reinforcement of the skills throughout the day. Additionally, parents attended a weekly School Readiness Parenting Program (SRPP; Graziano et al., 2018) lasting 1.5 – 2 hours. The first half of each session consisted of traditional behavior management strategies implemented within a group parent-child interaction therapy framework, whereas the second half focused on group discussions on school readiness. The feasibility and initial efficacy of STP-PreK in improving school readiness and children's externalizing behavior problems are reported elsewhere (Graziano et al., 2014; Graziano & Hart, 2016). A licensed psychologist completed a treatment fidelity checklist on a weekly basis for each classroom to provide supervision to all staff, $M = 98\%$, ranging from 93% to 100%. For parent training, fidelity was completed by a licensed psychologist or doctoral/master's level graduate students for 6 of 8 sessions, with weekly group supervision provided by a licensed psychologist. Average treatment fidelity ranged from 90% to 100% per session ($M = 98\%$), indicating that the therapists implemented the SRPP with very strong fidelity. Parents attended, on average, 90% of all parent training sessions. Attendance for each camp day was tracked, with children attending, on average, 96 % of the camp days.

Measures

Emotion recognition/understanding (ERU).—Children completed a standardized ERU task (Denham, 1986). Trained research assistants and graduate students asked children to expressively (name what the emotion is) and receptively (point to the emotion) identify 8 different emotions (sad, happy, angry, afraid, surprised, disgusted, embarrassed, guilty), which were presented visually via human and cartoon faces. Children scored 1 point for each correct expressive and receptive answer. Total scores on the human and cartoon faces were combined, with higher scores indicative of better ERU (α's = 0.72–0.78 across cartoon and human faces, pre- and post-intervention). This task has shown good internal consistency and test-retest reliability, along with concurrent and predictive validity (Denham 2006; Denham et al., 2012, 2020). Previous research using this task has shown ERU be associated with school readiness (Denham et al., 2012; Shields et al., 2001), EF (Denham et al., 2012), teacher and peer rating of prosocial behavior (Cassidy et al., 2003; Dunsmore & Karn, 2004), academic achievement (Leerkes et al., 2008), attention (Rhoades et al., 2011), and has demonstrated sensitivity to intervention effects (Graziano & Hart, 2016). Additionally, this measure has been used in cross-sectional and longitudinal research (Dunsmore & Karn, 2004; Ensor et al., 2011) across cultures and backgrounds (Pears & Fisher, 2005).

Academic functioning.—To assess academic functioning, children were administered six subtests of the Woodcock-Johnson Tests of Achievement, 3rd Edition (WJ-III ACH; Woodcock et al., 2001). The WJ is a widely used, norm-referenced measure of academic ability with extensive research on its excellent psychometric properties and has been administered in diverse populations of children. The six subtests administered were Applied Problems, Calculation, Writing Sample, Letter-Word Identification, Passage Comprehension, and Spelling. For the purposes of this study, the composite standard scores of math, reading, and writing were analyzed. The estimated test–retest reliability across subtests in children 2–7 years old is .90–.96. Additionally, the WJ has shown excellent one-year stability for this age group (.92 to .94; Woodcock et al., 2001). In order to minimize practice effects, separate forms of the WJ, form A and form B, were administered pre- and post-intervention.

Executive functioning (EF).—Children were administered the Head-Toes-Knees-Shoulders task (HTKS; Ponitz et al., 2008), which is a structured observational assessment of EF. In this task, children were given two paired behavioral rules ("touch your head," "touch your toes") and then asked to perform them in the opposite way. Scores range from 0 to 60, with higher scores indicating better EF. The HTKS is widely used and psychometrically sound task (McClelland et al., 2014; Ponitz, McClelland, Matthews, & Morrison, 2009; Wanless et al., 2011) that taps into multiple aspects of EF. The HTKS also taps into components of working memory (i.e., remembering and demonstrating new rules while listening to instructions), attentional focusing (i.e., paying attention to the instructions), inhibitory control (i.e., inhibiting their natural response to the test instructions while completing the correct response), and cognitive flexibility (i.e., when the rules change). Prior research has found that performance on the HTKS was validated by parent and teacher report of EF (Ponitz et al., 2009) and children with higher scores on the HTKS performed better on individual measures of EF (cognitive flexibility, working memory, and inhibitory control; McClelland et al., 2014). In order to minimize practice effects, separate versions of the HTKS task were administered pre- and post-intervention.

Social problem solving.—Children were administered the Challenging Situation Task (CST; Denham, Bouril, & Belouad, 1994) to assess social problem solving. Children were presented with hypothetical peer provocation scenarios (e.g., a peer knocking down the child's block tower) and asked to choose from four behavioral responses (prosocial, avoidant, aggressive, and crying). Scenarios and responses were depicted with respective cartoon illustrations and standardized scripts. As previous work has excluded avoidant and crying scores due to low inter-item average correlations (Denham et al., 2013), combined with the fact that these responses are sometimes adaptive and other times not, only prosocial and aggressive responses were used. Consistent with prior research, a prosocial composite was created by subtracting the number of aggressive responses from the prosocial responses with higher scores indicative of better social problem solving (i.e., more prosocial responses, less aggressive responses; Graziano & Hart, 2016). Given that there are too few items in each scale for Cronbach's alpha to be meaningful (Spiliotopoulou, 2009) and to be consistent with previous research (Denham et al., 2014, 2020), mean interitem correlations were used to assess internal consistency. Mean interitem correlations for prosocial and aggression pre- and post-intervention were all above .14, which is considered acceptable (Clark & Watson, 1995). Previous studies in young children have also demonstrated good concurrent validity, internal consistency, and test-retest reliability (Denham, 2006; Denham et al., 2014, 2020; Poulou & Bassett, 2018). Studies using the CST have shown prosocial choices were positively related to teacher report of social competence and classroom adjustment, positive emotions in the classroom, higher sociometric ratings, better ERU, and lower teacher ratings of sadness (Bierman et al., 2008; Denham et al., 1994, 2013). Previous research has also shown aggressive choices were related to more antisocial behavior, worse school adjustment and ERU, and less teacher report of positive emotions in the classroom (Bierman et al., 2008; Denham et al., 1994, 2013; Zahn-Waxler et al., 1994).

Behavior symptoms and impairment.—To assess ADHD and ODD symptom severity, parents and teachers completed the Disruptive Behavior Disorders (DBD) Rating Scale (Pelham et al., 1992). The DBD scale asks the respondent to rate the degree to which children display symptoms of ADHD, ODD, and conduct disorder (CD), using a 4-point scale ranging from 0 (*not at all)* to 3 (*very much)*. A mean rating for ADHD symptoms (hyperactivity/impulsivity and inattention) and ODD symptoms were examined (α's = 0.85–0.96 across parent and teacher reports). Validity and reliability are well-established on these scales of the DBD (.67–.81; Pillow, Pelham, Hoza, Molina, & Stultz, 1998), with this measure showing sensitivity to behavioral treatment across multiple studies (Pelham et al., 2005)

To assess overall behavioral impairment, parents and teachers completed the Impairment Rating Scale (IRS; Fabiano et al., 2006). The IRS measures the severity of children's impairment across academic functioning, classroom functioning, family functioning, self-esteem, relationships with peers and parents/teachers, and overall functioning. Impairment is rated on a 7-point Likert scale ranging from 0 (*no impairment*) to 6 (*extreme impairment)*. The IRS has excellent internal consistency, concurrent reliability, and convergent validity with other measures of impairment, as the IRS correlates with behavioral observations and frequency counts of behavior (Fabiano et al., 2006). The overall impairment item was used to examine children's behavioral impairment at home and school (α's = 0.84–0.97 across parent and teacher reports). The IRS has also shown sensitivity to behavioral treatment (Pelham et al., 2005). Consistent with prior work (Hartman, Rhee, Willcutt, & Pennington, 2007), the highest report between parent and teacher report were used for the DBD and IRS.

Data Analytic Plan

All analyses were conducted using SPSS 26. At pre-intervention, there were only two children (<1%) who did not complete the WJ. All other pre-intervention variables had no missing data. For post-intervention, 15 children (6.5%) did not complete the ERU task. Twenty-five children (10.9%) did not complete the WJ or the HTKS task, while their parents/teachers did not complete the rating scales (i.e., the DBD and IRS). All other post-intervention variables had no missing data. Little's Missing Completely at Random (MCAR) test revealed the data were missing at random, $\chi^2 = 165.324$, $p = .119$. There were no significant differences between children with complete versus partial data on demographic variables or any outcomes examined. Multiple imputation was conducted with 20 imputations, which is a sufficient estimate for the given sample size (Rubin, 1987). Nesting models were deemed unnecessary given that each year there were at most only two children recruited from the same classroom. Although this was secondary data analyses on previously collected data, power analyses conducted using G*power estimated a sample size of 205 was needed to detect an effect size as small as .10 (Erdfelder & Buchner, 1996). The data were checked for regression assumptions, skewness and kurtosis, and the influence of any outliers were examined using Cook's distance.

Preliminary analyses were conducted to examine the associations between demographic variables and outcome variables. As research has shown that age can have an effect on ERU (Denham et al., 2012), age was covaried in all analyses. Consistent with prior studies (Mahone et al., 2002), rather than using IQ as a covariate, residual IQ score was used in all analyses (Rapport et al., 2009). Next, a t-test was conducted to see if ERU improved pre- to post-intervention. To test the primary hypotheses, regression analyses were conducted on each outcome. In step 1 of the regression, pre-intervention scores were entered as covariates, along with age and residual IQ. In step 2 of the regression, pre-intervention ERU was entered. Post-intervention ERU scores were entered into step 3 of the regression to examine if change in ERU predicted intervention response within academic, EF, social-emotional, and behavioral domains. We defined intervention response as examining post-intervention scores, controlling for pre-intervention scores, over using a change score as recommended by prior work (Cronbach, & Furby, 1970; Tennant et al., 2019).

Results

Preliminary Analyses

All variables were normally skewed. However, three variables (i.e., pre WJ writing, post WJ writing, post HTKS) had high positive kurtosis values, which can indicate potential outliers. Cook's distance was less than one, indicating that any outliers in the data did not significantly impact the results. Further, the removal of these data points did not significantly impact results and therefore the full data set was used to maximize power. All other regression assumptions were met. There was a significant negative association between child age and the WJ reading composite ($r = -.20$, $p < .01$), indicating that older children did worse on the WJ reading post-intervention. Age was not significantly correlated with the WJ post math or writing composite (see Table 1); however, it is important to note that the composites used are standard scores which are already normed based on age. Age was significantly correlated with post scores on the HTKS (r = .33, p <.001), indicating that older children obtained higher scores on the HTKS task post-intervention. There was also a significant correlation between age and pre- and post-intervention ERU scores (r = .35, r = .24, p <.001, respectively), indicating that older children started and ended the intervention with better ERU. Lastly, age was positively correlated with post scores on the CST prosocial composite (r = .13, p <.05), indicating that older children tended to have better social problem-solving post-intervention.

Correlation analyses revealed significant associations between IQ and post scores on the WJ math composite (r = .53, p <.001), the WJ reading composite (r = .30, p <.001), and the WJ writing composite (r = .45, p <.001). Additionally, IQ was significantly correlated with post HTKS scores (r = .56, p <.001) and the post prosocial composite score (r = .32, p <.001), indicating that children with higher IQ scores at the start of the intervention performed better on the WJ composites, the HTKS task, and the CST task post-intervention. Further, IQ was positively correlated with pre- and post-intervention ERU (r = .43 p <.001 and r = .22, p <.01, respectively), indicating that children with higher IQ started and ended the intervention with better ERU. Given the findings above, all subsequent analyses controlled for child age and residual IQ. No other demographic variables were associated with our variables of interest.

Initial Emotion Knowledge Predicting Intervention Response

Linear regressions were conducted to examine the extent to which initial levels of ERU were associated with measures of EF, academic, social-emotional, and behavioral improvements. It is important to note that ERU significantly improved pre- to post-intervention, t = 14.075, p = <.001, Cohen's d = 1.34.

Academic Achievement and EF

As seen in Table 2, higher levels of ERU at baseline predicted greater improvements on all academic composites and EF. Not surprisingly, pre-intervention WJ (β = .38 – 65) and pre-intervention HTKS scores (β = .51) accounted for a large portion of the variance in each model. Pre-intervention ERU accounted for 2% of improvements in post-treatment WJ reading and writing scores, 3% of improvements in post-intervention WJ math scores, and 4% of improvements on the HTKS. Additionally, change in ERU predicted improvement in EF post-intervention, accounting for 13% of the variance. Change in ERU did not predict response to intervention on any academic composites.

Social Problem Solving

As seen in Table 3, higher initial levels of ERU predicted increases in prosocial responses, indicating that children with greater ERU at pre-intervention experienced greater improvements in social problem-solving post-intervention. Pre-treatment CST scores (β = .42) accounted for a large portion of variance in the overall model. Pre-treatment ERU accounted for 2% of improvements on the CST. Change in ERU did not predict response to intervention to prosocial responses.

Behavioral Symptoms and Impairment

The results for the behavioral symptoms and impairment (see Table 3) indicated that pre-intervention levels of ERU were not associated with parent/teacher reports of hyperactivity, ODD, and overall behavioral impairment. Pre-treatment inattention (β = .32), hyperactivity (β = .34), ODD (β = .28), and overall impairment (β = .29) accounted for a large portion of the variance in each respective model. However, pre-intervention ERU did significantly predict changes in inattentive symptoms, indicating that children who started the intervention with better ERU had decreased inattention symptom severity post-intervention. Pre-intervention ERU accounted for 4% of improvements of inattention symptom severity. In regard to change in ERU, there were no significant findings across any of the behavioral domains, indicating that change in ERU did not significantly impact intervention response for symptoms of ADHD and ODD.

Discussion

ERU is an essential component for children's healthy development across domains of school readiness. Although studies have mostly focused on ERU training and the malleability of ERU (Domitrovich, Cortes, & Greenberg, 2007; Izard et al., 2008), less work has focused on ERU's impact on intervention outcomes. The current study looked to fill this gap by examining how initial levels of ERU and changes in ERU predicted intervention response in a clinical sample of preschoolers following the STP-PreK. Consistent with a multidimensional conceptualization of school readiness (Schmitt, McClelland, Tominey, & Acock, 2015), the current study examined academic, EF, social-emotional, and behavioral outcomes. Results indicated that children who started the intervention with better ERU made greater improvements in academic, EF, and social-emotional functioning, while showing greater decreases in inattentive symptom severity. Although children who participated in the STP-PreK experienced significant behavioral gains (Graziano & Hart, 2016), the current study showed that initial levels of ERU did not predict changes in symptoms of hyperactivity, ODD, or overall impairment. Change in ERU predicted improvements in EF post-intervention but did not significantly predict intervention response across any of the other school readiness domains.

Building on previous work longitudinal work (Ensor et al., 2011), our intervention results showed that greater initial levels of ERU predicted significant improvements in social-emotional functioning, indicating more prosocial and less aggressive responses post-intervention. This is particularly important for children with ADHD as they tend to be significantly less accurate in identifying emotions and social cues (Cadesky, Mota, & Schachar, 2000), with overall social functioning as a predictor of long-term prognosis (Greene, Biederman, Faraone, Sienna, & Garcia-Jetton, 1997). ERU has consistently been shown to predict future aggressive behavior, which in turn has been linked to problem behaviors such as school dropout, callous-unemotional behaviors, substance abuse, and criminal activity (Schuberth et al., 2019). As young children with ADHD often misinterpret social cues and respond aggressively (Denham et al., 2002; Izard et al., 2001), better initial levels of ERU may serve as a protective factor. The increase in children's ability to read social cues may lead to improved social interactions with peers and counselors during the intervention. Additionally, better ERU may give children an advantage in emotionally provoking situations (i.e., situations presented during the CST task), leading to better peer interactions. Although ERU is only a small component of overall social functioning, our results suggest it is an important piece to consider when working with young children with ADHD.

Previous work has also highlighted the importance of children's cognitive functioning (i.e., EF) towards the development of social-emotional competence such as ERU (Denham et al., 2012; Voltmer & von Salisch, 2017). At the same time, better ERU is also related to improved EF (Blankson et al., 2013). The current study is the first, to our knowledge, to demonstrate that initial ERU predicts better cognitive gains (i.e., academics and EF) following intervention. In line with previous work, it may be the case that better or more sophisticated ERU capabilities help facilitate children's cognitive functioning and learning in the classroom via better social interactions with teachers and peers. This is also the first study, to our knowledge, to show that improvements in ERU also predicted improvements in EF post-intervention. Given the close interactive relationship between EF and ERU, it may be that smaller gains in ERU over a shorter period of time are enough to meaningfully impact EF. Conversely, a more sustained period of ERU growth may be needed to predict significant changes across other school readiness outcomes, such as academic achievement. As bidirectional relationships are found at the neural level between cognition and emotion (Pessoa, 2008), future directions should incorporate a bidirectional model to examine how changes in cognitive functioning during interventions may also predict changes in ERU.

Historically, better ERU relates to concurrent lower levels of externalizing behaviors in children (Trentacosta & Fine, 2010). The current study strengthened the literature by examining whether initial ERU and changes in ERU predicted improvements in ADHD/ODD symptoms and impairment following intervention. Consistent with previous research, pre-intervention levels of ERU predicted a lower severity of inattention symptoms post-intervention. This may due to the fact that children with better ERU are more attuned to their teachers and peers, making make it easier for them to pay attention. However, it is important to note that there may be a bidirectional relationship, as individuals with ADHD tend to look less at the face of others for all emotions, with a lack of attention to the face leading to poorer recognition (Airdrie, Langley, Thapar & van Goozen, 2018; Dadds et al., 2006).

Inconsistent with our hypothesis, initial ERU capabilities did not predict changes in symptoms of hyperactivity, ODD, or overall behavioral impairment. This is more in line with findings from Izard et al., (2001) who found ERU capabilities at age five did not significantly predict externalizing problems at age nine. Based on Gross' (1998) emotion generation model, other domains of emotion dysregulation, such as emotional lability and emotion regulation, may have a stronger connection to symptoms of hyperactivity and ODD (Martel & Nigg, 2006). Additionally, other factors commonly targeted in interventions, such as parenting, may have stronger influence on behavioral treatment outcomes, as parenting skills have a robust, consistent link to children's ADHD and ODD symptoms (Deault, 2010). It is also possible that children's initial levels of ERU represent a proxy for not merely early social-emotional functioning but also broader cognitive functioning, which would explain its association with improvements on more cognitively related constructs within the STP-PreK (e.g., academic functioning, EF, attentional functioning).

Finally, while ERU improved from pre- to post-intervention, change in ERU only predicted improvements in EF. As the intervention is only eight weeks in length, it may be the case that not enough time has progressed for the changes in ERU to affect other intervention outcomes. For example, other intervention studies have shown sleeper effects with significant outcomes only seen at the follow-up periods (Bell, Marcus, & Goodlad, 2013). Further, we only assessed ERU pre- and post-intervention, which did not allow us to determine the exact time the change took place. Future research should examine how changes in ERU might impact more long-term intervention outcomes.

Although this is the first study to evaluate how initial ERU and change in ERU relate to intervention outcomes in young children with ADHD, it is not without limitations. First, it is important to point out that a large portion of variance in each model was accounted by each pre-treatment variable (e.g., pre-treatment WJ scores). This points to the stability of some of these constructs as early as preschool (Auerbach, Zilberman-Hayun, Berger, & Atzaba-Poria, 2019; DuPaul, Kern, Caskie, & Volpe, 2015; Harms, Zayas, Meltzoff, & Carlson, 2014). While our findings explain smaller R^2 (.02–.13), they are significant as they demonstrate incremental benefits above the stability of these constructs. This study also had no follow up periods to assess long term maintenance of gains. Given the rapid changes in ERU found in early childhood (Denham et al., 2012), longitudinal data could help disentangle the bidirectional relationship between ERU and school readiness. Although it is important to collect parent and teacher information on symptomology and behavioral impairment, we did not have overt observations of their impairments. Future research should include an objective measure of children's behavioral functioning (e.g., compliance levels). Additionally, 83.5% of our sample identified as Latinx. Even though the ethnic homogeneity limits the generalizability of the results, it is important to note that Latinx children are the fastest growing group the United States and represent the most understudied ethnic minority in mental health research (La Greca, Silverman, & Lochman, 2009). Lastly, although our sample was comprised of low-middle SES families, it is important to acknowledge that about 78% of parents had completed at least some college. As both SES and parent education levels can have an impact on children's ERU (Bennett, Bendersky, & Lewis, 2005; Merz et al., 2015), future work should examine how lower levels of parental education and SES impact children's ERU and subsequent response to intervention.

In terms of clinical implications, the results highlight the importance of assessing ERU within children with ADHD, given its link to a host of school readiness outcomes (Denham et al., 2012; Izard et al., 2001). Particularly, initials levels of ERU in children with ADHD may serve as a barometer for intervention success when targeting EF, social-emotional, and academic functioning. As prior work has shown that children's social dysfunction is a long-term predictor of outcomes (Greene et al., 1997), our work suggests it may be more specifically linked to ERU. Additionally, our results indicate that EF may be more sensitive to changes in ERU than other school readiness outcomes. Given the significant EF deficits children with ADHD experience, our study indicates that ERU is a critical component to consider when working with children with ADHD. Lastly, while ERU appears to be a malleable intervention target (Pons et al., 2019), the extent to which such changes relate to improvements in adaptive functioning remains unclear. It may take a longer period of time for these improvements to be consolidated and have a differential impact on subsequent functioning. As this study had no comparison group, it cannot be ruled out that the improvement in ERU was due to typical development, accounting for the non-significant impact on intervention response, aside from EF. However, a previous STP-PreK randomized trial where only some children received the social-emotional curriculum demonstrated the relative stability of ERU within preschoolers with ADHD (Graziano & Hart, 2016). Only children receiving the STP-PreK with the social-emotional curriculum experienced significant gains in ERU. Further, children assigned to only parent training or the STP-PreK without social-emotional curriculum did not experience significant ERU gains even 6–9 months later.

Additionally, it may be the case that children with greater initial ERU could make similar intervention gains in more cost-effective intervention such as group behavioral parent training (Cunningham et al., 1995; Duncan, MacGillivray & Renfrew, 2017), which does not involve an intensive social-emotional curriculum. Determining which groups of children can benefit most from each intervention component is critical to maximize intervention gains while minimizing cost in the movement towards a more personalized medicine approach. Future work should also examine the interactions between parental factors and ERU in the prediction of long-term outcomes, given that behavioral parent training is the first line of treatment for preschoolers with ADHD (Chronis, Chacko, Fabiano, Wymbs & Pelham, 2004).

In terms of broader school implications, there has been a movement recognizing the importance of social-emotional functioning as part of the preschool and kindergarten curriculum (Maynard et al., 2017). Part of this movement has been towards recognizing the multiple dimensions of school readiness. Although behavioral, attentional, and emotion regulation strategies have been suggested and implemented in some intervention programs (Rosenthal & Gatt, 2010), our results show that even more basic emotional awareness is important to incorporate into school curriculums. Prior to more complex regulation of emotion and social skills training, fundamentally helping kids recognize basic emotions should be the first step. For example, within the STP-PreK curriculum, teachers use puppets along with other engaging activities to teach children about different emotions and social skills (e.g., emotional bingo, emotion of the day, role plays). Similarly, giving parents tools to improve their children’s ERU at home, prior to entering kindergarten, may also aid in improving their school readiness and subsequent functioning in kindergarten. Although this study had no comparison group, it may be the case that improving ERU at the beginning of the school year, for children with ADHD and those without, may help all children make more gains during the academic year

In summary, this study is the first to our knowledge to examine how initial ERU and change in ERU predicted intervention response within a sample of preschoolers with ADHD. Children with greater initial levels of ERU showed greater improvements across academic, EF, and social-emotional domains following the STP-PreK. Although not predictive of all behavior outcomes, initial ERU predicted decreases in inattention symptom severity. Further, improvements in ERU also predicted improvements in EF post-intervention. Thus, the behavioral components of the STP-PreK (e.g., positive reinforcement, rewards, time out) seem to be effective regardless of children's initial level of ERU. Conversely, our results indicated that the academic components of the STP-PreK, along with the self-regulation/social-emotional curriculum, seem to be better received by children who start the intervention already having better ERU. Our findings highlight the important role ERU plays in intervention outcomes for young children with ADHD, indicating the importance of assessing, monitoring, and targeting ERU.

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Table 1

Means, standard deviations, and correlations.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Age													
2. IQ	0.13*												
3. ERU Pre	0.35***	0.43***											
4. ERU Post	0.24***	0.22**	0.56***										
5. WJ Post Math	0.04	0.53***	0.20**	0.14									
6. WJ Post Reading	−0.20**	0.30***	−0.07	0.10	0.64***								
7. WJ Post Writing	−0.10	0.45***	0.11	0.25***	0.66***	0.69***							
8. HTSK Post	0.33***	0.56***	0.41***	0.21**	0.41***	0.10	0.22**						
9. Prosocial Post	0.13*	0.32***	0.12*	0.00	0.20***	0.20**	−0.03	−0.17*					
10. DBD P/T Inattention Post	−0.02	−0.12	0.04	−0.01	−0.04	−0.11	−0.10	−0.03*	−0.17*				
11. DBD P/T Hyperactivity Post	−0.09	0.08	0.07	0.07	0.15*	0.07	0.09	0.10	0.00	−0.76***			
12. DBD P/T ODD Post	−0.09	0.08	0.01	0.05	0.10	0.02	0.07	0.10	−0.02	0.54***	0.65***		
13. IRS P/T Post	0.01	0.02	0.11	0.03	−0.05	−0.07	−0.06	−0.06	−0.08	0.50***	0.50***	0.48***	
M	4.90	91.71	18.85	23.68	94.27	102.04	98.88	28.58	0.74	1.29	1.44	0.78	3.54
SD	0.68	13.99	3.78	3.27	14.66	14.88	54.72	18.75	2.73	0.76	0.76	0.58	1.62

Note. ERU = emotion recognition/understanding, WJ = Woodcock-Johnson Test of Achievement, 3rd Edition, HTSK = head toes knees shoulder task, DBD = Disruptive Behavior Disorders Rating Scale, P/T = highest rating from parent or teacher was used, ODD = oppositional defiant disorder, IRS = Impairment Rating Scale, *M* = mean, *SD* = standard deviation.

*** $p < .001$.

** $p < .01$.

* $p < .05$.

Table 2.

Initial and Changes in ERU Predicting Academic and Executive Functioning

	β	Unstandardized B	T-Test	Model R^2	F Change
WJ Math Composite Post (SS)					
Step 1: Child age	.06	1.88	1.36	.51	84.33***
WJ Math Composite Pre	.38***	.47	7.84		
IQ	.52***	7.57	11.00		
Step 2: ERU Pre	.14**	.68	2.55	.54	4.34*
Step 3: ERU Post	.09	.46	1.70	.54	2.88
WJ Reading Composite Post (SS)					
Step 1: Child age	−.13***	−3.02	−3.22	.62	127.86***
WJ Reading Composite Pre	.65***	.70	15.53		
IQ	.30***	3.10	8.11		
Step 2: ERU Pre	.12**	.47	2.72	.64	7.43**
Step 3: ERU Post	.07	.23	1.33	.64	1.78
WJ Writing Composite Post (SS)					
Step 1: Child age	.10	2.21	1.78	.41	47.40***
WJ Writing Composite Pre	.51***	.48	8.26		
IQ	.22***	3.24	3.58		
Step 2: ERU Pre	.15*	.54	2.12	.43	3.51*
Step 3: ERU Post	.07	.27	.99	.43	.98
HTKS Post					
Step 1: Child age	.05	1.86	.76	.22	22.80***
HTKS Pre	.51***	.77	8.75		
IQ	.11	2.86	1.86		
Step 2: ERU Pre	.13*	.83	1.98	.25	3.93*
Step 3: ERU Post	.44***	2.68	7.74	.39	59.87***

*** $p < .001$,

** $p < .01$,

* $p < .05$.

Note. WJ = Woodcock-Johnson Test of Achievement, 3rd Edition, SS = standardized scores, ERU = emotion recognition/understanding, HTKS = head toes knees shoulder task

Table 3.

Initial and Changes in ERU Predicting Social and Behavior Outcomes

	β	Unstandardized B	T-Test	Model R^2	F Change
Prosocial Composite Post					
Step 1: Child age	.10	.38	1.63	.22	23.32***
Prosocial Composite Pre	.42***	.42	7.09		
IQ	.13*	.37	2.25		
Step 2: ERU Pre	.12***	.08	5.34	.24	2.79*
Step 3: ERU Post	.04	.02	1.62	.24	.04
DBD P/T Inattention Post					
Step 1: Child age	−.11	−.13	−1.63	.12	9.93***
DBD P/T Inattention Pre	.32***	.46	4.96		
IQ	−.08	−.06	−1.18		
Step 2: ERU Pre	−.25***	−.04	−3.66	.16	13.42***
Step 3: ERU Post	−.01	−.00	−.15	.16	.20
DBD P/T Hyperactivity Post					
Step 1: Child age	−.08	−.08	−.92	.16	13.21***
DBD P/T Hyperactivity Pre	.34***	.57	4.23		
IQ	.06	.06	.56		
ERU Pre	.02	.00	.21	.16	.44
Step 2: ERU Post	.10	.02	.83	.17	6.41
DBD P/T ODD Post					
Step 1: Child age	−.10	−.09	−1.19	.09	6.65***
DBD P/T ODD Pre	.28***	.22	3.49		
IQ	.05	.04	.89		
Step 2: ERU Pre	.01	.00	.08	.09	.15
Step 3: ERU Post	.17	.03	.93	.13	17.19
IRS P/T Overall Post					
Step 1: Child age	.00	.03	.19	.10	8.62***
IRS P/T Overall Pre	.29***	.46	4.03		
IQ	.05	−.03	−.13		
Step 2: ERU Pre	.08	.04	1.14	.11	2.28
Step 3: ERU Post	.02	.02	.24	.12	4.80

*** $p < .001$,

** $p < .01$,

*$p < .05$.

Note. ERU = emotion recognition/understanding, DBD = Disruptive Behavior Disorders Rating Scale, P/T = highest parent or teacher rating, ODD = oppositional defiant disorder, IRS = Impairment Rating Scale