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The Association between Self-Regulation and Symptoms of Autism Spectrum Disorder in Preschoolers with Externalizing Behavior Problems

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Abstract
The purpose of the current study was to examine the role of autism spectrum disorder (ASD) and attention-deficit/hyperactivity disorder (ADHD) symptoms in predicting deficits in self-regulation across the domains of executive functioning and emotion regulation. Parents of 40 preschoolers with externalizing behavior problems reported on children's ADHD and ASD symptoms, and emotion regulation. Children completed a standardized executive functioning battery. Results indicated that 28% of parents and 53% of teachers rated children above the subclinical range on ASD symptoms. An interaction emerged such that higher ASD symptoms were only associated with poorer executive functioning for children with lower ADHD symptoms. However, ASD symptoms were predictive of poorer emotion regulation independent of ADHD symptoms. Findings revealed clinically significant ASD symptoms, which aided in explaining heterogeneity in self-regulation deficits.

Keywords Externalizing behavior problems · Autism spectrum disorder · Executive functioning · Emotion regulation · Attention-deficit/hyperactivity disorder

Externalizing behavior problems (EBPs), including aggression, oppositionality, inattention, and hyperactivity, are amongst the most prevalent mental health problems for young children (Keenan and Wakschlag 2000; Polanczyk et al. 2014). Children with EBPs typically experience impairment across a host of functional domains including academic achievement, behavioral adjustment, cognitive functioning (Campbell et al. 2000; Hinshaw 1992; Nigg and Barkley 2014), and social functioning (Nixon 2001). Similarly, children with autism spectrum disorder (ASD), which is marked by significant deficits in social interaction, communication, and restricted/repetitive behaviors, also tend to experience impairments across a host of functional domains (Ozonoff et al. 2007). Given the elevated rates of ASD symptomatology in children with EBPs (Grzadzinski et al. 2011), it is of interest to examine how co-occurring symptoms may aid in explaining pervasive negative outcomes associated with both disorders. Of interest to the current study, self-regulation constitutes a functional domain that is largely implicated in both EBPs and ASD (Graziano and Garcia 2016; Hill 2004; Nigg et al. 2005; Willcutt et al. 2005). Thus, the purpose of the present study was to examine how symptoms of ASD and EBPs are associated with children's self-regulation functioning.

Self-regulation broadly refers to the control of emotions, attention, and actions (Vohs and Baumeister 2004). More recent distinctions have been made between "bottom-up" and "top-down" processes as they relate to the self-regulatory capabilities of children (Martel et al. 2009). Bottom-up processes generally refer to reactive behaviors that do not require conscious effort and typically involve the regulation of emotions which are thought to be mediated by subcortical brain regions (Eisenberg et al. 1996). Conversely, top-down processes typically require a degree of conscious effort and effortful control and typically involve executive functioning skills, which are thought to be mediated by prefrontal brain regions (Nigg and Casey 2005). Both emotion regulation and executive functioning have been found to predict a host of childhood outcomes within the social (Eisenberg et al. 2000; Eisenberg et al. 2010), behavioral (Nolan et al. 2001; Upshur et al. 2009), and academic domains (Blair and Razza 2007; Welsh et al. 2010).

Self-Regulation and EBPs

Previous work has shown that self-regulation may be especially implicated in EBPs such as attention-deficit/

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hyperactivity disorder (ADHD). Within top-down processes, the executive functioning deficits of children with ADHD typically include poor inhibitory control and working memory (Nigg et al. 2002; Sergeant et al. 2002). Meta-analytic reviews have documented moderate effect sizes for executive functioning deficits in children with ADHD, with the largest impairments in response inhibition, vigilance, working memory, and planning (Willcutt et al. 2005). However, a lack of universality and significant heterogeneity of executive functioning deficits for children with ADHD has been documented (Nigg et al. 2005; Willcutt et al. 2005). Significant heterogeneity suggests that perhaps other factors may be contributing to the executive functioning deficits of children with ADHD.

Additionally, deficits in bottom-up processes such as emotion regulation have also been documented through parent reports (Anastopoulos et al. 2011) and observations during laboratory tasks (Melnick and Hinshaw 2000). A recent meta-analysis (Graziano and Garcia 2016) revealed that children with ADHD have the greatest impairments within the domains of emotion reactivity, negativity, and lability. However, as with executive functioning (Nigg et al. 2005), significant heterogeneity exists within the emotion regulation deficits of children with ADHD (Graziano and Garcia 2016).

Self-Regulation and ASD Symptoms

Not surprisingly, self-regulation deficits are not unique to children with EBPs, but are also common across other developmental disorders such as ASD (Hill 2004; Mazefsky et al. 2013). Within the top-down processes, considerable work has documented poor executive functioning in ASD as indexed by poor planning, flexibility, and inhibitory control (Hill 2004). Executive functioning deficits in children with ASD are predictive of later developmental outcomes including social functioning (Leung et al. 2016) and play skills (Faja et al. 2016).

Within the bottom-up processes, less is known about emotion regulation in children with ASD (Mazefsky et al. 2013). Some have urged for a broader focus when examining emotion regulation within children with ASD, as the majority of work has focused on emotion recognition with less work focusing on emotional reactivity (Mazefsky et al. 2012). Nonetheless, studies have documented that children with ASD have higher negative emotionality, poorer emotion recognition (Samson et al. 2012), and poorer ability to regulate negative emotions (Jahromi et al. 2013), even when compared with cognitively matched controls.

Prevalence of ASD Symptoms within EBPs

As both ASD and EBPs are associated with self-regulation deficits, it is important to consider the co-occurrence of these disorders. Indeed, high rates of comorbidity exist between ASD and EBPs, such as ADHD. Although previous iterations of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV; American Psychiatric Association, 2000) restricted the dual diagnosis of ASD and ADHD, considerable data exists suggesting higher levels of ASD symptomatology in children with ADHD compared to other psychiatric controls (Mulligan et al. 2009; Reiersen et al. 2008). Specifically, up to one-third of children with ADHD display clinically significant symptoms of ASD, which have been shown to be independent of behavior problems and reflective of ASD specific symptoms rather than social impairments related to behavioral functioning (Grzadzinski et al. 2011). Giving consideration to ASD symptoms within samples of children with ADHD may be particularly important when determining factors that may contribute to the heterogeneity of self-regulation outcomes within ADHD. Perhaps ASD symptoms, given their impact on self-regulation and co-occurrence with ADHD symptoms, may aid in explaining variability in self-regulatory functioning and may be conceptualized as a further risk factor. For instance, clinical features of ASD, such as elevated repetitive behaviors and poor theory of mind abilities (Ozonoff et al. 2007), may impact children's self-regulation by impacting executive functioning abilities such as cognitive flexibility. Specifically, theory of mind abilities and repetitive behaviors have been associated with performance on executive functioning tasks (Carlson et al. 2004; South et al. 2007).

It may be important to examine not only the extent to which ASD symptoms may explain heterogeneity in self-regulation above ADHD symptoms, but also how ASD and ADHD symptoms may interact to predict outcomes. In other words, it would be of interest to examine the impact of ASD symptoms on self-regulation outcomes for children with varying levels of ADHD symptomatology. For instance, given the association between ADHD symptoms and deficits in self-regulation, concurrent high levels of ASD symptoms may exacerbate said deficits. Alternatively, high levels of ASD symptoms may not predict self-regulation deficits for children with high levels of ADHD symptoms as the robust effects of ADHD on such outcomes may play the largest role. It would be of interest to note whether distinct patterns emerge for top-down versus bottom-up processes as this would aid in the differentiation of self-regulation profiles according to varying patterns of symptomatology.

Importantly, while considerable work has demonstrated elevated rates of ASD symptoms within children with ADHD (Mulligan et al. 2009; Reiersen et al. 2008), most studies have examined these associations in samples of school-aged children and adolescents, with limited work examining concurrent symptomatology during the preschool years. Examining the prevalence of ASD symptoms within a preschool sample of

children with EBPs may be especially important as differential diagnosis is particularly challenging during early childhood. Additionally, while poor agreement has been well documented between teacher and parent reports of ADHD symptoms (Mitsis et al. 2000), no work has examined the concordance of parent and teacher reports of ASD symptoms within samples of children with EBPs.

The Current Study

While self-regulation deficits are prevalent in children with EBPs such as ADHD, significant heterogeneity in both executive functioning and emotion regulation has been documented. ASD symptoms, which often co-occur with ADHD and are associated with deficits in self-regulatory functioning, may be especially valuable in predicting variability in self-regulation outcomes for young children with EBPs. While considerable work has attempted to differentiate self-regulation deficits within independent samples of children with ASD and ADHD (Happé et al. 2006; Sergeant et al. 2002), no studies to our knowledge have examined the additive effects of ASD symptoms above ADHD in predicting the self-regulatory functioning of preschoolers with EBPs. The purposes of the current study were to a) examine what percentage of preschoolers with EBPs exhibit clinically significant ASD symptoms and determine agreement between parent and teacher ratings of ASD symptoms, b) examine whether ratings of ASD symptoms are uniquely predictive of executive functioning and emotion regulation deficits, after accounting for symptoms of ADHD, and c) determine whether ASD and ADHD symptoms interact to predict emotion regulation and executive functioning deficits in preschoolers with EBP. We expected that a significant percent of children with EBP would present with clinically significant levels of ASD symptoms. We also expected ASD symptoms to be positively associated with deficits in emotion regulation and executive functioning beyond symptoms of ADHD. Finally, we expected a significant interaction to emerge in predicting emotion regulation and executive functioning outcomes. Given the independent impacts of ADHD and ASD symptoms on self-regulation outcomes, we expected that the effect of ASD symptoms on outcomes would be significantly stronger for children with high levels of ADHD symptoms, as this would present an additive exacerbation of said deficits.

Method

Participants & Recruitment

The study was conducted at a large urban university in the Southeastern United States with a large Hispanic/Latino population. 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. Eligibility to participate in the study was determined by (a) an externalizing behavior problems t-score of 60 or higher on the parent ($M = 65.64$, $SD = 11.25$) or teacher ($M = 64.55$, $SD = 12.60$) Behavior Assessment System for Children (BASC-2; Reynolds and Kamphaus 2004), (b) enrollment in preschool the previous school-year, (c) an IQ of 70 or higher ($M = 96.73$, $SD = 16.30$) on the Wechsler Preschool and Primary Scale of Intelligence (WPPSI-IV; Wechsler 2012), and (d) ability to attend an 8-week summer program. Children participated in an intake assessment before participation in the summer program to test for inclusion criteria.

The final sample for the current study included 40 preschoolers (77% male) with at-risk or clinically elevated levels of EBP whose parents provided consent to participate in the study and were part of a larger study ($n = 209$). The current study only included children from the most recent cohort whose parents and teachers completed the Autism Spectrum Rating Scale (ASRS; Goldstein and Naglieri 2009) in an effort to collect pilot data on this measure within a preschool EBP sample. The mean age of the participating children was 4.99 years (range 4 to 6 years, $SD = 6$ months) with Hollingshead SES scores in the lower to middle class range ($M = 44.44$, $SD = 12.00$). Further demographic information for this sample is provided in Table 1.

Study Design & Procedure

The study was approved by the university's Institutional Review Board. Recruited children participated in a summer treatment program for pre-kindergartners (STP-PreK). Results

Table 1 Demographics for sample

Characteristic	Percentage in sample
Child Race/ethnicity (%)	
Non-Hispanic/Latino White	7.50
African-American	5.00
Hispanic/Latino	82.50
Other/Biracial	5.00
Family Status (%)	
Intact two-parent household	66.70
Single parent household-divorced/separated	18.00
Single parent household-never married	15.40
Reporter of questionnaires	
Mothers	89.70
Fathers	10.30
Other (grandmother)	0.00

of an open trial and a randomized trial of the STP-PreK are reported elsewhere (Graziano et al. 2014; Graziano & Hart 2016). For the current study only pre-treatment data were utilized to examine the role of the ASD and ADHD symptoms across domains of self-regulation (i.e., executive functioning, and emotion regulation).

As part of the pre-treatment assessment to assess eligibility for participation in the summer program, consenting caregivers brought their children to the clinic on two occasions (e.g., screening visit and enrollment visit). During the screening visit, clinicians administered the WPPSI-IV (Wechsler 2012), while the consenting caregiver completed various questionnaires (e.g., BASC, ASRS, DBD, BRIEF-P and ERC). Preschool teachers also completed various questionnaires. Eligible participants were invited to attend the second laboratory visit for enrollment prior to the start of the summer program, where children were administered the Automated Working Memory Assessment (AWMA; Alloway et al. 2004).

Screening Measures

Externalizing Behavior Problems To assess children's behavioral functioning, parents and teachers completed the Behavior Assessment System for Children-Second Edition (BASC-2; Reynolds and Kamphaus 2004). Each item on the BASC-2 is rated on a 4-point scale with respect to the frequency of occurrence (never, sometimes, often, and almost always). The measure yields scores on broad internalizing, externalizing, and behavior symptom domains as well as specific adaptive/social functioning skills scales. The BASC-2 has well-established internal consistency, reliability and validity (Reynolds and Kamphaus 2004). The externalizing behavior problems composite, which assesses symptoms of hyperactivity, aggression, and conduct problems, was used as the primary screening measure (current sample $\alpha = .90$ for parents & .92 for teachers).

Intelligence Children were administered the Wechsler Preschool and Primary Scale of Intelligence –Fourth Edition (WPPSI-IV; Wechsler 2012) at the pre-treatment assessment. Core subtests (i.e., block design, information, matrix reasoning, bug search, similarities, and picture memory) were administered by trained graduate students and research assistants, under the supervision of a licensed clinical psychologist, and used to calculate a full-scale IQ.

ASD & ADHD Symptoms

ASD Symptoms Parents and teachers were asked to complete the Autism Spectrum Rating Scale-Short Form (ASRS; Goldstein and Naglieri 2009) to assess for the presence of ASD symptoms. Parents and teachers completed the short form for children between 2 and 5 years of age which includes 15 items reflecting *DSM-5* updated symptoms of ASD across domains of social interaction/communication and unusual behaviors. Each item on the ASRS is rated on a 5-point scale with respect to the frequency of occurrence (never, rarely, occasionally, frequently, and very frequently). Studies have demonstrated good reliability and validity for the ASRS (Goldstein et al. 2012). Additionally, the standardization sample for the ASRS included a large proportion of children with ADHD (Goldstein et al. 2012). For the purposes of this study the total raw score on the ASRS was used (current sample $\alpha = .76$ for parents & .83 for teachers).

ADHD Symptoms ADHD symptomatology for study analyses was measured using a continuous symptom rating scale. Specifically, parents and teachers were asked to complete the Disruptive Behavior Disorder Rating Scale (DBD; Pelham et al. 1992). Each symptom of ADHD and ODD on the DBD rating scale is rated on a 4-point scale with respect to the frequency of occurrence (not at all, just a little, pretty much, or very much), with individual scores per symptom ranging from 0 to 3. For the purposes of this study the mean rating for ADHD symptoms (hyperactivity/impulsivity and inattention) was used with higher scores indicating higher mean frequency of symptoms (current sample $\alpha = .90$ for parents & .91 for teachers).

Measures of Self-Regulation

Executive Functioning Standardized Assessment Children were individually administered four subtests from the AWMA (Alloway et al. 2004). The AWMA is a PC-based assessment of working memory skills for children and adults ages 4 through 22. Four subtests were chosen for inclusion in the present battery because of their ease of comprehension for young children and lack of reliance on (previously learned) academic information (e.g., recall of numbers). 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 asked to repeat back a progressively longer series of one and two-syllable words, in order. In the Listening Recall task, children are first asked to judge the validity of a sentence (true/false) and then asked to recall the last word in the sentence. During the Dot Matrix task, children are presented with a series of dots presented on a 4 X 5 grid, and asked to recall the spatial location of each dot, sequentially. During the Mister X task, children are presented with two similar cartoon figures each holding a ball in one hand. One of the figures is rotated between 45 and 315 degrees. Children are first asked to make a judgment about the spatial orientation of the figures (i.e., "Are they holding a ball in the same or different hands?")

and are then asked to recall the location of the rotated figure's ball from six possibilities. Raw scores are converted to standard scores using gender and age norms. The AWMA has adequate test–retest reliability (.76–.81; Tracy Packiam Alloway et al. 2006) and has demonstrated discriminant validity by distinguishing children with exclusive difficulties in working memory from children with disruptive behavior problems on behavioral rating scales of working memory function (e.g., BRIEF; Gioia et al. 2003) and academic measures (WISC-IV fluid intelligence; de Abreu et al. 2010). To reduce the number of analyses and given the high correlations among the four subtests (rs .42–.70, $p < .001$), an average standardized score was calculated and used in subsequent analyses with higher scores indicating better executive functioning.

Executive Functioning Parent/Teacher Reports Parents and teachers completed the Behavior Rating Inventory of Executive Functions-Preschool Version (BRIEF-P; Gioia et al. 2003). The parent and teacher versions contain 63 items rated on a 3-point Likert scale (never, sometimes, and often), which yield five non-overlapping but correlated clinical scales (inhibit, shift, emotional control, working memory, and plan-organize). The BRIEF-P has well-established internal consistency, reliability and validity (Isquith et al. 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 our parent and teacher measure of executive functioning (current sample $\alpha = .92$ for parents & .93 for teachers). Higher scores indicate poorer executive functioning skills.

Emotion Regulation Parents and teachers completed the Emotion Regulation Checklist (ERC; Shields and Cicchetti 1997). The ERC is a 23-item questionnaire that uses a 4-point Likert scale (1 = almost always to 4 = never) and yields two subscales: the Negativity/Lability scale (15 items), which represents negative affect/mood lability, and the Emotion Regulation scale (eight items), which assesses processes central to adaptive regulation. For the present study, a composite z-score was calculated to include the emotion regulation scale and the reversed negativity/lability scale (current sample $\alpha = .71$ for parents & .80 for teachers).

Data Analysis Plan

All analyses were conducted using the Statistical Package for the Social Sciences version 20.0 (SPSS 20). There were no missing data for the standardized executive functioning assessment and there was only one participant missing data on parent reports. However 8 participants were missing data on teacher reports. According to Little's Missing Completely at Random Test there was no evidence to suggest that the data were not missing at random ($\chi 2\ (27) = 27.22\ p = .45$). All available data were used for each analysis. Preliminary analyses examined the extent to which parent and teacher reports of ASD and ADHD symptoms were related to any demographic variables. Hierarchical regressions were conducted to examine the unique effect of ASD symptoms on self-regulation measures after accounting for ADHD symptoms. Lastly, an interaction between ASD symptoms and ADHD symptoms was tested within the final step of each regression.

Results

Preliminary Analyses

Descriptive statistics for all variables are presented in Table 2. Preliminary correlations revealed a moderate association between parent reported and teacher reported ASD symptoms ($r = .43$, $p < .05$) such that children rated by parents as having higher symptoms of ASD were also reported by teachers as having higher symptoms of ASD. Parent rated ADHD symptoms were also significantly correlated with teacher rated ADHD symptoms ($r = .40$, $p < .05$). However, neither parent nor teacher rated ADHD symptoms were associated with either parent rated or teacher rated ASD symptoms (r range: −.05–.17, p range: .30–.80). Of interest, 28% of the sample had parent rated ASRS raw scores above 21 which corresponds to a t-score of 60, suggesting subclinical or at-risk levels of ASD symptoms. Fifty-three percent of the sample had teacher rated ASRS scores within or above the subclinical range.

Analysis of demographic variables revealed no significant associations between demographic variables (child age, sex, ethnicity, SES, or IQ) and parent or teacher reported ASD or ADHD symptoms. Thus, demographic variables were not entered as covariates in subsequent analyses.

Teacher Rated ASD Symptoms & Self-Regulation

Separate regression analyses were conducted to determine the unique effect of ASD symptoms on self-regulation measures (executive functioning based on the AWMA and parent/teacher reports, and parent teacher reports of emotion regulation). ADHD symptoms based on the DBD rating scale were entered on the first step, and ASRS scores were entered on the second step to examine the unique effect of ASD symptoms. An interaction between ADHD symptoms and ASD symptoms were entered on a final step.

Executive Functioning As seen in Table 3, teacher rated ASD symptoms significantly predicted scores on the AWMA ($\beta = -.42$, $p < .01$) after accounting for ADHD symptoms. These

Table 2 Descriptive statistics

	M	*SD*	Sample Min-Max	Measure Range
Diagnostic Symptoms				
ASRS ASD Symptoms (P)	17.00	7.07	7–36	0–60
ASRS ASD Symptoms (T)	20.69	12.15	0–48	0–60
DBD ADHD Symptom Mean (P)	1.45	.60	.33–2.72	0–3
DBD ADHD Symptom Mean (T)	1.48	.71	.22–2.78	0–3
Executive Functioning				
AWMA Standard Score (O)	90.61	16.25	50–124	50–160
BRIEF Emergent Metacognition Problems T-Score (P)	71.23	13.80	44–101	30–110
BRIEF Emergent Metacognition Problems T-score (T)	65.94	13.81	41–90	30–110
Emotion Regulation				
ERC (P)	1.00	.34	.37–1.77	−3 - 3
ERC (T)	.95	.53	−.46–1.71	−3 - 3

P parent report, *O* observed measure, *T* teacher report. *AWMA* Automated working memory assessment, *DBD* disruptive behavior disorder scale, *ASRS* autism spectrum rating scale, *BRIEF* behavior rating inventory of executive functioning-preschool version, *ERC* emotion regulation checklist

findings suggest that children with more ASD symptoms tended to perform worse on the executive functioning assessment. However, teacher rated ASD symptoms were not predictive of parent or teacher rated emergent metacognitive problems on the BRIEF (β = −.04, $p = .83$; β = .26, $p = .09$, respectively).

Table 3 Model for predicting self-regulation from teacher reported autism & ADHD symptoms

	β (*p*-value)	*T*-value	Model R^2	ΔR^2	ΔF	N
Executive Functioning: AWMA (SS)						
Step 1. DBD ADHD Symptom Mean (T)	.25 (.17)	1.42	.06	.06	2.01	32
Step 2. ASRS ASD Symptoms (T)	**−.42 (.02)**	−2.52	.23	.17	6.37**	
Step 3. ASD X ADHD	.07 (.66)	.44	.24	.01	.19	
Executive Functioning: BRIEF Emergent Metacognition Problems (P)						
Step 1. DBD ADHD Symptom Mean (T)	−.11 (.57)	−.58	.01	.01	.33	32
Step 2. ASRS ASD Symptoms (T)	−.04 (.83)	−.22	.01	.00	.05	
Step 3. ASD X ADHD	−.10 (.62)	−.51	.02	.01	.25	
Executive Functioning: BRIEF Emergent Metacognition Problems (T)						
Step 1. DBD ADHD Symptom Mean (T)	**.58 (<.001)**	3.94	.34	.34	15.52***	32
Step 2. ASRS ASD Symptoms (T)	.26 (.09)	1.76	.42	.06	3.11	
Step 3. ASD X ADHD	.12 (.43)	.80	.42	.01	.64	
Emotion Regulation: ERC (P)						
Step 1. DBD ADHD Symptom Mean	−.28 (.12)	−1.58	.08	.08	2.51	32
Step 2. ASRS ASD Symptoms (T)	−.34 (.06)	−1.94	.19	.11	3.75	
Step 3. ASD X ADHD	.12 (.51)	.67	.20	.01	.45	
Emotion Regulation: ERC (T)						
Step 1. DBD ADHD Symptom Mean (T)	**−.38 (.03)**	−2.24	.15	.15	5.02*	32
Step 2. ASRS ASD Symptoms (T)	**−.47 (.004)**	−3.10	.37	.22	9.58**	
Step 3. ASD X ADHD	−.16 (.29)	−1.09	.39	.03	1.18	

Significant Beta values are bolded with respective *p*-values

*** $p < .001$, ** $p < .01$, * $p < .05$. *SS* standardized score, *P* parent report, *T*teacher report, *AWMA* automated working memory assessment, *DBD* disruptive behavior disorder scale, *ASRS* autism spectrum rating scale, *BRIEF*behavior rating inventory of executive functioning-preschool version, *ERC* emotion regulation checklist

Emotion Regulation Lastly, teacher rated ASD symptoms were predictive of teacher rated emotion regulation on the ERC (β = −.47, $p < .01$) after accounting for ADHD symptoms. These findings suggest that children with higher levels of ASD symptoms were rated by teachers as having worse emotion regulation. However, teacher rated ASD symptoms were not predictive of parent rated emotion regulation on the ERC (β = −.34, $p = .06$).

Parent Rated ASD Symptoms & Self-Regulation

Executive Functioning As seen in Table 4, neither parent rated ASD nor ADHD symptoms were predictive of performance on the AWMA (β = −.27 & -.06 $p = .10$ & .71, respectively). However a significant interaction between parent rated ADHD symptoms and ASD symptoms emerged (β = .39, $p < .05$; see Fig. 1). Probing of the interaction revealed that ADHD symptoms moderated the association between ASD symptoms and performance on the AWMA such that high ASD symptoms were only associated with poorer executive functioning performance for children with low levels of ADHD symptoms ($b = -1.62$, $t = 3.08$, $p < .01$). ASD symptoms did not play a significant role in predicting executive functioning performance for children with high levels of ADHD symptoms ($b = .08$, $t = .20$, $p = .84$).

While parent rated ADHD symptoms were positively associated with parent rated emergent metacognitive problems on the BRIEF (β = .51, $p < .01$), ASD symptoms did not significantly increase variance explained (β = .04, $p = .77$). Additionally, neither parent rated ASD nor ADHD symptoms were predictive of teacher rated emergent metacognitive problems (β = .11 & .19, $p = .59$ & .31, respectively).

Emotion Regulation Lastly, parent rated ASD symptoms were not predictive of teacher rated emotion regulation on the ERC(β = −.19, $p = .34$) nor parent rated emotion regulation on the ERC (β = −.27, $p = .10$) after ADHD symptoms were accounted for.

Discussion

The purpose of the current study was to first examine rates of ASD symptoms within preschoolers with EBP and secondly to determine whether such ratings of ASD were uniquely predictive of self- regulation deficits, after accounting for symptoms of ADHD. Previous work has examined ASD symptoms within school aged children with ADHD (Mulligan et al. 2009; Reiersen et al. 2008) and attempted to differentiate self-regulation across diagnoses (Happé et al. 2006; Sergeant

Table 4 Model for predicting self-regulation from parent reported autism & ADHD symptoms

	β (*p*-value)	*T*-value	Model R^2	ΔR^2	ΔF	*N*
Executive functioning: AWMA (SS)						
Step 1. DBD ADHD Symptom Mean (P)	−.06 (.71)	−.37	.004	.004	.14	39
Step 2. ASRS ASD Symptoms (P)	−.27 (.10)	−1.69	.08	.07	2.85	
Step 3. ASD X ADHD	**.39 (.02)**	2.49	.22	.14	6.22*	
Executive Functioning: BRIEF Emergent Metacognition Problems (P)						
Step 1. DBD ADHD Symptom Mean (P)	**.51 (.001)**	3.63	.26	.26	13.20**	39
Step 2. ASRS ASD Symptoms (P)	.04 (.77)	.29	.27	.00	.09	
Step 3. ASD X ADHD	.01 (.10)	.05	.27	.00	.00	
Executive Functioning: BRIEF Emergent Metacognition Problems (T)						
Step 1. DBD ADHD Symptom Mean (P)	.19 (.31)	1.04	.04	.04	1.07	32
Step 2. ASRS ASD Symptoms (P)	.11 (.59)	.54	.05	.01	.30	
Step 3. ASD X ADHD	−.04 (.83)	−.22	.05	.00	.05	
Emotion Regulation: ERC (P)						
Step 1. DBD ADHD Symptom Mean (P)	−.30 (.07)	−1.89	.09	.09	3.58	39
Step 2. ASRS ASD Symptoms (P)	−.27 (.10)	−1.71	.16	.07	2.92	
Step 3. ASD X ADHD	.24 (.14)	1.52	.21	.05	2.32	
Emotion Regulation: ERC (T)						
Step 1. DBD ADHD Symptom Mean (P)	.20 (.28)	1.11	.04	.04	1.22	32
Step 2. ASRS ASD Symptoms (P)	−.19 (.34)	−.97	.07	.03	.95	
Step 3. ASD X ADHD	.09 (.65)	.46	.08	.01	.21	

Significant Beta values are bolded with respective *p*-values

** $p < .01$, * $p < .05$. *SS* standardized score, *P* parent report, *T* teacher report, *AWMA* automated working memory assessment, *DBD* disruptive behavior disorder scale, *ASRS* autism spectrum rating scale, *BRIEF* behavior rating inventory of executive functioning-preschool version, *ERC* emotion regulation checklist

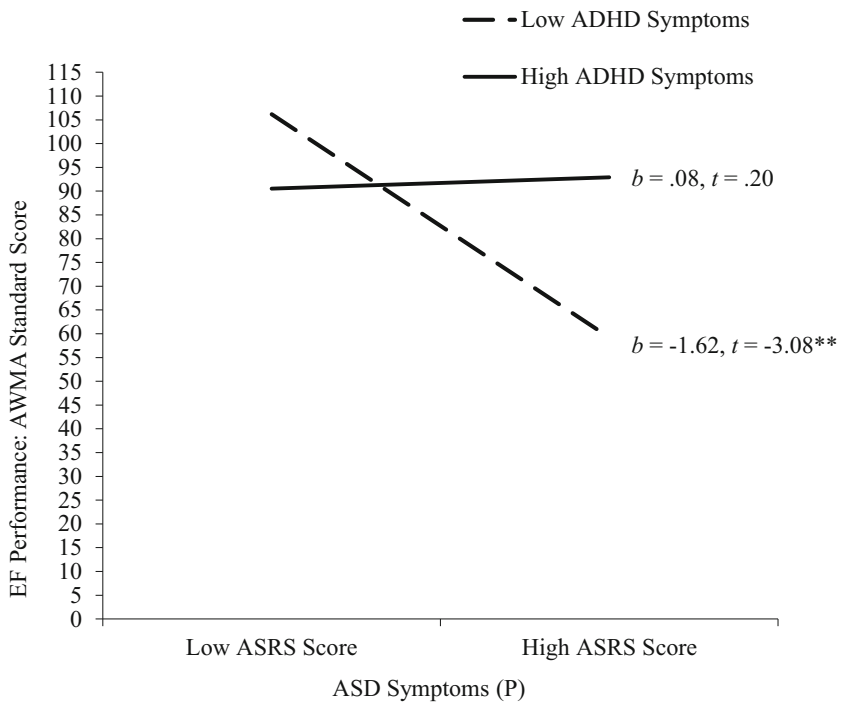

Fig. 1 Interaction between Parent Reported ADHD Symptoms and ASD Symptoms in Predicting Executive Functioning. EF = executive functioning, ASRS = Autism Spectrum Rating Scale, AWMA = Automated Working Memory Assessment.. P = parent report. ** $p < .01$.

et al. 2002). However, limited work has explored the additive effect of ASD symptoms above ADHD in predicting the self-regulatory functioning of preschoolers with EBPs. Results of the current study revealed clinically significant symptoms of ASD within preschoolers with EBPs. Importantly, symptoms of ASD were predictive of both executive functioning and emotion regulation deficits even after accounting for symptoms of ADHD. Implications of these results are discussed in further detail below.

Consistent with previous studies (Grzadzinski et al. 2011), about one-third of children in our sample with EBP were rated by parents as having elevated symptoms of ASD. Interestingly, higher ratings of ASD symptoms were obtained when examining teacher reports, as about 50% of the sample was rated by teachers as having elevated symptoms of ASD. Increased teacher perceptions of ASD may be attributable to heightened insight into social dysfunction often captured by ASD symptoms, which may present more overtly in classroom settings where more opportunities for peer interactions exist (Downer et al. 2010). Studies validating ASD screeners in population samples also tend to report elevated levels of ASD symptoms when relying solely on teacher reports rather than combined reports (Posserud et al. 2006).

With regard to our second study aim, main effects of ASD and ADHD symptoms on executive functioning were qualified by an interaction. Of note, neither parent nor teacher rated ADHD symptoms were individually associated with executive functioning performance, which may have been due to the restricted range in ADHD symptoms given the nature of our clinical sample. While numerous studies have documented differences in executive functioning *between* children with ADHD and typically developing children (Willcutt et al. 2005), considerable work has also documented significant heterogeneity in executive functioning *within* ADHD samples (Nigg et al. 2005). Given the clinical nature of our sample, it is more likely that heterogeneity in executive functioning was better explained by the association between ADHD symptoms and other clinical factors, such as ASD symptoms. Indeed, and contrary to our hypotheses, parent rated ASD symptoms were only predictive of performance on the executive functioning task for children with lower levels of ADHD symptoms, whereas ASD symptoms did not explain unique variance for children with high levels of ADHD symptoms. These findings highlight the robust effect of heightened levels of ADHD symptoms on top-down processes such as executive functioning skills that may not be further exacerbated by ASD symptoms as we hypothesized. Specifically, executive functioning skills involve processes such as working memory and inhibitory control, which may be more strongly implicated by symptoms of inattention and impulsivity/hyperactivity (Barkley 1997). The unique contribution of ADHD symptoms has also been supported by studies documenting executive functioning deficits in preschoolers are primarily associated with symptoms of ADHD and not symptoms of other disruptive behaviors disorders (Thorell and Wåhlstedt 2006). Interestingly, results also highlight that for children with lower levels of ADHD symptoms, ASD symptoms predicted executive functioning performance suggesting that ASD symptoms may explain heterogeneity in executive functioning when ADHD symptoms are lower, even within a clinical sample.

Within the bottom-up processes, teacher rated ASD symptoms were predictive of poorer teacher rated emotion regulation. These findings suggest that perhaps ASD symptoms may exacerbate emotion regulation deficits implicated with high levels of ADHD symptoms. For instance, features often implicated in children with ASD, including behavioral rigidity, poor emotion recognition, and poor theory of mind, may differentially exacerbate emotion regulation deficits. Specifically, emotion recognition and theory of mind abilities impact social communicative abilities necessary for the development of emotion regulation skills (Laurent and Rubin 2004).

There are limitations to the current study that should be noted. Primarily, the sample was relatively small and inclusion criteria for the current study limited heterogeneity in ASD symptoms as children with a primary diagnosis of ASD were excluded. Perhaps within a larger and more heterogeneous community sample of children with ADHD, higher levels of comorbid ASD symptoms may exist. In fact, large population-based studies have documented high levels of comorbidity in children with ADHD (Rosenberg et al. 2011). It will also be important for future work to examine the association between ASD and ADHD symptoms within more clinical samples of children with ASD in order to more fully understand the association between self-regulatory functioning and symptomatology. Relatedly, an additional limitation of the current study was the limited heterogeneity in ADHD symptoms. Although interactions implicated "high" versus "low" levels of ADHD symptoms, these distinctions may have been biased as all children in the sample had heightened levels of EBP. Perhaps in a non-clinical sample, more variability between "high" and "low" levels of ADHD symptoms would yield more clinically meaningful distinctions between groups.

Nonetheless, a strength of the current study to consider is the ethnic composition of the sample as the majority of families enrolled identified as Hispanic/Latino. Notably, Hispanic/Latino children represent the fastest growing and most understudied ethnic minority within mental health research (La Greca et al. 2009). Given the documented rates of later ASD diagnosis in Hispanic/Latino children (Valicenti-McDermott et al. 2012), it may be important to consider the prevalence rates of ASD symptoms within preschoolers presenting with EBP.

Theoretical implications that may be drawn from the current study suggest that while ASD symptoms aid in explaining heterogeneity in self-regulation deficits of children with EBP, symptoms differentially relate to top-down versus bottom-up processes. Specifically, top-down processes (i.e., executive functioning) are not exacerbated by ASD symptoms but rather more heavily influenced by ADHD symptoms. Conversely, bottom-up processes (i.e., emotion regulation) are more heavily influenced by ASD symptoms. In terms of clinical implications, results revealed that significant symptoms of ASD exist within young children with EBP, suggesting that social communication deficits are prominent within this population. While previous work has documented significant impairment within social functioning for children with EBP (Eisenberg et al. 2001; Koblinsky et al. 2006; Ros and Graziano 2017), results of the current study reveal that said social impairments may in fact represent more clinically significant deficits comparable to the pervasive social deficits characteristic of ASD. With regard to young children, preschool teachers report that about half of children with EBP are not prepared for the kindergarten transition (West et al. 2001). Social communication deficits, perhaps captured by ASD symptoms, may contribute to lack of readiness for school in preschoolers with EBP. Thus, more work should focus on remediating social communicative difficulties in children with EBP as current efforts have lacked efficacy in remediating social impairments within this population. Clinical implications also suggest more attention should be placed on training teachers to identify and differentiate between symptoms of ASD and EBP. Given the differentially high rates of teacher reported ASD symptoms found in the current study and previous work (Posserud et al. 2006), early intervention efforts should incorporate more training and professional development opportunities for early childhood teachers focused on the prevalence and symptomology of developmental disorders.

Summary

In summary, the current study revealed the impact of ASD symptoms on self-regulation in young children with EBP. Specifically, the clinically significant levels of ASD symptoms among this population illustrate alarming social deficits for preschoolers with EBP. Importantly, ASD symptoms play a role in both the executive functioning and emotion regulation skills beyond symptoms of ADHD suggesting a unique role of social communicative deficits on self-regulation. Future work should expand these findings to examine the stability of these associations in response to behavioral treatments aiming to improve self-regulation in young children.

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Compliance with Ethical Standards

Conflict of Interest Rosmary Ros, Della Gregg, Katie C. Hart, and Paulo A. Graziano declare that they have no conflicts of interest.

Ethical Approval All procedures performed involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participant's parents included in the study.

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