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Temperamental negative affect, emotion-specific regulation, and concurrent internalizing and externalizing pathology among children with ADHD

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Abstract

Children with attention-deficit/hyperactivity disorder (ADHD) experience high rates of temperamental negative affect and comorbid internalizing and externalizing pathology. The current study explored the role of emotion-specific regulation in accounting for the link between temperamental negative affect and psychopathology among children with ADHD. Forty parents of children ages 8–11 ($N=29$ males, $N=11$ females) completed measures of child temperament, emotion-specific dysregulation (i.e., anger dysregulation, sadness dysregulation), and psychopathology. Children completed a measure of emotion-specific dysregulation. Results revealed that anger dysregulation fully statistically accounted for the relationship between temperamental negative affect and concurrent externalizing problems. Sadness dysregulation did not account for the relationship between temperamental negative affect and internalizing problems. These novel findings implicate the robust role of anger dysregulation in explaining the link between temperamental negative affect and concurrent externalizing pathology. The results of this study have significant implications for the treatment of emotionally driven externalizing behavior among children with ADHD.

Keywords ADHD · Emotion regulation · Temperament · Internalizing problems · Externalizing problems

ADHD and comorbidity

Attention-deficit/hyperactivity disorder (ADHD), a neurodevelopmental disorder characterized by core symptoms of inattention, hyperactivity, and impulsivity, is one of the most prevalent childhood disorders, affecting approximately 5% of children (APA 2013). Although diagnostic criteria primarily capture deficits in core inattention and hyperactive/impulsive symptoms, children with ADHD experience a host of negative outcomes including deficits in academic, social, and emotional functioning, and higher rates of comorbid internalizing and externalizing problems (Wilens et al. 2002). Emerging research has increasingly identified the importance of comorbid psychopathology on the functioning of children with ADHD, as children with ADHD and internalizing and/or externalizing problems experience poorer overall functioning, increased utilization of health and education services, greater family conflict, more problems with academic performance, and greater social impairment (Larson et al. 2011). A range of correlates are hypothesized to relate to comorbid psychopathology among children with ADHD including genetic, biological, environmental, and sociocultural factors (Pfiffner et al. 2005; Thapar et al. 2001).

Temperament and ADHD

One biological factor that has been explored extensively in the child psychopathology literature is temperament. Temperament encompasses individual dispositional differences in emotional, motor, and attentional reactivity and regulation (Rothbart 2007). Studies suggest temperament is present in infancy, moderately stable throughout the lifespan, predictive of internalizing and externalizing problems in

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childhood, and related to psychopathology in adulthood (Keenan 2000; Nigg 2006). Thus, examination of temperament may prove useful to understand the development of internalizing and externalizing problems in youth. Rothbart (2012) has conceptualized temperament in middle childhood and early adolescence as composed of three dimensions: surgency, negative affect, and effortful control. Surgency is comprised of high intensity pleasure, lack of shyness, and reduced fear, and captures novelty-seeking tendencies. Children high in trait surgency are often characterized as uninhibited/impulsive, exuberant, and high in activity level (Dollar and Stifter 2012). Effortful control, a measure of one's ability to utilize attentional and inhibitory control to inhibit a dominant, prepotent response, has been studied widely as a measure of executive attention (Rothbart et al. 2003). Research has indicated negative affectivity, a trait encompassing frustration, depressive mood, and aggression, is highly predictive of both internalizing and externalizing problems (Oldehinkel et al. 2004). Indeed, trait negative affectivity has emerged as one of the strongest predictors of psychopathology in childhood (Mikolajewski et al. 2013).

Research investigating temperamental profiles in children with ADHD is emerging. The most consistent finding in the literature is that children with ADHD exhibit deficits in effortful control, displaying poor inhibitory control and poor executive attention (Martel 2009; Nigg 2006). This is not surprising, given ADHD has been theorized to involve deficits in executive functioning and behavioral inhibition through dysregulated frontal–striatal circuits and delayed cortical maturation (Shaw et al. 2007; Tripp and Wickens 2009). However, there have been mixed findings regarding the relation of ADHD to the other temperament dimensions, particularly surgency and negative affect. Some studies comparing children with ADHD to controls have revealed between-group differences in surgency and negative affect suggesting children with ADHD exhibit higher rates of negative affect and surgency compared to controls (Cho et al. 2008; Foley et al. 2008). However, studies examining within-group differences among children with ADHD have failed to find differences in surgency (De Pauw and Mervielde 2011) or negative affectivity in subsets of children with ADHD (Karalunas et al. 2014). Thus, temperamental negative affect may be present in some but not all children with ADHD. Indeed in one recent, notable study of children with ADHD, several typologies of temperament were theorized (Karalunas et al. 2014, 2018). An "irritable typology" characterized by high *negative affectivity*, reduced amygdala-insula connectivity, and "a doubling of risk onset of new behavioral or emotional disorders" (Karalunas et al. 2014, 2018) was theorized. The "irritable typology" was contrasted to a "mild ADHD typology" (i.e., only core ADHD deficits) and a "surgent typology" characterized high approach-motivation and activity level (Karalunas et al. 2014, 2018). These results indicated trait negative affectivity and comorbid internalizing and externalizing disorders constitute a specific subset of children with ADHD. Research suggests that negative affectivity and high emotional arousal may predispose individuals to exhibit a poor emotion regulation capacity (Bradley 2000). These findings indicate the potential role of emotion regulation, particularly, regulation of negative arousal that may arise from temperamental negative affectivity, in leading to the development of internalizing and externalizing problems in youth.

The role of emotion regulation

Emotion regulation describes multidimensional processes (e.g., physiological, neurobiological, cognitive, behavioral) whereby individuals attempt to modify the intensity, valence, and duration of emotions in order to adapt to environmental demands and influence goal-directed behavior (Cole et al. 2004; Thompson 1994). Emotion dysregulation occurs when one or more of the multidimensional processes are disrupted (Zeman et al. 2006). Research suggests a subset of children with ADHD experience elevated and impairing rates of emotion dysregulation (Shaw et al. 2014). Behaviorally, children with ADHD and emotion dysregulation present as emotionally reactive and impulsive, experience more intense levels of both positive and negative emotions (e.g., frustration, irritability, exuberance), exhibit greater lability of negative emotions, and display deficits in emotional awareness and competence (Bunford et al. 2015; Jensen and Rosen 2004; Sobanski et al. 2010). Numerous methods have been used to assess emotion dysregulation in youth including utilization of respiratory sinus arrhythmia as an index of physiological emotion dysregulation (Leaberry et al. 2018; Musser et al. 2013) and use of observational assessments to assess emotional expression and regulatory abilities (Carter et al. 2000). Several well-validated parent- and child-report measures have been developed to assess the behavioral dimension of emotion regulation including the Emotion Regulation Checklist (Shields and Cicchetti 1997), and the Emotion Regulation Questionnaire for Children and Adolescents (Gullone and Taffe 2011). Research has utilized parent-report measures and observational tasks to assess the behavioral dimension of emotion regulation for youth in middle childhood, likely because of the limitations of child report of emotional competence (Owens et al. 2007) and the difficulties of assessing cognitive emotion regulation processes (i.e., catastrophizing, rumination) at this developmental stage (Woolley et al. 2004).

Research suggests emotion regulation is a significant risk factor for the development of internalizing and externalizing pathology in youth (McLaughlin et al. 2011; Steinberg and Drabick 2015). Emotion regulation has been assessed most

readily through utilization of broad-based measures that capture the regulation of a variety of emotional valences (e.g., sadness, anger, irritability, frustration, worry, etc.; Bunford et al. 2015; Shields and Cicchetti 1997). However, studies have indicated that children more prone to anger and frustration exhibit high rates of externalizing pathology, whereas children more prone to sadness primarily exhibit internalizing pathology (Eisenberg et al. 2004). Although yet to be explored, it is possible that dysregulation of specific emotions (e.g., sadness versus anger dysregulation) may represent a *specific risk* for the development of internalizing versus externalizing pathology among children with ADHD, such that sadness dysregulation may serve as a specific risk factor for internalizing pathology while anger dysregulation may confer specific risk for externalizing pathology. Utilizing measures that assess behavioral emotion regulation processes more specifically, such as the Children's Emotion Management scales (Zeman et al. 2001), which assess the regulation of sadness and anger separately, may shed further light on which emotion systems (i.e., anger versus sadness) may present risk for internalizing versus externalizing pathology. More research is needed to investigate this; however, it is evident that emotion dysregulation may serve as another factor associated with the development of internalizing and externalizing problems among children with ADHD.

Research suggests emotion regulation may promote adaptive coping (Troy and Mauss 2011) while emotion dysregulation may lead to maladaptive modulation of arousal and poor coping, which may increase risk for the development of psychopathology (Carthy et al. 2010). Although yet to be explored among childhood ADHD populations, studies examining the link between temperament and emotion regulation in youth with depression have suggested temperamental negative affectivity may result in ineffective use of emotion regulation strategies, which may increase risk for depressive symptomatology (Yap et al. 2007). Additionally, research conducted in preschool samples has indicated high trait-level negative affect (e.g., anger, frustration) and low regulatory abilities increase risk for externalizing behavior problems (Eisenberg et al. 2004); however, this has not been investigated in an older (i.e., middle childhood, young adolescence) sample of children. Exploring the relationship between temperament, emotion regulation, and psychopathology in *childhood* is an area of research that is greatly needed, given childhood is a critical developmental period for the ability to regulate various negative emotions (Zeman et al. 2006).

It is possible that emotion regulation may partially explain the relationship between temperamental negative affectivity and internalizing and externalizing behavior problems among children with ADHD. Temperamental negative affectivity is strongly implicated in the development

of internalizing and externalizing problems (Scheper et al. 2017); however, this may in part be influenced by emotion regulation capacity. Although research examining the link between temperament and emotion regulation in children is still in the early stages of development, studies have suggested temperamental negative affect is related to deficient emotion regulation (e.g., maladaptive use of emotion regulation strategies; Jaffe et al. 2010; Yap et al. 2007, 2011). Emotion dysregulation, examined broadly, has emerged in the literature as a transdiagnostic factor that confers risk for both internalizing problems (e.g., anxiety) and externalizing problems (e.g., aggression; Henry et al. 2016; McLaughlin et al. 2011). Given research suggesting children exhibit internalizing versus externalizing pathology that is dependent upon the nature of emotional impairments (i.e., sadness versus anger; Eisenberg et al. 2004), emotion-specific regulation processes (i.e., sadness-specific versus anger-specific emotion dysregulation) may partially explain the link between temperamental negative affect and internalizing and externalizing problems.

Current study

Few studies have explored the association between temperamental negative affectivity, emotion-specific regulation processes, and internalizing and externalizing pathology among children with ADHD, despite evidence of higher rates of temperamental negative affect and emotion dysregulation among children with ADHD and co-occurring emotional and behavioral problems (Karalunas et al. 2014, 2018). This may be in part because some studies have viewed temperament, emotion regulation, and psychopathology as overlapping constructs that exist on a spectrum rather than distinct independent constructs (Rettew and Mckee 2005; Tackett 2006). However, vulnerability theoretical models have separated these constructs by positing that temperamental traits such as reactivity and effortful control predispose children to exhibit specific emotional responses (i.e., poor emotion regulation capacity; Zalewski et al. 2011). Thus, temperament is distinguished from emotion regulation because temperamental traits are individual differences in reactivity, affect, and self-regulation, while emotion regulation is a set of strategies or response modulation processes that a child utilizes to regulate affect and reactivity (Zalewski et al. 2011). A child high in trait negative affect with poor effortful control regulatory abilities may be predisposed to react rather than employ adaptive emotion regulation strategies to regulate negative affect and arousal, whereas a child lower in negative affect with higher effortful control abilities may have a tendency to employ strategies to modulate emotional responses. Furthermore, internalizing and externalizing problems can be distinguished from temperamental characteristics and

emotion regulation responses because these are the behavioral or emotional symptoms (e.g., rule-breaking behavior, withdrawn behavior) that ensue as a result of predisposing characteristics (e.g., tendency to display negative affect) and emotional responses patterns (e.g., maladaptive regulation of arousal). Although research suggests that there is some overlap between temperament and internalizing and externalizing pathology constructs, studies have revealed that a significant relationship still exists between temperament and psychopathology even when removing confounding items (Lemery et al. 2002). In sum, studies have suggested temperament, emotion regulation, and psychopathology are correlated, but distinct theoretical constructs (Zalewski et al. 2011). There is great utility in exploring the relationship between these constructs within in ADHD sample, given the need to identify transdiagnostic factors that may serve as the target of interventions for youth with ADHD who display comorbid internalizing and/or externalizing pathology.

Externalizing problems such as oppositionality and defiance are among the most common presenting problems of youth who present for psychosocial treatment (Hattatoglu and Mustafa 2014). Although externalizing pathology is often targeted in the treatment of youth with ADHD through use of behavioral therapy, there is limited evidence that treatment gains are maintained over time (Jensen et al. 2007; Molina et al. 2009). It may be important to identify potential mechanisms that may inform the development of novel treatments that lead to sustained treatments gains for youth with ADHD who present with internalizing and/or externalizing pathology. Thus, the purpose of the current study was to investigate the relationship between temperamental negative affect, emotion-specific (i.e., sadness regulation, anger regulation) regulatory processes, and psychopathology among children with ADHD to posit a theoretical model of internalizing and externalizing problem development among youth with ADHD and to identify potential factors that may inform the development of novel treatment interventions.

The authors posited several hypotheses:

1. Among children with ADHD, both temperamental negative affect and anger dysregulation would independently be related to externalizing problems. Further, the authors hypothesized a significant indirect effect of negative affect to externalizing problems through anger-specific dysregulation whereby greater temperamental negative affect would only be significantly related to externalizing problems in the presence of greater anger-specific dysregulation.
2. Among children with ADHD, both temperamental negative affect and sadness dysregulation would independently be related to internalizing problems. Further, the authors hypothesized a significant indirect effect of negative affect to internalizing problems through sadness-

specific dysregulation whereby greater temperamental negative affect would only be significantly related to internalizing problems in the presence of greater sadness-specific dysregulation.

Methods

Participants

Forty male ($n=29$) and female ($n=11$) children ages 8–11 years (M age $=9.38$, SD$=1.03$) with ADHD were recruited for the current study. The current study served as a preliminary investigation of temperament in youth with ADHD. All families in the current study were recruited through advertisements distributed through local elementary schools in a Midwestern metropolitan area specifically targeting children with ADHD. All children met criteria for either ADHD-Combined Presentation ($n=27$, 67.5%), ADHD-Predominantly Inattentive Presentation ($n=12$, 30%), or ADHD-Predominantly Hyperactive/Impulsive Presentation ($n=1$, 2.5%). Twenty-eight children (70%) were receiving medication treatment for ADHD while participating in the current study. The demographic breakdown of participants was 30 Caucasian (75%), 4 African-American (10%), 3 Latino/Hispanic (7.5%), and 3 Biracial (7.5%), which is reflective of the area from which the population was drawn (U.S. Census Bureau 2010).

Procedures

Parents and children provided informed consent and assent for participation in the study. All study procedures were approved by the institutional review board. All participants received a free ADHD diagnostic evaluation screening; thus, other assessments were completed that were not included in the current study. Parents and children completed the interview, assessments, and questionnaires in a 3-h assessment period. For the current study, the Diagnostic Interview Schedule for Children-Parent (DISC-P; Shaffer et al. 2000) was administered to parents to assess child ADHD status. Additionally, parents completed the Vanderbilt ADHD-Diagnostic Rating (VADPRS; Wolraich et al. 1998, 2003) scale to provide another measure of ADHD symptoms. The Vanderbilt ADHD Teacher Rating Scale (VADTRS; Wolraich et al. 1998, 2003) was sent to each child's primary teacher to assess for teacher report of ADHD symptoms. Children were diagnosed with ADHD if they met criteria for ADHD on the DISC-P and at least one other measure of ADHD (i.e., VADPRS or VADTRS). Parents and children separately completed the parent- and child-report Children's Emotion Management Scales (Zeman et al. 2001) to assess regulation of anger and sadness. Parents also completed the

Early Adolescent Temperament Questionnaire (Capaldi and Rothbart 1992; Ellis and Rothbart 2001) to assess temperamental negative affectivity and the Child Behavior Checklist (Achenbach and Rescorla 2001) to assess for internalizing and externalizing problems. Parents and children were provided with small gift cards for study participation.

Measures

Diagnostic Interview Schedule for Children—Parent (DISC-P; Shaffer et al. 2000). The DISC-P is a fully structured diagnostic clinical interview utilized to assess for the presence of child psychiatric diagnoses according to the Diagnostic and Statistical Manual of Mental Disorders (4th ed; DSM-IV; APA 1994) criteria. The DISC-P was used to assess ADHD diagnostic status according to parent report of diagnostic symptom occurrence across multiple settings (i.e., home, school) and degree of impairment from symptoms. For the purpose of the current initial investigation, only the ADHD module of the DISC-P was administered. The current study did not assess for the presence of comorbid disorders. Research supports the validity and reliability of the DISC-P across numerous settings (Shaffer et al. 2000). The DISC-P demonstrates good inter-rater reliability for parent report of ADHD symptom counts (ICC = .84) and criterion counts (ICC = .77; Shaffer et al. 2000). See Shaffer et al. (2000) for a more thorough review of the psychometric properties of the DISC-P.

Vanderbilt ADHD Parent and Teacher Rating Scales (VADPRS and VADTRS; Wolraich et al. 1998, 2003). The Vanderbilt ADHD Rating Scales assess for the presence of ADHD according to the DSM-IV criteria. The first 18 items of both parent and teacher report measures include items assessing for ADHD inattentive and hyperactive/impulsive symptoms. Parents and teachers rate the frequency of symptoms on a Likert scale ranging from 0 "never" to 3 "very often." Symptoms are considered significant for ADHD if they are rated as a 2, occurring "often" or 3, occurring "very often." Research supports the reliability and validity of the ADHD subscales of the VADPRS and VADTRS in both research and clinical settings (Wolraich et al. 2003). For the two factors (inattention, hyperactivity/impulsivity) coefficient alphas range from .72 to .85 (Wolraich et al. 2003).

Early Adolescent Temperament Questionnaire—Revised (EATQ; Capaldi and Rothbart 1992; Ellis and Rothbart 2001). The EATQ is a 62-item parent-report questionnaire utilized to assess several child temperamental dimensions. Parents rate the extent to which a number of statements describe their child on a 5-point Likert scale ranging from 1 "almost always untrue of your child" to 5 "almost always true of your child." Exploratory factor analysis has revealed four scales: effortful control, surgency, affiliativeness, and negative affect. Numerous methodologies have been utilized

to calculate negative affect. Several studies have calculated negative affect by compositing frustration, depressive mood, and aggression subscales (Ellis 2002; Hoffmann et al. 2017), whereas other studies have composited fear and frustration subscales to calculate negative affect (Clark et al. 2015; Muris and Meesters 2009). Given the authors interest in examining the relationship between temperamental negative affect and anger versus sadness-specific emotion regulation, the first methodology, compositing frustration, depressive mood, and aggression subscales was implemented. However, given the overlap between the aggression subscale items of the EATQ (e.g., slams doors when angry) and anger dysregulation items of the CEMS (e.g., my child does things like slam doors when they are mad), the aggression subscale was not utilized in the calculation of negative affect. Instead, only frustration and depressive mood subscales were composited to provide a measure of temperamental negative affect that would not be confounded by the overlap of aggression between constructs. The frustration subscale includes items that capture negative affect related to the interruption of ongoing tasks or goal blocking such as "is annoyed by little things other kids do, gets very irritated when someone criticizes him/her, gets irritated when I will not take her/him someplace s/he wants to go, hates it when other people don't agree with him/her," etc. The depressive mood scale includes items that capture the tendency to exhibit unpleasant affect and lowered mood such as, "often does not seem to enjoy things as much as his/her friends, is sad more often than other people realize, sometimes seems sad even when s/he should be enjoying him/herself like at Christmas, or on a trip," etc. The revised EATQ has been validated for use in children ages 8–15 and has demonstrated good internal consistency and test–retest stability. Coefficient alphas on negative affect scales in previous studies have ranged from .71 to .76 (Capaldi and Rothbart 1992; Ellis and Rothbart 2001; Muris and Meesters 2009). For the current study, the coefficient alpha for the negative affect subscale was comparable to previous studies ($\alpha = .73$).

Children's Emotion Management Scales—Parent and Child report (CEMS; Zeman et al. 2001). The CEMS consists of an 11-item Anger scale and a 12-item Sadness scale to assess parent and child report of anger symptoms and sadness symptoms. Parents and children respond on a 3-point Likert scale: 1 (*hardly ever*), 2 (*sometimes*), 3 (*often*). The parent and child report Dysregulated Anger Expression and Dysregulated Sadness Expression scales were utilized for the current study to assess parent and child report of anger and sadness dysregulation. The child-report and parent-report scales were composited to create a single anger dysregulation score and a single sadness dysregulation score to permit multiple informant report of emotion dysregulation. The CEMS scales provide an assessment of the behavioral dimension of emotion regulation. The Dysregulated Anger

Expression scale assesses ineffective regulation and maladaptive expression of anger (e.g., parent: "my child does things like slam doors when they are mad"; child: "I do things like slam doors when I am mad") while the Dysregulated Sadness Expression scale assesses ineffective regulation and maladaptive expression of sadness (e.g., parent: "My child whines/fusses about what's making them sad"; child: "I whine/fuss about what's making me sad"). The construct validity of the factors has been validated in several studies. For each individual emotion management scale, coefficient alphas range from .62 to .77 and test–retest reliability ranges from .61 to .80 (Zeman et al. 2001, 2002; Suveg and Zeman 2010). Chronbach's alpha was $\alpha = .80$ for the composited anger dysregulation scale and $\alpha = .59$ for the composited sadness dysregulation scale.

Child Behavior Checklist (CBCL; Achenbach and Rescorla 2001). The CBCL is a 113-item parent-report measure of children's socioemotional and behavioral functioning that yields two composites (internalizing problems and externalizing problems). The Internalizing Problems scale is composed of anxious/depression, somatic problems, and withdrawn concerns subscales. These include symptoms such as "feels he/she has to be perfect, feels worthless or inferior, is withdrawn, has nightmares, feels dizzy or lightheaded," etc. The Externalizing Problems scale is composed of aggressive behavior and rule-breaking behavior subscales. These include behavioral symptoms such as "doesn't seem guilty after misbehaving, breaks rules at school, home, or elsewhere, cruelty, bullying, or meanness to others, destroys his/her own things," etc. The CBCL-Internalizing and CBCL-Externalizing scales were used in the current study to assess child internalizing and externalizing problems. The CBCL has demonstrated high test–retest reliability and good internal consistency. In previous studies, the coefficient alpha on the internalizing and externalizing problem scales was .90 and .94 (Achenbach and Rescorla 2001). In the current study Chronbach's alpha was $\alpha = .90$ for the externalizing problems scale and $\alpha = .78$ for the internalizing problems scale.

Statistical analysis

Results of the evaluation of assumptions indicated adequate normality, linearity, and homoscedasticity of residuals. No univariate or multivariate outliers emerged. There were 2 cases of missing data on the CBCL-externalizing variable and 1 case of missing data on the CBCL-internalizing variable. Missing data were excluded listwise by analysis. Means and standard deviations of each variable appear in Table 1. Bivariate Pearson's correlations were conducted to examine the correlation between temperamental negative affect, anger and sadness dysregulation, and internalizing and externalizing problems. Temperamental negative affect was significantly positively correlated with both the anger

Table 1 Means and standard deviations of temperament, emotion dysregulation, and internalizing and externalizing problems variables

Variable	Mean (SD)	Range	n
EATQ-NA	32.33 (5.63)	19–43	40
Sad Dysreg	5.65 (1.46)	3–9	40
Ang Dysreg	5.23 (1.48)	3–8.5	40
CBCL Int	9.92 (6.04)	0–25	39
CBCL Ext	14.42 (8.57)	0–32	38

EATQ-NA Early Adolescent Temperament Questionnaire—Negative Affect, *CBCL* child behavior checklist

Table 2 Bivariate Pearson's correlations between temperament, emotion dysregulation and internalizing and externalizing problems

	Sad dysreg	Ang dysreg	CBCL Int	CBCL Ext
EATQ-NA	.49**	.48**	.50**	.48**
Sad Dysreg		.39*	.21	.36*
Ang Dysreg			.42**	.67**
CBCL Int				.50**

EATQ-NA Early Adolescent Temperament Questionnaire—Negative Affect, *CBCL* child behavior checklist

*$p < .05$; **$p < .01$

dysregulation composite ($r = .48$, $p = .002$) and the sadness dysregulation composite ($r = .49$, $p = .001$), and with both internalizing problems ($r = .50$, $p = .001$) and externalizing problems ($r = .48$ $p = .002$). Children rated by parents as experiencing higher temperamental negative affect had higher anger and sadness dysregulation and higher internalizing and externalizing problems. Sadness dysregulation was significantly positively correlated with anger dysregulation ($r = .39$, $p = .013$) and externalizing problems ($r = .36$, $p = .028$), but not internalizing problems ($r = .21$, $p = .19$). Anger dysregulation was positively correlated with both internalizing ($r = .42$, $p = .007$) and externalizing problems ($r = .67$, $p < .001$). Correlations appear in Table 2.

Results

An indirect effect analysis was conducted using ordinary least squares path analysis in IBM SPSS Statistics version 25 using the PROCESS macro (Hayes 2012) to examine the relationship between temperamental negative affect, emotion dysregulation (i.e., anger versus sadness dysregulation) and internalizing versus externalizing problems. The first model estimated the effects of temperamental negative affect on externalizing problems directly as well as indirectly through anger dysregulation. The influence of the antecedent variable (X), temperamental negative

affect, on the proposed indirect effect variable (M), anger dysregulation, and the consequent variable (Y), externalizing problems, was examined. Child sex (Male/Female), age, and ADHD medication status (Yes/No) were entered into the model as covariates. Model coefficients appear in Table 3. Covariates were non-significant at every step of the model. However, the covariate, sex, was trending toward significance in the prediction of externalizing problems ($\beta = 4.84$, $p = .06$; see Table 3). Results indicated that temperamental negative affect was a significant predictor of anger dysregulation (a path, $\beta = .13$, SE $= .04$, $p = .007$). In turn, anger dysregulation was a significant predictor of externalizing problems (b path, $\beta = 3.54$, SE $= .79$, $p < .001$), while controlling for temperamental negative affect. A bias-corrected bootstrap confidence interval for the indirect effect (ab, $\beta = .45$) based on 10,000 bootstrap samples was entirely above zero (.07 to 1.11). The direct effect of temperamental negative affect on externalizing problems was not significant (c path, $\beta = .09$, SE $= .22$, $p = .69$) with anger dysregulation in the model, indicating that no direct effect of temperamental negative affect on the estimation of externalizing problems existed independent of its indirect effect through anger dysregulation. Thus, anger dysregulation fully statistically accounted for the relationship between temperamental negative affect and externalizing problems such that the data were best fit by an indirect effect of temperamental negative affect on externalizing problems through anger dysregulation.

This model explained 56% of the variance in externalizing problems. This relationship is depicted in Fig. 1a.

The second model estimated the effects of temperamental negative affect on internalizing problems directly as well as indirectly through sadness dysregulation. The influence of the antecedent variable (X), temperamental negative affect, on the proposed indirect effect variable (M), sadness dysregulation, and the consequent variable (Y), internalizing problems, was examined. Child sex (Male/Female), age, and ADHD medication status (Yes/No) were entered into the model as covariates. Covariates were non-significant in every step of the model. Results indicated that temperamental negative affect was a significant predictor of sadness dysregulation (a path, $\beta = .14$, SE $= .04$, $p = .002$). However, sadness dysregulation was not a significant predictor of internalizing problems (b path, $\beta = -.05$, SE $= .70$ $p > .05$). Temperamental negative affect was a significant predictor of internalizing problems ($\beta = .41$, SE $= .19$, $p = .04$). However, given the lack of significant association between sadness dysregulation and internalizing problems, no further indirect effects analyses were conducted.

Alternate model testing

Given the cross-sectional nature of the current study, an alternate model was tested to examine whether the data were well fit with the anger dysregulation and externalizing pathways reversed. The influence of the antecedent

Table 3 Direct and indirect effects of independent variables on outcome variables and significance of indirect effect models
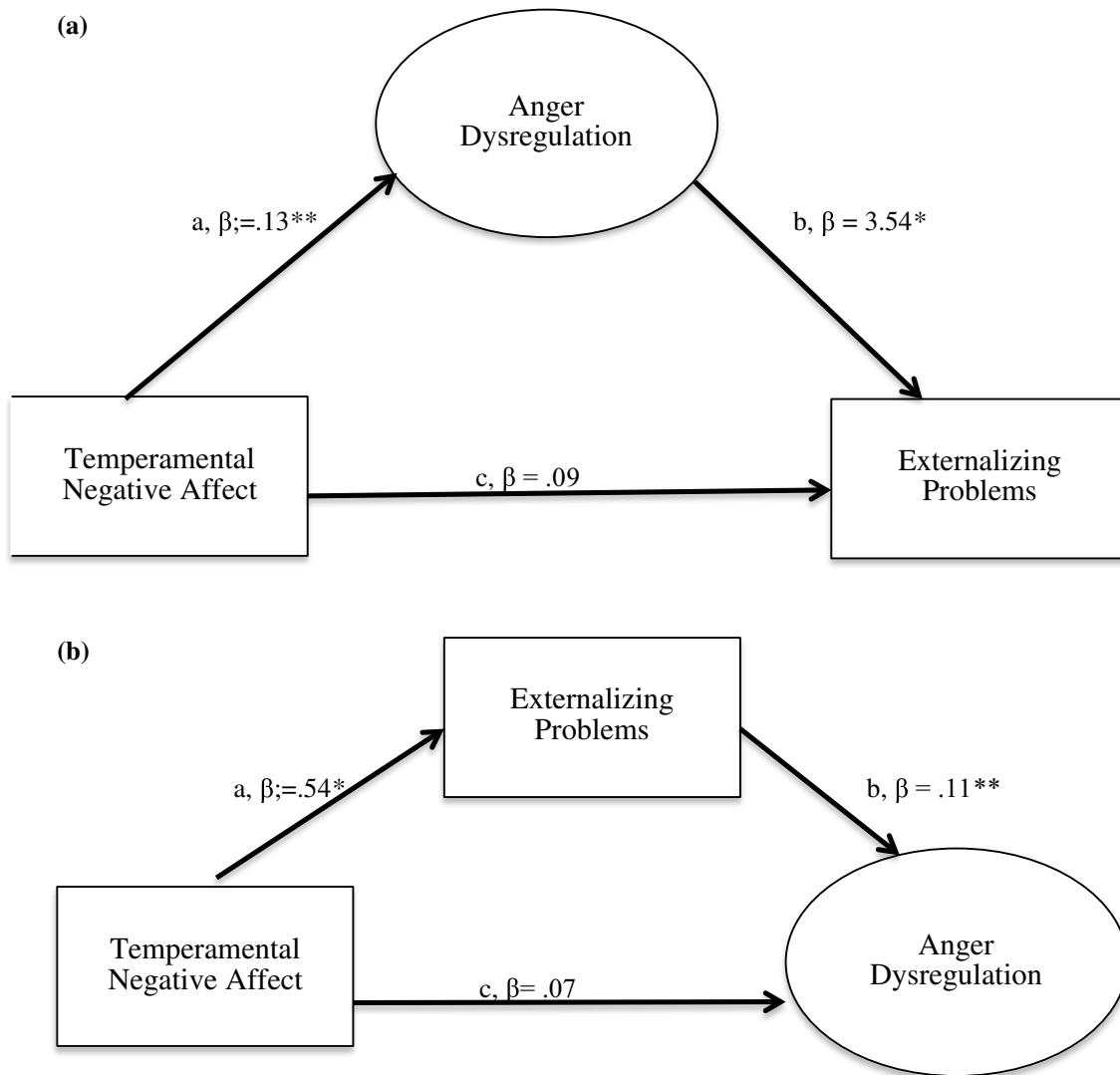
Model 1	M (Ang Dysreg)			Y (CBCL Ext)		
Antecedent	Coeff.	SE	p	Coeff.	SE	p
X (EATQ-NA)	0.13	0.04	.007	0.09	0.22	0.69
M (Ang Dys)	–	–	–	3.54	0.79	< .001
Constant	1.27	2.54	0.62	−11.16	11.59	0.34
Sex	−.58	0.52	0.28	4.84	2.43	0.06
Age	−.01	0.22	0.96	0.20	1.00	0.85
Meds	−.01	0.58	0.99	4.86	2.65	0.08
Model 2	M (CBCL Ext)			Y (ang Dysreg)		
Antecedent	Coeff.	SE	p	Coeff.	SE	p
X (EATQ-NA)	0.54	0.25	.04	0.07	0.04	0.08
M (CBCL Ext)	–	–	–	0.11	0.02	< .01
Constant	−6.66	14.49	0.65	1.99	2.03	0.33
Sex	2.78	3.00	0.36	−.88	0.42	0.05
Age	0.16	1.25	0.90	−.03	0.17	0.88
Meds	4.89	3.33	0.16	−.53	0.48	0.27

$R^2 = .28$; $F(4, 33) = 3.14$; $p = .03$

$R^2 = .56$; $F(5, 32) = 8.25$; $p < .001$

$R^2 = .29$; $F(4, 33) = 3.40$; $p = .02$

$R^2 = .55$; $F(5, 32) = 7.93$; $p < .001$

(a)

a, β;=.13**

b, β = 3.54*

Anger
Dysregulation

Temperamental
Negative Affect

c, β = .09

Externalizing
Problems

(b)

Externalizing
Problems

a, β;=.54*

b, β = .11**

Temperamental
Negative Affect

c, β= .07

Anger
Dysregulation

Fig. 1 **a** A model exploring indirect effects of temperamental negative affect on externalizing problems among children with ADHD through anger-specific emotion regulation. **b** A model exploring indirect effects of temperamental negative affect on anger dysregulation among children with ADHD through externalizing problems. *$p < .05$; **$p < .01$; anger dysregulation is a composited, latent construct

variable (X), temperamental negative affect, on the alternate proposed indirect effect variable (M), externalizing problems, and the consequent variable (Y), anger dysregulation, was examined. Child sex (Male/Female), age, and ADHD medication status (Yes/No) were entered into the model as covariates. Model coefficients appear in Table 3. Covariates were non-significant at every step of the model. However, the covariate, sex, was trending toward significance in the prediction of anger dysregulation ($\beta = -.88$, $p = .05$; see Table 3). Results indicated that temperamental negative affect was a significant predictor of externalizing problems (a path, $\beta = .54$, SE $= .25$, $p = .04$). In turn, externalizing problems were a significant predictor of anger dysregulation (b path, $\beta = .11$, SE $= .02$, $p < .001$), while controlling for

temperamental negative affect. A bias-corrected bootstrap confidence interval for the indirect effect (*ab*, $\beta = .06$) based on 10,000 bootstrap samples was entirely above zero (.01 to .11). The direct effect of temperamental negative affect on anger dysregulation was not significant (c path, $\beta = .07$, SE $= .04$, $p = .08$) with externalizing problems in the model, indicating that no direct effect of temperamental negative affect on the estimation of anger dysregulation existed independent of its indirect effect through externalizing problems. Thus, externalizing problems fully statistically accounted for the relationship between temperamental negative affect and anger dysregulation. This model explained 55% of the variance in anger dysregulation. This relationship is depicted in Fig. 1b. In sum, the results suggested that the data could

be fit by either the proposed model or the alternative model. Each model explained an equal amount of variance in the outcome variables externalizing problems (i.e., model 1 explained 56% of the variance in externalizing problems) and anger dysregulation (i.e., model 2 explained 55% of the variance in anger dysregulation).

Discussion

The current study demonstrated that anger-specific emotion dysregulation fully accounted for the relationship between temperamental negative affect and concurrent externalizing problems among children with ADHD. As hypothesized, children high in temperamental negative affect experienced greater anger dysregulation, and in turn, children with greater anger dysregulation had more externalizing problems. However, the previously significant direct path between temperamental negative affect and externalizing problems was non-significant once anger dysregulation was entered into the model, indicating temperamental negative affect exerted an indirect effect on externalizing problems through anger dysregulation. Interestingly, this effect was unique to anger-specific dysregulation and externalizing problems. Sadness-specific emotion dysregulation did not account for the relationship between temperamental negative affect and internalizing problems. These novel findings implicate that anger dysregulation may explain the link between temperamental negative affect and concurrent behavioral functioning.

Alternate model testing results indicated externalizing problems also explained the relationship between temperamental negative affect and concurrent anger dysregulation. Children high in temperamental negative affect exhibited greater externalizing problems, and in turn, children with greater externalizing problems had higher anger dysregulation. Given the cross-sectional nature of the current study, a causal, temporal relationship between anger dysregulation and externalizing problem constructs could not be established. However, previous longitudinal research examining emotion regulation and externalizing problems (e.g., aggression) in youth has established a temporal relationship between emotion regulation and aggression such that, emotion dysregulation is related to increased aggression over time, but aggression does not predict increased emotion dysregulation over time (McLaughlin et al. 2011). Preliminary findings from the current study indicating anger dysregulation fully accounted for the relationship between temperamental negative affect and externalizing problems demonstrate the robust role of emotion regulation in linking temperamental negative affect to externalizing problems. The findings that externalizing problems also explain the link between temperamental negative affect and anger

dysregulation may indicate that externalizing problems further exacerbate deficits in anger dysregulation among children with ADHD or may reflect the dynamic relation of anger and externalizing behavior. However, it is equally likely that externalizing problems precede the development of deficient anger dysregulation. The temporal relationship cannot be ascertained and further longitudinal research is needed to explore this given the preliminary, cross-sectional nature of the current study. Despite the need for further longitudinal research, the current preliminary study takes an important first step in identifying potential mechanisms linking temperamental negative affect to psychopathology among youth with ADHD.

Implications

Theoretical implications These results have significant implications for research investigating the role of emotion regulation on the behavioral functioning of children with ADHD. Previous research suggests greater temperamental negative affect and irritability contributes to increased risk for comorbid emotional and behavioral disorders among children with ADHD (Karalunas et al. 2014, 2018). It would appear that among children with ADHD, difficult temperament alone does not uniquely estimate concurrent externalizing problems. Rather, temperamental negative affect may predispose children with ADHD to deficient emotion regulation. When this dysregulation specifically occurs with regard to anger, there is a greater risk of co-occurring externalizing problems. Indeed, previous studies suggest temperamental negative affect is associated with frustration and heightened physiological arousal and reactivity (Oldehinkel et al. 2004; Santucci et al. 2008). Heightened frustration and reactivity in turn impairs the ability to effectively regulate anger expression. Increased expression of negative emotions such as anger experienced concurrently with heightened arousal may thus lead to a diminished ability to inhibit impulses and utilize adaptive emotion regulation strategies to reduce arousal, which may in turn result in anger-driven externalizing behavior. Thus, the results of this study lend support to previous findings that externalizing behaviors often arise as a result of expression of dysregulated negative emotion and emotional undercontrol (Nigg 2006; Southam-Gerow and Kendall 2002). Emotional undercontrol is likely exacerbated among children with ADHD who exhibit deficits in effortful control regulatory processes, disinhibition, and impulsivity (Eisenberg et al. 2010; Nigg 2006).

Interestingly, in the current study, temperamental negative affect was correlated with both sadness dysregulation and internalizing problems independently; however, sadness dysregulation did not predict internalizing problems. Thus, emotion dysregulation did not account for the relationship

between temperamental negative affect and internalizing problems. Previous research has differentiated children with internalizing versus externalizing problems based on emotion regulation deficits. Whereas children with externalizing problems exhibit greater emotional disinhibition and emotional undercontrol (Southam-Gerow and Kendall 2002), studies suggest children with internalizing problems experience a reactive, overcontrolled pattern of emotion regulation characterized by frequent use of maladaptive cognitive emotion regulatory strategies such as blaming and rumination (Garnefski et al. 2005). Thus, overregulation rather than dysregulation of negative emotion may contribute to the development of internalizing problems.

Research by Eisenberg et al. (2010) has indicated children with internalizing difficulties experience emotional overcontrol in that they exhibit more rigid, inhibited behavior; however, they argue this pattern of emotional overcontrol is reactive rather than volitional. Difficulties regulating attentional control, as opposed to deficits in inhibitory control characteristic of children with externalizing problems, are theorized to lead to the development of internalizing problems (Eisenberg et al. 2010). Although not explored in the current study, it is possible that children with ADHD and comorbid internalizing problems experienced greater difficulties with attentional control (rather than behavioral control), which may in turn, predispose this subset of children to reactive cognitive overcontrol of emotions and subsequent internalizing difficulties. The lack of assessment of cognitive emotion regulation may partially explain null findings in the current study that sadness dysregulation was not related to internalizing problems among children with ADHD. The measure used to assess for emotion dysregulation in the current study did not assess for cognitive emotion regulatory strategies. The sadness dysregulation measure demonstrated poor internal consistency in the current study, which likely limited the validity of this measure. Additionally, the internalizing problem outcome variable includes symptoms of both depression and anxiety (e.g., nervousness, shyness, worry, unhappy, sad); thus, internalizing problems may be better predicted by a general negative affect temperamental factor rather than an emotion-specific factor (e.g., sadness dysregulation). Examining specific emotion regulatory deficits (i.e., emotional disinhibition versus cognitive regulation or attentional control) and emotional overcontrol versus undercontrol among children with ADHD is an area of research that is much needed as this would shed light on factors related to the development of comorbid internalizing and externalizing problems, both of which are highly prevalent in this population.

Clinical implications The current study highlights the need for novel emotion regulation focused assessment and treatment interventions for children with ADHD and behavior problems. Although, previous research indicates a subset of children with ADHD experience significant and impairing levels of emotion dysregulation (e.g., 25–45%; Shaw et al. 2014), deficits in emotion regulation are not considered in the diagnostic criteria for ADHD (APA 2013). Additionally, the efficacy of cognitive-behavioral or emotion regulation focused treatments have yet to receive "level one best support" for the treatment of childhood ADHD (American Academy of Pediatrics (AAP) 2011; Waxmonsky et al. 2013). Instead, current practice for the treatment of childhood ADHD typically involves stimulant medication and parent or teacher administered behavioral therapy (AAP 2011).

Although behavioral therapy has been demonstrated as effective for reducing externalizing behavior problems in children, the current study provides novel evidence that emotionally derived externalizing problems among children with ADHD may arise from dysregulation of anger. Thus, although behavioral interventions may reduce externalizing behavior immediately following treatment, these interventions may not target core emotion regulation deficits that maintain emotionally driven problem behavior over time (Molina et al. 2009). Indeed, in one of the largest treatment studies of children with ADHD, the Multimodal Treatment Study (MTA), children administered multi-component behavior therapy and medication management showed significantly greater improvement in ADHD and oppositional defiant disorder (ODD) symptoms following treatment, but this improvement declined by half at 10-month follow-up (MTA Cooperative Group 2004). At three-year follow-up, there was no significant difference in ADHD or ODD symptoms between the behavior therapy plus medication management group and any other treatment group [i.e., (1) medication management, (2) multi-component behavior therapy only, (3) usual community care; Jensen et al. 2007]. At 6- and 8-year follow-up, children with ADHD from the MTA were significantly worse than a normative comparison group on behavioral (e.g., ADHD and ODD symptoms), academic, and overall functioning (Molina et al. 2009). Thus, although current behavioral interventions may lead to externalizing symptom reduction following treatment, improvements are not maintained over time, and children with ADHD continue to experience impairing symptoms in adolescence in adulthood. These findings highlight the critical need for interventions in which improvement in internalizing and externalizing problems is sustained over time.

The current study suggests emotion regulation explains the link between temperamental negative affect and emotionally driven externalizing behavior among children with ADHD. Thus, targeting emotion dysregulation may be an area of intervention for preventing or treating emotionally driven externalizing behavior among children with ADHD. Preliminary evidence suggests early emotion regulation/ emotion coaching focused intervention for youth ages four

to six with ADHD leads to improvement in emotional and social competence and reduced aggressive, hyperactive, and oppositional behavior (Webster-Stratton et al. 2011). Additionally, a recent open trial evaluated the effectiveness of a 12-week multisystemic group intervention targeting emotion regulation among children with ADHD (Rosen et al. 2018). Core treatment components included (1) problem solving, (2) emotion recognition (e.g., identification of physiological and cognitive cues) (3) coping skills and (4) perspective taking skills. Not only was this treatment found to be feasible, parents also reported clinically significant improvements in internalizing, externalizing, and emotion-regulation-related difficulties following treatment (Rosen et al. 2018). Thus, although there is only preliminary feasibility evidence, this research is promising and highlights the potential efficacy of cognitive behavioral, emotion regulation focused interventions for reducing the impairing emotionally driven externalizing problems that children with ADHD experience at disproportionate rates.

Limitations

The present study presents evidence of the critical role of emotion regulation in the development of emotionally driven externalizing problems among children with ADHD; however, there are several limitations that should be addressed. First, the current study was an initial cross-sectional investigation of the relations between concurrent temperamental negative affect, emotion dysregulation, and internalizing or externalizing problems. Thus, it is not possible to determine the temporal relationship between constructs. Numerous studies have indicated that temperament is a stable, dispositional trait preceding the development of psychopathology (Nigg 2006); however, this cannot be ascertained given the cross-sectional nature of the study. Additionally, the temporal relationship between emotion dysregulation and psychopathology has also been debated in the literature; thus, direct and indirect effects should not be interpreted as causal. Future studies should examine these constructs longitudinally in a larger sample to determine the sequential development of temperament, emotion regulation, and comorbid pathology. This study utilized an ADHD-only sample to provide a preliminary investigation of temperament in youth with ADHD; thus, another limitation is the relatively small sample size. These findings should be replicated in a larger sample of youth with ADHD to determine whether results are generalizable to the larger population of youth with ADHD.

In the current study, parent- and child-report measures of emotion dysregulation were compiled to provide multi-informant examination of emotion dysregulation. However, some research has indicated children with ADHD exhibit a positive illusory bias in which they tend to overestimate their emotional competence (Owens et al. 2007). Thus, although significant findings emerged, this methodology may have actually provided an underestimate of child emotion dysregulation. Although multi-informant report of emotion dysregulation was examined, the self-report child temperament scale was not administered to children in the current study. Additionally, the parallel measure of internalizing and externalizing problems for youth (Achenbach Youth Self-Report) has only been validated in youth ages 11–18; thus, for this initial study, only parent report of temperament and internalizing and externalizing problems was examined. Future research would benefit from multi-informant examination of temperament and internalizing and externalizing pathology to provide a more valid assessment of psychopathology. Additionally, although well-validated measures were utilized to assess temperament, emotion regulation, and psychopathology constructs, there is debate in the literature as to whether these constructs are overlapping (Rettew and McKee 2005). Previous studies have utilized factor analyses methodologies to remove overlapping items between constructs from analyses (Lemery et al. 2002); however, due to the preliminary nature of the current study, we were underpowered to perform these analyses. Instead, the authors removed aggression items from the calculation of negative affect to reduce the likelihood of covariation between constructs. Although research suggests the relationship between temperament and psychopathology remains significant when overlapping items are removed (Lemery et al. 2002), it would be beneficial to utilize this methodology in a larger sample to control for the potential confound between items.

In the current initial investigation, the authors were interested in exploring how the temperamental factor negative affectivity contributed to the development of emotion dysregulation and internalizing and externalizing problems in youth with ADHD. Negative affectivity has emerged in the literature as a powerful predictor of psychopathology (Mikolajewski et al. 2013). Previous studies have suggested interactions among other temperamental dimensions (e.g., surgency, effortful control) may also predict psychopathology (Oldehinkel et al. 2004). However, studies have also suggested that deficits in effortful control are present in all children with ADHD (Nigg 2006); thus, effortful control may not be a unique predictor of internalizing or externalizing problems among youth with ADHD. Although outside the scope of the current study, future research should investigate differential temperamental profiles or alternate models among children with ADHD and should examine whether other temperament dimensions independently contribute to emotion dysregulation or interact with negative affectivity to lead to emotion dysregulation. Additionally, the current study did not include an examination of comorbidity. It is likely that comorbid disorders also contribute to the

development of emotion dysregulation and psychopathology. The inclusion of comorbid diagnoses (e.g., oppositional defiant disorder, conduct disorder, depressive disorders, anxiety disorders) in models of internalizing and externalizing pathology development among children with ADHD would shed more light on this relationship.

Conclusion

Numerous studies have indicated the significance of difficult temperament and emotion dysregulation in conferring risk for the development of psychopathology in youth. The current study provides novel evidence that among children with ADHD, temperamental negative affectivity exerts an effect on externalizing problems through anger-specific emotion dysregulation. Temperamental negative affect among a subset of children with ADHD may result in heightened frustration and greater physiological arousal and reactivity. Difficulties regulating and undercontrol of negative emotions such as frustration and anger may lead to the development of emotionally derived externalizing problems among children with ADHD. Novel interventions targeting transdiagnostic risk factors, particularly, emotion dysregulation, are imperative to prevent and treat the development of comorbid pathology among children with ADHD. These interventions are critically needed given the limited effectiveness of current behavioral interventions in leading to long-term improvements in emotional and behavioral functioning among children with ADHD.

Compliance with ethical standards

Conflict of interest All authors declare that they have no conflicts of interest.

Research Involving human participants and/or animals All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

Informed consent Informed consent was obtained from all individual participants included in the study.

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