



Attention-deficit hyperactivity disorder and children's emotion dysregulation: A meta-analysis



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HIGHLIGHTS

- We examined the link between ADHD and four domains of emotion dysregulation.
- Youth with ADHD have the greatest impairment on emotion reactivity/lability.
- The ADHD & CU traits link is weakened in the presence of conduct problems.
- Conduct problems did not moderate the link between ADHD and emotion regulation.
- Cognitive functioning moderates the link between ADHD and emotion reactivity/lability.

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ABSTRACT

While executive functioning deficits have been central to cognitive theories of Attention-Deficit Hyperactivity Disorder (ADHD), recent work has suggested that emotion dysregulation may also play a key role in understanding the impairments suffered by youth with ADHD. However, given the multiple processes involved in emotion dysregulation, the extent to which youth with ADHD are impaired across multiple domains of emotion dysregulation including: emotion recognition/understanding (ERU), emotion reactivity/negativity/lability (ERNL), emotion regulation (EREG), and empathy/callous-unemotional traits (ECUT) remains unclear. A meta-analysis of 77 studies ($n = 32,044$ youths) revealed that youth with ADHD have the greatest impairment on ERNL (weighted $ES\ d = .95$) followed by EREG (weighted $ES\ d = .80$). Significantly smaller effects were observed for ECUT (weighted $ES\ d = .68$) and ERU (weighted $ES\ d = .64$). Moderation analyses indicated that the association between ADHD and ERNL was stronger among studies that had a sample containing older youth (no other demographic factors were significant). Additionally, the association between ADHD and ECUT was significantly weaker among studies that controlled for co-occurring conduct problems. Co-occurring conduct problems did not moderate the link between ADHD and any other emotion dysregulation domain. Lastly, the association between ADHD and ERNL was significantly weaker when controlling for youth's cognitive functioning. Cognitive functioning did not moderate the link between ADHD and ERU, EREG, or ECUT, respectively. Theoretical/practical implications for the study of emotional dysregulation in youth with ADHD are discussed.

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1. Introduction

Attention-Deficit Hyperactivity Disorder (ADHD) is one of the most common childhood psychiatric disorders with prevalence rates ranging from 5 to 7% worldwide (Polanczyk, Willcutt, Salum, Kieling, & Rohde, 2014; Willcutt, 2012). The core symptoms of ADHD, consisting of inattention, hyperactivity, and impulsivity, are associated with significant impairment across youth's social, cognitive, academic, behavioral, and familial functioning (Loe & Feldman, 2007; Mash & Barkley, 2003) resulting in significant societal costs (annual societal cost of \$42.5 billion; Pelham, Foster, & Robb, 2007). In terms of the etiology of ADHD, the past two decades have seen a resurgence of cognitive theories that along with empirical data have stressed the role of executive functioning (EF) processes or cognitive control (Barkley, 1997; Harms, Martin, & Wallace, 2010; Marsh & Blair, 2008). More recently, however, researchers have emphasized *emotion dysregulation* as a core feature of ADHD and a significant contributor to the functional impairment suffered by youth and adults with ADHD (Barkley & Fischer, 2010; Bunford, Evans, & Wymbs, 2015; Nigg, Blaskey, Stawicki, & Sachek, 2004; Shaw, Stringaris, Nigg, & Leibenluft, 2014).

Broadly speaking, *emotion dysregulation* occurs when an individual fails to modify an emotional state so as to promote adaptive behaviors that are necessary to accomplish his/her goals (Thompson, 1994). Within the ADHD literature, emotion dysregulation has been conceptualized as emotional impulsiveness, difficulty in effortful regulation of induced emotions, and/or difficulty inducing positive, more acceptable mood states (Barkley, 2010; Bunford, Evans, & Wymbs, 2015). However, as outlined by Gross (1998) model of emotion generation, there are several processes that occur in the modification of an emotional state prior to the overall "dysregulation" that may be eventually observed. These processes include the individual's ability to select, attend to, and appraise/evaluate emotionally arousing stimuli that lead to the experience of an emotional state in both a physiological and behavioral manner. Subsequently, modulation efforts take place both unconscious or consciously in response to such emotional state to promote an adaptive emotional response. It is also important to acknowledge that an individual's selection into a particular situation plays a role in the emotional cues that inherently may be triggered by the situation.

Despite such recognition of the complexity and multiple processes involved in emotion dysregulation, it remains unclear as pointed out recently by Shaw et al. (2014), which aspects of the emotion generation process are impaired among children with ADHD. Examining which

aspects of the emotion generation process are impaired among youth with ADHD is particularly important given that overall emotion dysregulation is found across other externalizing and internalizing disorders (Aldao, Nolen-Hoeksema, & Schweizer, 2010; Zlomke & Hahn, 2010). Hence, it is important to examine whether any associations between ADHD and various emotion dysregulation domains remain after accounting for co-occurring conduct problems (CP; e.g., aggression and/or Oppositional Defiant Disorder/Conduct Disorder) which are highly co-morbid with ADHD. Lastly, given the important role of evaluating/appraising emotional cues, as part of the emotion generation process, it is not surprising that individual differences in cognitive functioning impact an individual's capacity to regulate emotions (Zelazo & Cunningham, 2007). Given the heterogeneity in cognitive/executive functioning deficits exhibited by children with ADHD (Barkley, 1997; Nigg, Blaskey, Huang-Pollock, & Rappey, 2002; Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005), an accurate understanding of which domains of emotion dysregulation are affected by ADHD needs to account for individual differences in cognitive functioning. Modeled after Gross (1998) emotion generation process, Fig. 1 outlines our framework for examining the multiple levels of emotion dysregulation that may be affected in ADHD as well as moderating factors.

1.1. Emotion recognition/understanding (ERU)

While entry into a situation that contains emotional cues is recognized as the first step of Gross (1998) model of emotion generation, the current study focuses on individual differences that occur after the exposure to such emotional cues starting at the second and more evaluative step in terms of an individual's emotion recognition/understanding (ERU). ERU refers to youth's ability to process and infer the emotions of others as well as one's self. Measurement of ERU entails correctly identifying emotional states in various forms of communication including facial and/or bodily expression, gestures, and speech prosody (Etcoff, 1986; Regenbogen et al., 2012). Various research groups have created reliable and valid standardized tasks assessing youth's ERU such as asking youth to name emotions presented in pictures of faces or video vignettes (Boakes, Chapman, Houghton, & West, 2007; Da Fonseca, Seguer, Santos, Poinso, & Deruelle, 2009; Denham, 1986; Ekman & Friesen, 1976), or the use of a Prosody Test (Tucker, Watson, & Heilman, 1977). From a neural mechanism perspective, the activation of the amygdala has been shown to be a bottom-up response to emotional stimuli (Brown, Ryan, & Creswell, 2007; Deveney et al., 2013)

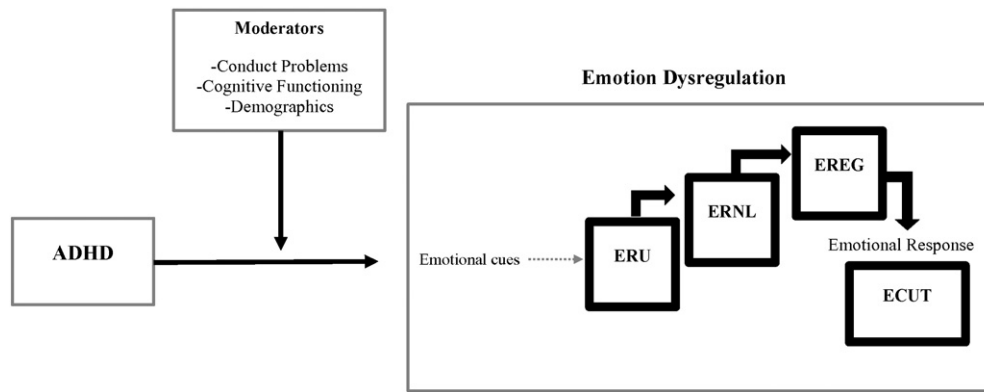


Fig. 1. Conceptual model of emotion dysregulation and ADHD. *Note.* Unidirectional arrows represent the simplest pathway although as indicated by Gross (1998) emotion generation model these processes can occur in parallel at multiple time points. ERU = emotion recognition/understanding, ERNL = emotion reactivity/negativity/lability, EREG = emotion regulation, ECUT = empathy/callous-unemotional traits.

while neocortical structures contribute to a top-down processing and understanding of emotional stimuli (Borod, 1992; Ochsner et al., 2009). Youth's ERU has been readily tied to adaptive behaviors such as academic functioning (Izard et al., 2001), but perhaps most notably within the social functioning domain (Denham, 1998; Izard, 1971; Marsh & Blair, 2008; Trentacosta & Fine, 2010). For example, youth who have greater ERU tend to exhibit greater social adjustment, engage in more prosocial behaviors as well as empathetic responses, and are generally more liked by their peers (Denham, Bassett, Zinsner, & Wyatt, 2014).

Within clinical samples, significant work has shown that youth with Autism Spectrum Disorder have difficulty with ERU (see Harms et al., 2010 for a review). On the other hand, mixed evidence exists to whether youth with ADHD also have difficulty with ERU. For example, while Dyck, Ferguson, and Shochet (2001) found that youth with ADHD performed more poorly on two ERU tasks compared to controls, a more recent study by Deschamps, Schutter, Kenemans, and Matthys (2014) found no differences in youth with ADHD and controls on their ability to recognize and share the emotions depicted in two stories.

1.2. Emotional reactivity/negativity/lability (ERNL)

In addition to facilitating adaptive responses, initial processing and recognition of emotions also play a role in determining emotional response tendencies (Gross, 1998) or reactivity, which can be conceptualized as an individual's threshold, intensity, and duration of affective arousal (Rothbart & Derryberry, 1981). Reactivity can refer to both positive and negative emotions with the term emotional negativity being used only when describing reactivity to negative emotions. Measurement of ERNL can be captured via rating scales, such as the anger/frustration scale of the Children's Behavior Questionnaire (Rothbart, Ahadi, Hershey, & Fisher, 2001), the emotional lability subscale of the Conners' Parent and Teachers Rating Scales (Conners, Sitarenios, Parker, & Epstein, 1998a, 1998b) or the lability/negativity subscale of the Emotion Regulation Checklist (ERC; Shields & Cicchetti, 1997), as well as observationally via coding systems (e.g., Saarni, 1984) of the youth's intensity of emotional display during frustration/challenging tasks. While there is mixed evidence on whether the emotional valence of the visual stimuli (e.g., negative emotions versus positive ones) relates to greater reactivity (see Wager, Phan, Liberzon, & Taylor, 2003 for a review) the temperament literature has documented significant individual differences, as early as infancy, in emotional reactivity to novel and stressful events (Calkins, 2007; Fox, 1989; Rothbart & Seese, 2007).

Within the clinical psychology and psychiatric literature the term lability, borrowed from the biological and physical sciences, conveys the instability and disorganization that is assumed to underlie a high degree

of emotional reactivity (Cole, Michel, & Teti, 1994). Another analogous term recently used within the ADHD literature is emotional impulsivity which is defined as including low frustration tolerance, quickness to anger, irritability, and emotional excitability (Barkley & Fischer, 2010). Given our interest in ADHD, the current paper focuses on emotional reactivity or lability as it pertains to both positive and negative emotions (with the expectation that most studies only broadly examine reactivity across emotions) as we recognize that high reactivity or lability to positive emotions certainly have a role in other psychiatric disorders such as bipolar disorder (see Gruber, 2011).

While some studies have shown that youth with ADHD are rated by parents and/or teachers as having higher levels of ERNL compared to controls (e.g., Banaschewski et al., 2012; Anastopoulos et al., 2011), others have found only mild effects when implementing observation based measures (e.g., Melnick & Hinshaw, 2000). Hence, it will be important to empirically examine the magnitude of any associations between ADHD and ERNL, taking into account any potential reporter bias (i.e., parent rating both ADHD and ERNL), as this will help determine whether ERNL should be conceptualized as a feature of ADHD.

1.3. Emotion regulation (EREG)

Following Gross (1998) emotion generation model, the next step entails modulation of the emotional response tendencies or reactivity described in the previous section. While there is no single definition for emotion regulation (EREG), from a top-down perspective, EREG refers to effectively responding to emotional reactivity in a flexible manner that facilitates adaptive functioning (Bunford, Evans, & Wymbs, 2015; Calkins, 2007; Cole et al., 1994; Gross, 2011). Hence, EREG not only refers to the reduction in the intensity of emotional arousal and/or experiences but also includes the capacity to generate and sustain emotions when needed (Cole, Martin, & Dennis, 2004). Specifically related to ADHD, Barkley (2010) and Bunford, Evans, & Wymbs (2015), further note the importance of cognition/attention in down-regulating or escalating arousal that an emotion has induced as well as organizing his/her self for a coordinated set of behaviors that lead an individual to return to baseline functioning. Measurement of EREG can be captured via rating scales, such as the regulation subscale of the Emotion Regulation Checklist (Shields & Cicchetti, 1997), the emotion control subscale of the Behavior Rating Inventory of Executive Function (Gioia, Isquith, Guy, & Kenworthy, 2000) as well as observationally via coding of the youth's effectiveness in maintaining interest in a frustrating/challenging task, or the use of coping strategies during such task, as well as expressing emotions appropriately (i.e., not getting overly disruptive/angry; Saarni, 1992). While outside the scope of the current paper, Bunford, Evans, and Wymbs (2015) provide an excellent review wherein they outline advantages/disadvantages of various methods for measuring

EREG including ecological momentary assessment and pathophysiological indicators.

Across development, youth with EREG difficulties experience greater levels of behavioral, social, familial, and academic impairment (Blair, Denham, Kochanoff, & Whipple, 2004; Cole, Zahn-Waxler, Fox, Usher, & Welsh, 1996; Eisenberg et al., 2000; Graziano, Reavis, Keane & Calkins, 2007; John & Gross, 2004; Williford, Calkins, & Keane, 2007). It is important to acknowledge that EREG includes efforts at both at an extrinsic and intrinsic level and can be observed behaviorally as well as via biological markers. For example, youth with greater levels of respiratory sinus arrhythmia (RSA) withdrawal, a psychophysiological marker for emotion regulation (Calkins, 2007; Porges, Doussard-Roosevelt, Portales, & Greenspan, 1996), tend to have fewer externalizing and internalizing problems and better cognitive functioning (see meta-analysis by Graziano & Derefinko, 2013).

Within clinical samples or from a developmental psychopathology perspective, EREG difficulties are prevalent across psychiatric disorders (Aldao et al., 2010; Zlomke & Hahn, 2010). For example, within the internalizing domain, depression is often conceptualized as a disorder of impaired EREG given that sustained negative affect and a persistent reduction in positive affect are core features of a major depressive episode in adults (Campbell-Sills & Barlow, 2007; Joormann & Gotlib, 2010). EREG difficulties have also been incorporated into theoretical adult models of generalized anxiety disorder (Mennin, Holaway, Fresco, Moore, & Heimberg, 2007), social anxiety disorder (Kashdan & Breen, 2008), and bipolar disorder (Gruber, 2011). Adolescents and/or adults suffering from eating disorders and/or substance abuse also frequently have poor EREG as the use of substances and use/restraint of food can be conceptualized as an escape or coping strategy (Polivy & Herman, 2002; Sher & Grekin, 2007).

As it relates to the current study, some studies have found that youth with ADHD have more difficulty controlling their emotions during challenging/frustrating/disappointment tasks compared to controls (e.g., Melnick & Hinshaw, 2000; Walcott & Landau, 2004; Wheeler Maedgen & Carlson, 2000). This association between ADHD and EREG is theorized to arise partially out of shared neurocognitive/executive functioning processes involved both in the expression of ADHD symptoms (Barkley, 1997) as well as in EREG (Bush, Luu, & Posner, 2000). However, given the heterogeneity found in executive functioning deficits among children with ADHD (Nigg, Willcutt, Doyle, & Sonuga-Barke, 2005), it is important to establish the magnitude of any links between EREG and ADHD as it would provide empirical evidence on how important EREG is in conceptualizing ADHD.

1.4. Empathy/callous–unemotional traits (ECUT)

The final aspect of the emotion generation process is engaging in an adaptive emotional response such as empathy. The cognitive aspect of empathy generally refers to one's ability to comprehend the affective or cognitive status of another (Gini, Albiero, Benelli, & Altoè, 2007; Kokkinos & Kipritsi, 2012) while the affective component, refers to the ability to experience another's affective state and/or express concern for another's position (Thomas, Batson, & Coke, 1981; Ze, Thoma, & Suchan, 2014). Measurement of empathy can be captured via rating scales such as the 'My Child' questionnaire (Kochanska, DeVet, Goldman, Murray, & Putnam, 1994) which assess early conscience development. Coding systems (e.g., Strayer, 1989) are also employed during empathy eliciting tasks, often referred to as measuring theory of mind (Premack & Woodruff, 1978), which require youth to respond to various vignettes depicting a character's emotional state by answering how that character was feeling as well as how they are feeling with higher matched scores (between how the character was feeling and themselves) indicative of greater empathy.

Within the developmental literature, there are mixed findings as to the association between youth's empathetic responses and social and behavioral outcomes (Eisenberg & Miller, 1987). Some studies

have suggested that these mixed findings are a function of the cognitive versus affective aspect of empathy with null findings more likely to be found within the cognitive empathy domain (Sutton, Smith, & Swettenham, 1999). For example, youth may have high levels of cognitive empathy in terms of understanding the emotional state of others but simply do not emotionally care to act upon such understanding (Sutton, 2003) or use such knowledge to manipulate the situation (Garandeau & Cillessen, 2006). Sex and age have also been documented as important moderators for whether a link between empathy and prosocial and adaptive behavioral functioning is found (Rose & Rudolph, 2006; Wentzel, Filisetti, & Looney, 2007). Additionally, it is particularly pertinent to examine ECUT within the broader concept of emotion dysregulation given evidence linking ERU to ECUT (Dawel, O'Kearney, McKone, & Palermo, 2012; Kimonis et al., 2008) as well as ECUT and ERNL (Willoughby, Waschbusch, Moore, & Propper, 2011).

Within clinical psychology and psychiatry, low levels of empathy, guilt, and caring for others have recently been categorized under the term callous–unemotional (CU) traits (Frick, Ray, Thornton, & Kahn, 2013). Measurement of CU traits typically involves rating scales such as the Antisocial Process Screening Device (Frick & Hare, 2001) or the Inventory of Callous–Unemotional Traits (Frick, 2003). Youth with CU traits experience deficits in both cognitive and affective aspects of empathy (Pardini, Lochman, & Frick, 2003). Substantial research has documented CU traits as an important characteristic for identifying the most pervasive, severe, and aggressive patterns of antisocial behavior (see Frick et al., 2013 for a recent review). What remains unclear, as pointed out by Stadler et al. (2011), is whether CU traits are associated with ADHD independent of CP as a recent review found mixed evidence for such a link (e.g., Herpers, Rommelse, Bons, Buitelaar, & Scheepers, 2012).

2. Potential moderators

2.1. Demographic factors

The association between emotion dysregulation and ADHD may also differ according to youth's sex. Developmental work has shown that while boys and girls exhibit similar levels of ERU (Hoffmann, Kessler, Eppel, Rukavina, & Traue, 2010), girls tend to experience greater ERNL (Charbonneau, Mezulis, & Hyde, 2009; Sobanski et al., 2010), and engage in more empathetic behaviors (Van Tilburg, Unterberg, & Vingerhoets, 2002) and more effective EREG (Zlomke & Hahn, 2010) compared to boys. Within an ADHD sample, Bunford, Evans, and Langberg (2014) found that girls exhibited significantly higher levels of self-reported emotion dysregulation characterized, by a lack of emotional awareness and difficulty engaging in goal-directed behaviors, compared to males. However, when compared to a community/normative sample, males with ADHD were more deviant from the norm in terms of emotion dysregulation than females with ADHD. Given that the emotion dysregulation factors are developmental processes that youth improve over time with experience (Kochanska & Knaack, 2003) it is also important to examine age as a moderator. Age may be particularly important when considering ERNL as the ADHD adult literature has noted that ERNL is present in up to 90% of adult cases (Kooij, Ackerlin, & Buitelaar, 2001), although comorbidity rates with anxiety, depression, and bipolar disorder make it difficult to determine how much of such ERNL is attributed to ADHD (Skirrow, McLoughlin, Kuntsi, & Asherson, 2009).

2.2. Cognitive functioning

Higher order cognitive skills, generally referred to as executive functions (EF), play a key role in various aspects of self-regulation including emotion regulation (Blair, 2002; Bush et al., 2000; Zelazo & Cunningham, 2007). Although multiple definitions of EF have been proposed (Jurado & Rosselli, 2007), strong support exists for a model

consisting of core neuropsychological skills that include cognitive flexibility, working memory, and inhibitory control (Miyake et al., 2000). Overall levels of intelligence and verbal abilities/fluency have also been found to relate to EF among children with and without ADHD (Blair & Razza, 2007; Hughes, 1998; Mahone et al., 2002) and as such can impact youth's EREG. Specifically, within the emotion generation process outlined by Gross (1998), EF or cognitive control can play a key role in the initial evaluation of emotional cues as well as in the more regulatory or modulation of arousal phase. Additionally, it appears that EF and EREG capabilities develop in concert during the early childhood and preschool period (Bell & Wolfe, 2004; Carlson & Wang, 2007; Fox & Calkins, 2003) and are interconnected from a neural perspective allowing a reciprocal effect on one another (Blair, 2002; Bush et al., 2000; Sjöwall, Roth, Lindqvist, & Thorell, 2013). The initial evaluation of emotional cues also requires the use of EF for cognitive understanding or perspective taking skills that can be referred to as "theory of mind" (Denham, Zoller, & Couchoud, 1994; Nilsen & Graham, 2009). Development of EF and theory of mind skills are dependent on one another and influence ERU (Blankson et al., 2013). Indeed children who perform better on theory of mind tasks tend to score higher on ERU tasks (Cutting & Dunn, 1999; Waller, Hyde, Grabell, Alves, & Olson, 2014) and are more likely to engage in empathetic responses and less likely to be rated as having CU traits (Waller et al., 2014). When viewed in conjunction with the fact that there is significant heterogeneity in terms of EF/cognitive control deficits among youth with ADHD (Barkley, 1997; Nigg et al., 2002; Willcutt et al., 2005), it becomes crucial for any investigation of emotion dysregulation among youth with ADHD to account for the impact of cognitive functioning.

2.3. Conduct problems

Conduct problems (CP) is defined generally as behaviors that violate the rights of others (e.g., aggression, destruction of property) and/or cause conflict with societal norms or authority figures (e.g., non-compliance/oppositional behaviors, anti-social behaviors, rule-breaking behaviors; Campbell, Shaw, & Gilliom, 2000). These dimensions of CP can be measured both continuously in a dimensional manner or can diagnostically be captured under the categories of oppositional defiant disorder (ODD) and conduct disorder (CD) in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5 American Psychiatric Association, 2013). The presence of co-occurring CP may impact any associations between ADHD and emotion dysregulation (Nigg et al., 2004; Sobanski et al., 2010). Youth with CP, independent of ADHD, have been shown to have emotion dysregulation deficits across domains. For example, youth with CP, but not ADHD, are more likely to have CU traits (Frick, Cornell, Barry, Bodin, & Dane, 2003; Woodworth & Waschbusch, 2008) and have difficulty regulating their emotions (Cole, Teti, & Zahn-Waxler, 2003; Frick & Morris, 2004). On the other hand, some studies indicate that EREG problems are associated with ADHD above and beyond CP (Bunford et al., 2014; Sjöwall et al., 2013). Melnick and Hinshaw (2000) classified youth with ADHD as either high or low in co-occurring aggression and found ERNL differences only between youth with ADHD and high levels of aggression compared to controls. A meta-analysis by Trentacosta and Fine (2010) also found moderate effects ($r = -.26$) linking overall levels of CP and difficulty with ERU. While ADHD was not included in Trentacosta and Fine's (2010) meta-analysis, a more recent study suggests that poor ERU may be more strongly associated with comorbid CP rather than purely with ADHD (Factor, Rosen, & Reyes, 2013). Taken together and considering the high comorbidity rates between ADHD and CP, ranging from 30 to 50% (Mannuzza, Klein, Abikoff, & Moulton, 2004), it is possible that emotion dysregulation factors theoretically attributed to ADHD may be partially or fully accounted by the presence of CP, which is important to note may also be partially a consequence of ADHD (Biederman et al., 2008; Gresham, Lane, & Lambros, 2000).

3. Goals of the current meta-analysis

In summary, theoretical and recent empirical data suggest that emotion dysregulation is a core feature of ADHD. However, as outlined by Gross (1998), there are several processes throughout the emotion generation model that may lead to dysregulation. Hence, the research literature remains unclear on the extent to which youth with ADHD show difficulties across all emotion dysregulation processes/domains or more focal deficits. From a developmental psychopathology perspective, it is important to understand whether for example, the EF deficits found in some youth with ADHD, affect emotion dysregulation broadly or relate to impairment in the more regulatory component of the emotion generation model (i.e., EREG). Understanding where in the emotion generation model (see Fig. 1) youth with ADHD have difficulty would help inform interventions to target such processes.

The goal of the current study was to conduct a meta-analysis to examine a) the magnitude of the associations between ADHD status and emotion dysregulation, b) determine any differences in the magnitude of these associations according to the domain of emotion dysregulation (ERU, ERNL, EREG, and ECUT), and c) determine the extent to which demographic variables (i.e., sex, age), comorbid CP, and individual differences in cognitive functioning impact the association between ADHD and emotion dysregulation. While there have been several meta-analyses conducted as it relates to ADHD and treatment (DuPaul & Eckert, 1997; Faraone, Biederman, & Mick, 2006; Van Der Oord, Prins, Oosterlaan, & Emmelkamp, 2008), genes (Gizer, Ficks, & Waldman, 2009; Li, Sham, Owen, & He, 2006; Nikolas & Burt, 2010), executive functioning (Frazier, Demaree, & Youngstrom, 2004; Martinussen, Hayden, Hogg-Johnson, & Tannock, 2005; Willcutt et al., 2005), neural correlates (Cortese, 2012; Dickstein, Bannion, Castellanos, & Milham, 2006), we are not aware of any meta-analysis that has specifically focused on emotion dysregulation. However, there has been some theoretical and review papers on aspects of emotion dysregulation in general psychopathology (Southam-Gerow & Kendall, 2002) and specifically to ADHD (Barkley, 2010; Bunford, Evans, & Wymbs, 2015; Shaw et al., 2014; Skirrow et al., 2009).

Given the neurobiological overlap between emotion and cognitive regulation (Semrud-Clikeman, Walkowiak, Wilkinson, & Butcher, 2010), we expected the association between ADHD and EREG to be the strongest. Given recent developmental work showing ERNL to be a strong predictor of later psychopathology (Stringaris & Goodman, 2009) and high rates of ERNL among adults with ADHD (Amador-Campos, Gómez-Benito, & Ramos-Quiroga, 2014), we hypothesized a moderate association between ADHD and ERNL. We did not expect a strong association between ADHD and ERU given evidence that such links may be strongest for youth with Autism Spectrum Disorder (Jones et al., 2011). Similarly, we expected a low association between ADHD and ECUT given evidence that such links are strongest for youth with high levels of CP (Haas, Waschbusch, King, & Walsh, 2014). In terms of demographic predictors, given the rapid development of self-regulation skills, including emotion regulation and executive functioning, throughout childhood (Anderson, 2002; Kochanska & Knaack, 2003) as well as studies documenting greater levels of ADHD for boys (Gaub & Carlson, 1997), we expected that the link between ADHD and emotion dysregulation to be stronger for samples with younger children and a greater proportion of males. Lastly, we expected weaker effects between ADHD and emotion dysregulation for studies that controlled for CP as well as cognitive functioning.

4. Method

4.1. Literature review

We conducted a comprehensive search for empirical research regarding the relation between ADHD and youth's emotion dysregulation over the last 20 years (since the early publications leading to Barkley's (1997) influential theory), using PsychINFO (1994–2015), Science

Citation Index Expanded (1994–2015), Social Sciences Citation Index (1994–2015), Arts & Humanities Citation Index (1994–2015), Google Scholar (1994–2015), and MEDLINE (1994–2015). The terms used in the search included *ADHD, AD/HD, ADD, Attention-Deficit/Hyperactivity Disorder, Attention-Deficit Disorder, Externalizing behavior problems, conduct problems, aggression, behavior problems, and attention problems*. These terms were crossed with terms related to children's emotion dysregulation, including *emotion, emotion dysregulation, emotion regulation, affect, affect regulation, reactivity, emotion reactivity, emotional impulsivity, negative reactivity, negativity, empathy, callous-unemotional traits, psychopathy, problem-solving, anger, frustration, emotional lability, irritability, mood regulation, emotional control, coping, emotion recognition, emotion processing, emotional understanding, facial recognition, theory of mind, emotion knowledge, emotional intelligence, and emotional competence*. In addition to the database search, references used in identified studies and review articles were surveyed to identify other potentially relevant studies. Due to the extensive number of studies identified through database search and study ancestry, unpublished data were not utilized for the present analyses.

4.2. Inclusion and exclusion criteria

Eighty-three studies satisfied the inclusion criteria. Publication years of the identified studies ranged from 1998 to 2015. Our inclusion criteria were liberal in terms of the design of the studies as the main goal of this meta-analysis was to determine the magnitude of any associations between ADHD and children's emotion dysregulation factors. Studies had to report youth as having ADHD through a diagnostic process ($n = 77$). Hence, some studies that examined children “at-risk” for ADHD were excluded (e.g., Kats-Gold, Besser, & Priel, 2007) or those who examined ADHD symptoms within normative samples (e.g., Singh & Waldman, 2010). Studies could either compare emotion dysregulation factors between children with ADHD and a control group (e.g., children displaying normative levels of ADHD symptoms) or use correlational methods to examine concurrent associations between ADHD symptom severity and emotion dysregulation outcomes. In addition, sufficient statistical data to allow the calculation of effect sizes had to be present (e.g., means, standard deviations, correlational tables, regressions, test statistics such as *t*-test, ANOVA, etc.). Articles written in languages other than English were excluded.

Additionally, since our focus was on four main emotion dysregulation outcomes (i.e., ERU, ERNL, EREG, ECUT), over 50 articles examining relations between ADHD and other social-emotional outcomes (e.g., social skills, cooperation, problem-solving, peer status) were excluded. Additionally, given that our theoretical model sought to clarify the link between emotion dysregulation and ADHD along with other associated externalizing problems (i.e., aggression, ODD), articles which examined ADHD and co-occurring depression and anxiety were excluded (Classi, Milton, Ward, Sarsour, & Johnston, 2012). Treatment outcome articles that only examined change in emotion dysregulation as a function of treatment were also excluded (Herbert, Harvey, Roberts, Wichowski, & Lugo-Candelas, 2013) unless baseline data was available linking ADHD symptom severity to emotion dysregulation and/or provided data on emotion dysregulation for a control group. Articles that solely examined brain regions associated with emotion dysregulation in children with ADHD without observable or corresponding reports were also excluded (e.g., Finger et al., 2008). Because we were interested in only youth's emotion dysregulation, any article in which the mean and/or range of age was over 18 was excluded (e.g., Barkley & Fischer, 2010).

4.3. Coding of moderators

Studies were coded for several demographic and methodological features. Two judges (first and second authors) independently coded studies. Interjudge reliability was assessed via intraclass correlation

coefficients (ICC) for continuous codes, and via kappas (κ) for categorical codes. When a discrepancy was found, both coders independently reviewed the study again and decided whether they would retain their original code or modify it. Remaining discrepancies were resolved through discussion between coders. The reliability between coders was excellent (all ICC values $> .90$ and κ values = 1.00).

4.3.1. Demographic variables

We coded studies for average age of sample, gender (% male), ethnicity (% Caucasian), time lag (time in years between ADHD symptom and emotion dysregulation outcome), type of sample (between group comparison of ADHD vs. control, $n = 58$ or within group comparison of ADHD symptoms and emotion dysregulation among clinic/at-risk groups, $n = 19$). We also coded studies for how ADHD was diagnosed. Thirty studies used the “gold” standard of a diagnostic interview plus a combination of parent and teacher reports. Sixteen studies used only parent and/or teacher reports while 13 studies used a diagnostic interview with or without parent reports. Finally, 17 studies used medical records of a previous diagnosis with or without parent report confirmation with one study solely using adolescent-self report. Most studies did not examine subtypes of ADHD ($n = 61$) while almost all studies were cross-sectional in nature ($n = 76$) so we were unable to examine subtype or time lag between diagnosis and emotion dysregulation as a moderator. We also coded how emotion dysregulation was measured (e.g., observational/laboratory measure, parent, teacher, or self-report).

4.3.2. Co-morbid conduct problems (CP)

As noted in the introduction, there is a significant debate on whether the link between ADHD and emotion dysregulation is due to the comorbidity between ADHD and CP (aggression and/or ODD/CD diagnoses). Hence, we coded studies for a) whether children's CP were controlled or co-varied in analyses of ADHD and emotion dysregulation ($n = 27$) or not controlled or co-varied in analyses ($n = 50$) due to not measuring conduct problems or combining conduct problems with ADHD when examining the association with emotion dysregulation. Of note, we contacted several authors to inquire about separating out the association between ADHD and emotion dysregulation while controlling for conduct problems and were successful across several studies (e.g., Dadds, Cauchi, Wimalaweera, Hawes, & Brennan, 2012; Frick et al., 2003).

4.3.3. Controlling for cognitive functioning

As noted in the introduction and outlined by Gross (1998) emotion generation model, youth's cognitive functioning plays a key role throughout multiple facets of emotion dysregulation. Additionally, given the established cognitive deficits often found in youth with ADHD, it is important to account for cognitive functioning when examining emotion dysregulation. Hence, we coded studies for a) whether children's cognitive functioning was measured either broadly via IQ scores (e.g., verbal abilities, fluid reasoning) or more specific executive functioning (EF) tasks or global measures of EF were controlled, co-varied, or were stated as having no impact on the analyses of ADHD and emotion dysregulation ($n = 46$) or not controlled or co-varied in analyses ($n = 31$) due to not measuring cognitive functioning or simply not providing any information.

4.4. Computation of effect sizes

For the effect size (ES) metric, Cohen's *d* was calculated from correlations between ADHD status and/or symptom severity and emotion dysregulation outcomes. However, when correlations were not provided, Cohen's *d* was estimated from other available data sources, including group comparisons (*t*-tests), analyses of variance (ANOVAs), or means and standard deviations for extreme or tertiary groups assigned according to criterion (e.g., comparing youth with ADHD versus a control group). All effect size estimates and all transformations from other

data sources to Cohen's d were calculated according to the formulas provided in Lipsey and Wilson (2001) using Microsoft Excel (Neyeloff, Fuchs, & Moreira, 2012). Positive ESs in the present meta-analysis indicated positive associations between ADHD and emotion dysregulation (e.g., ERU difficulties, difficulty engaging in empathetic responses/higher CU traits, greater ERNL, greater EREG difficulties).

Seventy-seven studies with adequate meta-analytic information were identified, yielding ESs for ERU (21 studies, total $n = 2126$), ERNL (22 studies, total $n = 21,942$), EREG (20 studies, total $n = 2040$), and ECUT (24 studies, total $n = 7,360$). In studies in which two or more pertinent dependent variables were used, such as two different measures of emotion recognition or two different reporters, the average effect size was used. All averaged measures used in the current study were judged by both coders as being of approximately equal validity. Additionally, effect sizes from studies that used the same sample for investigating outcomes within the same domain (e.g., Haas et al., 2011; Waschbusch, Carrey, Willoughby, King & Andrade, 2007; Waschbusch, Craig, Pelham & King, 2007; Woodworth & Waschbusch, 2008) were also averaged. All study references appear in the Appendix A.

4.5. Data analysis

Primary analyses were conducted using a random effects model approach (Hughes, 1998) using Microsoft Excel (Neyeloff et al., 2012). This approach was chosen to reflect the likelihood that individual studies would produce ESs different from other studies in the analysis. All ESs were transformed to z -scores using Fisher's r to z transformation. After aggregation, ESs were transformed again to d for comparison. To estimate the size of the effects, we adopted Cohen's criteria: small = .20, medium = .50, and large = .80. As a result of the large number of studies included, we used a minimum alpha level of .01 (two-tailed tests).

Heterogeneity analyses were also conducted to determine whether ESs were more heterogeneous than would be expected due to sampling error alone. The measure I^2 is a modification of Cochrane's Q test (Cochran, 1954) which measures whether the ratio of variation that exceeds chance, thereby accounting for the number of studies utilized in meta-analysis with more accuracy (Higgins & Thompson, 2002). Values for I^2 range from 0 to 1; an I^2 of 0% indicates no heterogeneity, whereas I^2 s of 25%, 50%, and 75% represent low, moderate, and high heterogeneity, respectively (Higgins, Thompson, Deeks, & Altman, 2003). For variables with moderate to high heterogeneity, potential moderators to the ES were identified using weighted least squares regression procedures (Hedges, 1994) using SPSS. Finally, weighted file drawer analyses were conducted following Rosenberg's (2005) approach to determine the number of studies that would be necessary to reduce the mean effect to a negligible level.

5. Results

5.1. Primary analyses

Study identification information, coded categories, and ESs representing the relation between ADHD and youth's emotion dysregulation outcomes can be found in Table 1. The relation between ADHD and measures of children's ERNL had a weighted ES of $d = .95$ (95% CI [.91, .99], $p < .001$) indicating a large effect. A large effect was also found for the association between ADHD and measures of youth's EREG, weighted ES of $d = .80$ (95% CI [.70, .92], $p < .001$). Moderate effects were found for the associations between ADHD and ECUT (weighted ES of $d = .68$; 95% CI [.63, .74], $p < .001$) and ERU (weighted ES of $d = .64$; 95% CI [.54, .74], $p < .001$). Fisher r -to- z comparisons indicated that the strength of the association between ADHD and ERNL was significantly greater compared to all other ADHD and emotion dysregulation associations ($p < .001$). The strength of the association between ADHD and EREG was also significantly greater compared to the association

Table 1

Effect sizes across measures of emotion dysregulation.

	ERU	ERNL	EREG	ECUT
Weighted mean ES	.64	.95	.80	.68
Cohen's criteria	Moderate	Large	Moderate	Moderate
95% CI	.54 to .74	.91 to .99	.70 to .92	.63 to .74
Number of effect sizes	21	22	20	24
Total N across studies	2126	21,942	2,040	7,360
Range of effect sizes	-.05 to 3.27	.02 to 14.04	.15 to 1.94	-.01 to 14.04
t	13.97***	63.51***	16.84***	27.75***
Weighted file drawer analysis	54.92	434.97	122.94	116.32
I^2	79%	99%	79%	95%
Nature of moderation	None	a, d	None	b, c

Note. EREG = emotion regulation, ERNL = emotion reactivity/negativity/liability, ECUT = empathy/callous-unemotional traits, ERU = emotion recognition/understanding.

a. Age: stronger association between ADHD and emotion dysregulation among studies which had a sample containing older children. b. Design of study: stronger association between ADHD and emotion dysregulation for between-subject studies vs. within study studies. c. Conduct problems: weaker association between ADHD and emotion dysregulation among studies that co-varied co-occurring aggression and/or Oppositional-Defiant Disorder/Conduct Disorder diagnosis. d. Cognitive Functioning: weaker association between ADHD and emotion dysregulation among studies that co-varied for cognitive abilities or executive functioning.

*** $p < .001$.

between ADHD and ERU ($p < .01$) as well as the association between ADHD and ECUT ($p < .01$). Lastly, no significant differences were found in the strength of the associations between ADHD and ERU and ADHD and ECUT ($p = .26$).

5.2. Heterogeneity and moderation analyses

The measure I^2 was used to assess whether ESs were more heterogeneous than would be expected due to sampling error alone. Values for I^2 range from 0 to 1; an I^2 of 0% indicates no heterogeneity, whereas I^2 s of 25%, 50%, and 75% represent low, moderate, and high heterogeneity, respectively (Higgins et al., 2003). Once heterogeneity was identified, potential moderators to the ES were identified using weighted least squares regression procedures for continuous variables. Results of heterogeneity and moderator analyses are presented in Table 1.

The I^2 values for the ADHD and emotional dysfunction outcomes indicated high heterogeneity for ERU, ERNL, EREG, and ECUT (79%, 99%, 79%, and 95%, respectively). Demographic moderators included average age, gender (% male), ethnicity of sample (% Caucasian), and type of design (between subjects vs. within subjects). Co-morbid CP and cognitive functioning were also examined as moderators.

5.2.1. Demographic moderators

As seen in Table 2, regression analyses indicated that age of sample was significantly associated with the average strength of the relation between ADHD and ERNL ($\beta = .81$, $p < .001$). This indicates that the association between ADHD and ERNL was stronger among studies which had a sample containing older youth with ADHD. Age did not have an effect on the association between ADHD and ERU, EREG, or ECUT. The design of studies reviewed was also a marginal predictor of the association between ADHD and ECUT ($\beta = .41$, $p = .053$) with between-subject studies (those comparing children with ADHD versus control/typically developing) obtaining higher effect sizes compared to within subject studies examining symptom severity of ADHD and outcomes. No other significant demographic moderators were identified (e.g., percentage of males within a sample, method of diagnosing ADHD).

5.2.2. Measurement moderators

In terms of how studies measure emotion dysregulation, regression analyses using weighted least squares (accounting for sample size and controlling for the previously identified significant demographic variables: age and design) revealed that studies that used parent/teacher/

Table 2

Moderation analyses: demographics (Model 1), conduct problems (Model 2), and cognitive control (Model 3).

Outcome	β	t-Value	Model R^2	F Change
<i>Emotion recognition/understanding (ERU) (n = 21 studies)</i>				
Model 1: age	-.15	-.53	.18	1.27
Percentage of males	.26	1.01	—	—
Design of study	.38	1.47	—	—
Model 2: conduct problems ^a	-.38	-1.64	.30	2.69
Model 3: cognitive control ^a	-.14	-.45	.19	.206
<i>Emotion reactivity/negativity/lability (ERNL) (n = 22 studies)</i>				
Model 1: age	.81***	5.76***	.67	11.32***
Percentage of males	-.20	-1.34	—	—
Design of study	-.01	-.07	—	—
Model 2: conduct problems ^a	-.14	.11	.68	.626
Model 3: cognitive control ^a	-.37*	-2.24*	.75	5.02*
<i>Emotion regulation (EREG) (n = 20 studies)</i>				
Model 1: age	.09	.40	.20	1.30
Percentage of males	-.10	-.48	—	—
Design of study	.40	1.74	—	—
Model 2: conduct problems ^a	-.23	-.99	.25	.984
Model 3: cognitive control ^a	-.14	-.56	.21	.313
<i>Empathy/callous-unemotional traits (ECUT) (n = 24 studies)</i>				
Model 1: age	.11	.49	.24	2.02
Percentage of males	-.30	-1.41	—	—
Design of study	.41 ⁺	2.07	—	—
Model 2: conduct problems ^a	-.61**	-3.14**	.51	9.88**
Model 3: cognitive control ^a	.34	1.42	.32	2.00

Note. No multicollinearity issues were found across any of the moderation analyses.

^a Model 2 (conduct problems) and Model 3 (cognitive control) controlled for any significant demographic variables found in Model 1.⁺ $p < .10$.* $p < .05$.** $p < .01$.*** $p < .001$.

or self-reports ($n = 13$) reported a significantly higher effect size between ADHD and EREG $F(3,16) = 5.79, \beta = .64, p < .01; d = .90$ versus those that used laboratory/observational/physiological regulation measures ($n = 7$), $d = .38$. Of interest, all studies that examined ADHD and ERU utilized observational/laboratory assessments ($n = 21$). Thus, it remains unclear whether parents or teachers' report of ERU would yield different results. On the other hand, studies that examined ADHD and ECUT as well as ERNL relied almost exclusively on some combination of parent and/or teacher reports ($n = 20$ and $n = 19$, respectively) versus laboratory/observational measures ($n = 3$ and $n = 2$, respectively) preventing the examination of whether the effects differ depending on the measure. Additionally, it is important to note that within the ERNL

domain, most studies (64%) conceptualized children's ERNL as a combination of both positive and negative emotions while 36% examined only children's negative emotionality. Interestingly, no study solely examined youth's positive reactivity.

5.2.3. CP and cognitive functioning as moderators

To examine the influence of co-occurring CP, separate regression using weighted least squares (accounting for sample size) was performed for each emotion dysregulation outcome (controlling for demographic variables). Co-varying CP had no effect on the strength of the association between ADHD and EREG ($\beta = -.23, p = .34$), ERU ($\beta = -.38, p = .12$), or ERNL ($\beta = -.14, p = .44$). However, co-varying CP did have a significant effect on the strength of the association between ADHD and ECUT ($\beta = -.61, p = .006$). As seen in Fig. 2, studies that co-varied CP had weaker effect sizes between ADHD and ECUT ($d = .25$) compared to studies that did not co-vary CP, ($d = .84$).

To determine whether accounting for youth's cognitive functioning influenced the association between ADHD and emotion dysregulation domains, separate regression using weighted least squares (accounting for sample size) were performed for each emotion dysregulation outcome. As seen in Table 2, co-varying cognitive functioning had no effect on the strength of the association between ADHD and EREG, ERU, or ECUT. The null finding within the ERU domain may have been due to the fact that only 3 studies within the ERU domain did not control for cognitive functioning. However, co-varying cognitive functioning did have a significant effect on the strength of the association between ADHD and ERNL ($\beta = -.37, p = .04$). As seen in Fig. 3, studies that co-varied cognitive functioning had weaker effect sizes between ADHD and ERNL ($d = .35$) compared to studies that did not co-vary cognitive functioning, ($d = .99$).

5.3. File drawer analysis

According to Rosenthal (1995), if only a few studies with null results are needed to change the significance level of a finding, then this finding is susceptible to the "file drawer threat," indicating that the finding is not reliably significant. To account for the bias toward publishing or submitting only significant findings, we conducted a weighted file drawer analysis using Rosenberg (2005)'s fail safe number software. This statistic examines the number of studies with null findings (assuming the addition of multiple studies; $N+$) that would need to exist to bring the significant ESs of relations to less than $p = .01$. Results of File Drawer analyses are provided in Table 1.

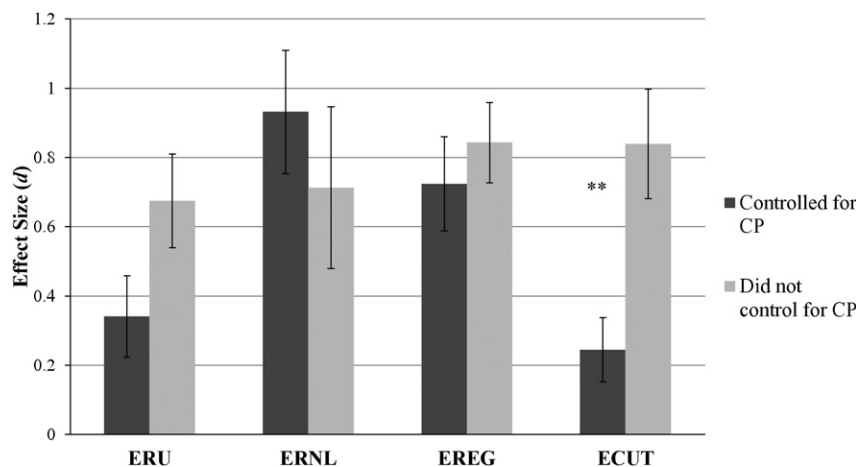


Fig. 2. Association between ADHD and emotion dysregulation domains moderated by conduct problems. Note. ** $p < .01$. CP = conduct problems, ERU = emotion recognition/understanding, ERNL = emotion reactivity/negativity/lability, EREG = emotion regulation, ECUT = empathy/callous-unemotional traits.

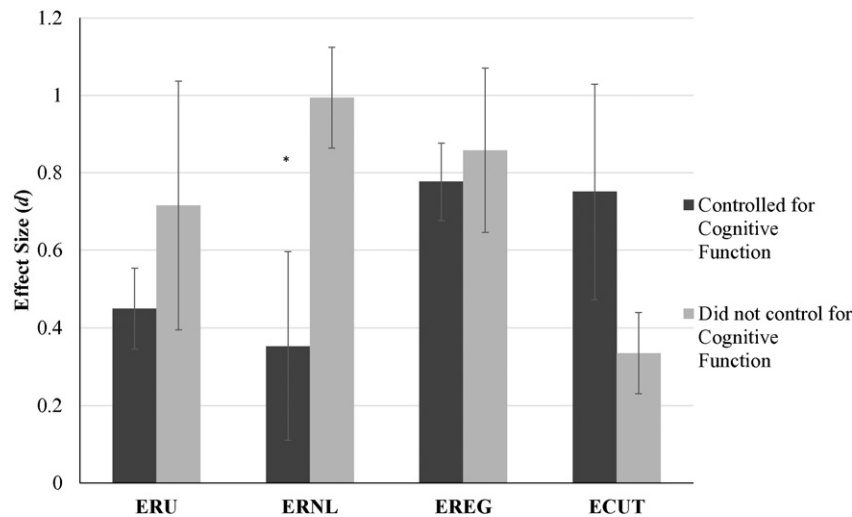


Fig. 3. Association between ADHD and emotion dysregulation domains moderated by cognitive functioning. *Note.* * $p < .05$. ERU = emotion recognition/understanding, ERNL = emotion reactivity/negativity/lability, EREG = emotion regulation, ECUT = empathy/callous-unemotional traits.

6. Discussion

Given emerging research suggesting that emotion dysregulation is a core aspect of ADHD (Bunford et al., 2015; Martel, 2009; Shaw et al., 2014), the current study sought to determine the extent to which ADHD is associated with multiple facets of emotion dysregulation as outlined in Gross (1998)'s emotion generation model. Central to determining the role of emotion dysregulation in ADHD was examining the extent to which the presence of co-occurring CP as well as cognitive functioning impact the proposed association between ADHD and emotion dysregulation. Our research questions were examined via a meta-analysis of 77 studies, the first to our knowledge that has focused on ADHD and emotion dysregulation in children and adolescents. Additionally, understanding which aspects of emotion dysregulation are impaired in youth with ADHD holds significant clinical implications in terms of informing both behavioral and pharmacological interventions.

Starting with the more basic process, impairment in emotion recognition/processing has long been conceptualized as a core feature of Autism Spectrum Disorder in children (Hall, Szechtman, & Nahmias, 2003; Wong, Beidel, Sarver, & Sims, 2012). On the other hand, mixed evidence exists to whether youth with ADHD also have difficulty with ERU (Deschamps et al., 2014; Dyck et al., 2001), with some suggestions that they may be due to co-occurring CP (Dodge, 1993), or more specifically attributed to deficits in cognitive functioning/understanding skills (Blankson et al., 2013). Given the well-documented social deficits among youth with ADHD (Bagwell, Molina, Pelham, & Hoza, 2001; Barkley & Fischer, 2010), it was important to examine these mixed findings. Our meta-analysis documents a moderate effect size ($d = .64$) showing that ERU is also compromised in youth with ADHD. This finding suggests that youth with ADHD, at a more basic level, have some difficulty encoding and processing emotional information. While the social deficits documented in youth with ADHD are sometimes attributed to co-occurring CP and/or difficulties controlling their emotions (Frankel & Feinberg, 2002), they can also occur independently (Bunford et al., 2015; McQuade & Hoza, 2008). Hence, there may be quite a bit more to the story regarding the underlying reasons for why youth with ADHD experience social impairment. The empirical data summarized here appear to support the possibility that children with ADHD suffer from basic ERU deficits, independent of co-occurring CP or cognitive functioning, which may contribute to their difficulties in social interactions. More longitudinal work is needed examining ERU changes across development for youth with ADHD and whether changes in such ERU relates to changes in social functioning. It is also important to acknowledge the possibility that the ERU deficits found in the current study may

be at least part of a more general encoding and processing deficit. Therefore, more studies are needed comparing processing skills across both emotional and non-emotional situations among youth with ADHD.

Perhaps the most complex dimension of emotion dysregulation reviewed is emotion reactivity. Part of the complexity is the multiple terms that are used across different disciplines (developmental psychology, neuropsychology, clinical psychology, psychiatry) ranging from terms like emotionality, reactivity, lability, emotional impulsivity. Regardless of the term and slight differences in how one conceptualizes an individual's strength of response to an emotional experience, there is consensus that high emotional reactivity tend to be associated with poor outcomes across domains (Campbell-Sills, Barlow, Brown, & Hofmann, 2006; Shapero & Steinberg, 2013; Silk, Steinberg, & Morris, 2003). Our findings document a significant and strong link between ADHD and emotional reactivity such that youth with ADHD are more likely to experience intense negative and positive emotions and are reported as more reactive to stressful and/or frustrating situations ($d = .95$). Perhaps just as noteworthy, is the fact that this association was not moderated by co-occurring CP. On the other hand, individual differences in cognitive functioning did moderate the link between ADHD and ERNL such that studies that controlled for cognitive functioning reported significantly lower effect sizes (more than half the magnitude) compared to studies that did not control for cognitive functioning. Developmental research has provided convincing evidence showing that cognitive and emotion control processes develop in parallel and provide bidirectional/reciprocal effects on one another (Bell & Wolfe, 2004; Blair, 2002; Bush et al., 2000; Carlson & Wang, 2007; Fox & Calkins, 2003; Sjöwall et al., 2013). Our finding further highlights the importance of understanding the heterogeneity of cognitive functioning among youth with ADHD given its impact on the experience of emotions.

It is also important to note that almost all studies relied exclusively on parent/teacher or self-report. While it certainly appears that ERNL has a significant and central role in the conceptualization of ADHD, it will be crucial for future studies to examine objective/observational measures of ERNL. Additionally, most studies reviewed conceptualized youth's ERNL as a combination of both positive and negative emotions with no study solely examining children's positive reactivity. Given that reactivity to positive events can on their own contribute to children's functioning (Catalino & Fredrickson, 2011), it will be important for future work within the ADHD child literature to examine differences in positive reactivity. Within the negative emotionality domain, almost no studies compared the reactivity of different negative emotions (e.g., anger vs. sadness) which will be important to do given that

some theoretical work has focused on anger as the primary emotion involved in emotional impulsivity (Barkley & Fischer, 2010). Lastly, it is important to note the high degree of overlap between emotional lability and emotional reactivity measures. This is an important point as these constructs are not synonymous as lability constitutes more of the back and forth of the emotional reactivity process. Hence, more measurement work is needed to create an assessment and/or questionnaire that can accurately differentiate emotional reactivity from lability. A more precise differentiation of these constructs will allow us to determine whether youth with ADHD simply have strong emotional reactions that subside and/or if they actually have a more up and down experience of emotions (i.e., lability).

Since Barkley's (1997) influential behavioral inhibition theory of ADHD, deficits in EREG has been posited as a correlate of ADHD with this correlate gaining more importance over the last decade (Barkley, 2010; Bunford, Evans & Wymbs, 2015; Shaw et al., 2014). Part of the increased interest in EREG in youth with ADHD is due to recent observations that such EREG difficulties contribute to significant impairments for children with ADHD, above and beyond severity of symptoms (Bunford et al., 2014; Sjöwall et al., 2013). However, similar to work on executive functioning (EF) showing the heterogeneity of the disorder in that most youth with ADHD do not have significant impairments in EF (Nigg, 2013), it was crucial to empirically examine the potential link between deficits in the control or regulation aspect of emotion dysregulation and ADHD. Our meta-analysis found that indeed youth with ADHD do have significant difficulties with EREG ($d = .80$) as observed in the laboratory and/or reported by parents and teachers. Perhaps just as important, this association was independent of co-occurring CP, which was previously theorized as being the primary culprit for emotion dysregulation findings (Nigg, 2005).

It is important to note that the magnitude of the relation between ADHD and EREG difficulties is larger than that of effect sizes of executive dysfunction reported in the literature (Willcutt et al., 2005), and that the magnitude of the link between ADHD and EREG did not vary as a function of whether the study controlled for youth's cognitive functioning. Perhaps it is not too surprising that the level of EREG difficulties found in youth with ADHD is similar in nature to that of EF difficulties. From a physiological perspective there is a significant overlap in the brain structures (e.g., ACC and orbitofrontal cortex) that facilitate the regulation of both emotions and higher order cognitive processes (Semrud-Clikeman et al., 2010). A recent meta-analysis has indeed found a small association between a biological marker of emotion regulation (i.e., RSA withdrawal) and cognitive outcomes including EF (Graziano & Derefinko, 2013), although that same study pointed to the lack of studies linking biological markers of emotion regulation to cognitive outcomes. To more accurately capture the heterogeneity of ADHD, it will be important for future work to examine the link between EF and emotion dysregulation across different levels analyses ranging from biological markers to neural networks measured during cognitive, emotion induction, and frustration tasks.

When examining the link between ADHD and empathy, it is important to acknowledge that recent research within clinical psychology has focused on callous-unemotional (CU) traits as a proxy for referring to low levels of guilt, empathy, and caring for others (Frick et al., 2013). CU traits have mainly been examined within the context of CP as children displaying high levels of CU traits tend to experience more aggressive, pervasive, and disruptive behaviors across age groups (Enebrink, Andershed, & Långström, 2005; Hawes & Dadds, 2005; Lynam, Miller, Vachon, Loeber, & Stouthamer-Loeber, 2009). The results of our meta-analysis provides clear support that the association between ADHD status and ECUT is largely explained by co-occurring CP but was unaffected by accounting for children's cognitive functioning. However, it is important to note that even after accounting for CP, a small association between ADHD and ECUT exists ($d = .25$). The mechanisms linking ADHD and CU traits may differ from those of youth displaying more severe CP. Specifically, given the aforementioned ERU deficits

documented in this paper, it is possible that youth with ADHD do not engage in as many empathetic responses simply due to initially not recognizing the emotional state of others. On the other hand, youth with severe CP may simply not care enough to engage in any empathetic responses. It will be important for future work to compare these subgroups of youth with disruptive behavior disorders across various emotion dysregulation tasks to further understand the mechanisms linking ADHD and CU traits.

Other moderation analyses indicated a significant association between youth age and ERNL (but not with any other emotion dysregulation outcome) with the magnitude of the association being stronger with samples that included older children. This finding is consistent with the developmental trajectories of mood disorders such that more occurrences of lability (i.e., less stability) start to emerge in adolescence and across young adulthood (Carstensen et al., 2011). However, given that almost all studies we reviewed were cross-sectional in nature, we cannot preclude the possibility that such ERNL may be at least partially a consequence of the various functional impairments a child with ADHD may suffer from early childhood to adolescence. For example, a constant pattern of peer rejection and academic difficulties may influence a child's stress reactivity system such that it creates an overload in which future incidents may instigate a quicker emotional response (Dodge et al., 2003). More longitudinal work, particularly measuring ERNL in the toddlerhood and preschool period, is needed to determine whether early signs of ERNL predict later ADHD status. It is also important to acknowledge that the link between age and ERNL may also be a function of common method variance as almost all studies that we reviewed that measured ERNL did so using rating scales which implicitly make age based comparisons. Additionally, teachers tend to judge youth's behavioral and social-emotional functioning relative to their peers. Hence, high levels of ERNL may be viewed by raters as more typical of younger children which would result in less of a reported difference when compared to young children with ADHD.

Of note, no other demographic factors including sex, moderated the associations between ADHD and youth's emotion dysregulation factors. The null finding as it relates to sex is noteworthy as a handful of studies have suggested that boys may be more likely to have EREG difficulties (Weinberg, Tronick, Cohn, & Olson, 1999), ERU (Kothari, Skuse, Wakefield, & Micali, 2013), and ECUT (Essau, Sasagawa, & Frick, 2006) while girls may have more instances of ERNL (Labouvie-Vief, Lumley, Jain, & Heinze, 2003). Hence, despite higher rates of ADHD among boys as well as in the diagnosis of Autism Spectrum Disorder (Jang et al., 2013), which may influence ERU findings, the current meta-analysis found that the link between ADHD and emotion dysregulation is similar in strength for boys and girls, alike.

In terms of limitations, it is important to acknowledge that almost all studies we reviewed were cross-sectional in nature thus precluding us from determining the directionality of the link between ADHD and emotion dysregulation. For example, it is conceivable that the social difficulties and peer rejection experienced early in life among some children with ADHD would affect children's stress responses overtime and perhaps contribute to greater levels of ERNL in adolescence. Within the EREG domain and given the overlap in brain regions associated with cognitive control and EREG, it is likely that EREG difficulties have a bi-directional link with ADHD as self-regulation processes involved in emotion, behavior, and attention develop rapidly in an intertwined manner across the toddlerhood period, prior to any formal identification of ADHD (Cole et al., 2004). It will be important for future longitudinal studies to measure emotion dysregulation across domains in toddlerhood and carefully track the development of ADHD symptoms to more accurately model the bidirectional or developmental cascade that may occur due to early difficulties with emotion dysregulation. It is important to note that while the method of diagnosing youth's ADHD was not a significant moderator in the analyses, a small percentage of included studies used non-evidence based methods such as relying solely on past medical records while one study relied primarily on

adolescent self-report to arrive at a diagnosis. We were also not able to examine whether subtype of ADHD moderated any link between ADHD status and emotion dysregulation as most studies did not examine these subtypes separately or did not have enough children in certain subtypes. Of note, [Bunford et al. \(2014\)](#) reported that emotion dysregulation did not differ as a function of adolescents' ADHD subtype. On the other hand, it is possible that the link between ADHD and emotion dysregulation is stronger for youth with the combined subtype presentation (indicative of both inattention and hyperactivity/impulsivity difficulties) whereas youth with a predominantly inattentive type presentation (indicative of only attention problems) may have more subtle emotion dysregulation impairments ([Barkley, 2010](#); [Wheeler Maedgen & Carlson, 2000](#)). Lastly, given that the current study's framework sought to clarify the link between emotion dysregulation and ADHD along with other associated externalizing problems (i.e., aggression, ODD), comorbid affective disorders (i.e., anxiety and depression) were excluded. However, it is important to acknowledge that affective disorders are marked by both EREG and ERNL difficulties and as such may be implicated in the comorbidity with ADHD (see [Meinzer, Pettit, & Viswesvaran, 2014](#) for a review).

In summary, this study marks the first meta-analysis to examine the role of emotion dysregulation across domains in youth with ADHD. We found evidence to suggest that youth with ADHD display the strongest deficits within the ERNL domain followed by EREG and ERU, and that such deficits are independent of co-occurring CP. It is important to note that youth's cognitive functioning only had a significant impact on the link between ADHD and ERNL. Hence, it is possible that deficits in cognitive/EF skills among youth with ADHD are more readily responsible for the initial experience and quick reactivity to emotional states but may not affect the modulation or more effortful regulatory component that takes place after the emotional experience. From a clinical intervention perspective, perhaps it would be more fruitful if we can help teach youth with ADHD to not only "calm down" (i.e., regulatory component) but also how to evaluate and more proactively think about how to handle challenging situations prior to them initiating an emotional reaction.

Notably, the strength of the association between ADHD and ECUT was moderated by co-occurring CP with a smaller yet significant independent association remaining after accounting for co-occurring CP. Given the developmental trajectory of early ADHD and ODD toward later CD ([Biederman et al., 2008](#); [Gresham et al., 2000](#); [Van Lier, Der Ende, Koot, & Verhulst, 2007](#)), the current study points to the importance of remaining vigilant that youth with only ADHD may still display

CU traits. More work is needed examining whether the CU traits present in young children with ADHD (in the absence of ODD) differ from those with a more comorbid presentation (ADHD + ODD) and how CU traits in the absence of CP impact children's developmental course. From a theoretical perspective, our findings highlight the importance of conceptualizing ADHD not only as a disorder with deficits in top-down cognitive processes but also one that experiences emotional difficulties from a bottoms-up perspective ranging from difficulty just recognizing others' emotions to experiencing negative emotions intensely. When combined with poor emotion regulation, it is evident how these bottoms-up emotional processes can have significant implications for engaging in appropriate social behaviors. It will be important for neuroscience research to examine the neural correlates and specific brain regions involved in these emotion dysregulation processes among children with ADHD as this may aid in the early identification of children at-risk for emotion dysregulation. Lastly, while both stimulant medication and behavioral parent training are considered evidence-based treatments for ADHD ([Chronis, Jones, & Raggi, 2006](#); [Pelham & Fabiano, 2008](#)), they have both failed to successfully improve the social functioning of youth with ADHD ([Evans, Langberg, Raggi, Allen, & Buvinger, 2005](#)). It will be important for future clinical interventions, both behaviorally and pharmacologically, to measure changes in youth's emotion dysregulation across domains and if necessary develop ancillary interventions that more directly targets emotion regulation as well as emotion recognition/understanding as these emotional processes may be key improving the social functioning of youth with ADHD.

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Contributors

Paulo Graziano designed, analyzed, and wrote the study. Alexis Garcia conducted literature searches and coded articles for analyses as well as provided editorial comments on the manuscript. Both authors contributed to and have approved the final version of the manuscript.

Conflict of interest

All authors declare that they have no conflict of interest.

Appendix A. Coded qualities and weighted effect sizes of studies of ADHD and children's emotion dysregulation outcomes.

Study		Demographic variables				Emotion dysregulation factors					
		Mean age in years	% of sample male	% of sample Caucasian	Design (between vs. within subject)	How was ADHD diagnosed?	Controlled for CP?	Controlled for cognitive functioning?	Emotion dysregulation domain measured	Effect Size (d)	N
1	Anastopoulos et al. (2011)	8.70	61	N/A	Between	Parent & teacher report, diagnostic interview	No	No	ERNL (P)	.95	358
2	Aspan et al. (2014)	14.70	100	N/A	Between	Previous records	No	Yes	ECUT (M)	1.15	44
3	Babb, Levine, and Arseneault (2010)	9.56	63	64	Between	Parent & teacher report, diagnostic interview	Yes	Yes	EREG (O)	1.50	80
4	Banaschewski et al. (2012)	11.60	69	100	Between	Parent & teacher report, diagnostic interview	No	Yes	ERNL (M)	1.85	988
5	Berlin, Bohlin, Nyberg, and Janols (2004)	8.35	100	N/A	Between	Parent & teacher report, diagnostic interview	No	Yes	EREG (P)	1.46	63
6	Blader et al. (2013)	9.31	79	69	Between	Parent & teacher report	Yes	No	ECUT (T)	.49	160
7	Blaskey, Harris, and Nigg (2008)	10.06	67	80	Between	Parent & teacher report, diagnostic interview	Yes	Yes	ERU (O)	.14	134
8	Boakes et al. (2007)	10.21	100	N/A	Between	Parent report	No	Yes	ERU (O)	.63	48
9	Braaten and Rosen (2000)	8.05	100	81	Between	Parent & teacher report, diagnostic interview	No	Yes	ERNL (P) ECUT (O)	1.22 1.07	43
10	Brammer and Lee (2012)	7.40	50	49	Between	Diagnostic report	No	Yes	ECUT (P)	1.22	106

Appendix A (continued)

Study	Demographic variables				How was ADHD diagnosed?	Controlled for CP?	Emotion dysregulation factors			
	Mean age in years	% of sample male	% of sample Caucasian	Design (between vs. within subject)			Controlled for cognitive functioning?	Emotion dysregulation domain measured	Effect Size (d)	N
11 Brotman et al. (2010)	13.80	62	N/A	Between	Diagnostic interview	No	Yes	ERU (O)	.10	55
12 Bubier and Drabick (2008)	7.79	54	N/A	Within	Parent report	Yes	Yes	EREG (B)	.24	63
13 Bunford et al. (2014)	13.5	76	77	Within	Parent & teacher report, diagnostic interview	Yes	Yes	EREG (S)	.30	180
14 Cadesky, Mota, and Schachar (2000)	9.23	77	N/A	Between	Parent & teacher interviews	Yes	Yes	ERU (O)	.65	200
15 Cordier, Bundy, Hocking, and Einfeld (2010)	8.75	80	67	Between	Previous records	Yes	No	ERNL (P) ECUT (O)	1.28 .43	238
16 Carroll et al. (2006)	10.16	83	N/A	Between	Previous records	No	No	ERNL (S)	.39	70
17 Corbett and Glidden (2000)	9.79	64	N/A	Between	Parent report	No	Yes	ERU (O)	1.19	74
18 Crundwell (2005)	8.47	100	78	Within	Parent & teacher report, diagnostic interview	No	No	ERNL (P)	.95	32
19 Cukrowicz, Taylor, Schatschneider, and Iacono (2006)	14.49	47	98	Between	Diagnostic interview	Yes	No	ERNL (S)	2.49	2876
20 Dadds et al. (2012)	10.52	76	N/A	Within	Parent & teacher report, diagnostic interview	Yes	No	ERU (O) ECUT (M)	.06 -.02	195
21 Da Fonseca et al. (2009)	10.17	78	100	Between	Parent & teacher report, diagnostic interview	No	Yes	ERU (O)	.77	54
22 Demurie, De Corel, and Roeyers (2011)	13.97	86	N/A	Between	Previously diagnosed, confirmation with parent report	Yes	Yes	ECUT (O)	.41	44
23 Deschamps et al. (2014)	7.00	61	N/A	Between	Previously diagnosed, confirmation with parent report	No	Yes	ERU (O) ECUT (M)	.08 .65	131
24 De Pauw and Mervielde (2011)	10.40	83	100	Between	Previously diagnosed, confirmation with parent report	No	No	ERNL (P)	1.04	519
25 Dittmann, Banaschewski, Schacht, and Wehmeier (2014)	9.60	73	N/A	Within	Previous records	No	Yes	ERNL (P)	.18	504
26 Downs and Smith (2004)	8.30	100	N/A	Between	Previous records	Yes	Yes	ERU (O)	1.22	36
27 Dyck et al. (2001)	12.09	74	N/A	Between	Previous records	No	Yes	ERU (O)	1.09	71
28 Factor, Reyes, and Rosen (2014)	9.83	64	61	Between	Diagnostic interview	Yes	No	ERNL (P)	.02	64
29 Falk and Lee (2012)	7.4	71	56	Between	Parent & teacher report, diagnostic interview	No	No	ECUT (P)	.39	208
30* Fowler et al. (2009)	14.50	91	N/A	Within	Parent & teacher report, diagnostic interview	Yes	No	ECUT (S)	.22	156
31 Frick et al. (2003)	12.36	52	N/A	Between	Parent report	Yes	No	ECUT (M)	.41	98
32 Graziano, McNamara, Geffken, and Reid (2011)	10.75	78	71	Within	Parent report	No	Yes	ERNL (P)	1.28	80
33 Greenbaum, Stevens, Nash, Koren, and Rovet (2009)	9.10	66	N/A	Between	Previous records	No	Yes	ERU (O)	.98	64
34 Haas et al. (2014)	9.72	76	82	Between	Parent & teacher report, diagnostic interview	No	Yes	ECUT (P)	1.91	72
35 Haas et al. (2015)	9.7	76	82	Between	Parent & teacher report, diagnostic interview	No	Yes	ECUT (P)(T)	3.1	72
36 Hogue, Dauber, Lichvar, and Spiewak (2012)	15.10	54	2	Between	Parent report, diagnostic interview	No	No	ECUT (P)	.52	168
37 Jarratt, Riccio, and Siekierski (2005)	11.80	69	78	Between	Parent & teacher report, diagnostic interview	No	Yes	EREG (P)	1.12	68
38 Jensen and Rosen (2004)	9.25	75	75	Between	Previous records	No	No	ERNL (P)	.93	67
39 Katic et al. (2013)	9.10	71	71	Within	Previously diagnosed, confirmation with parent report	No	Yes	EREG (P)	.68	316
40 Kolko and Pardini (2010)	8.80	85	45	Within	Parent & teacher report, diagnostic interview	No	No	ECUT (T)	.26	177
41 Linder, Kroyzer, Maeir, Wertman-Elad, and Pollak (2010)	12.50	59	N/A	Between	Informal interview based on DSM-IV	No	No	EREG (P)	1.09	158
42 Ludlow, Garrod, Lawrence, and Gutierrez (2014)	13.86	81	N/A	Between	Parent report	No	Yes	ERU (O)	.77	48
43 Martel and Nigg (2006)	9.45	63	72	Between	Parent & teacher report, diagnostic interview	No	Yes	ERNL (P)	1.32	179

(continued on next page)

Appendix A (continued)

Study		Demographic variables				How was ADHD diagnosed?	Controlled for CP?	Emotion dysregulation factors			
		Mean age in years	% of sample male	% of sample Caucasian	Design (between vs. within subject)			Controlled for cognitive functioning?	Emotion dysregulation domain measured	Effect Size (d)	N
44	Martel, Nigg, and Von Eye (2009)	12.46	61	75	Between	Parent & teacher report, diagnostic interview	No	No	ERNL (P)	1.04	363
45	Marton, Wiener, Rogers, Moore, and Tannock (2009)	10.14	100	N/A	Between	Parent & teacher report, diagnostic interview	Yes	Yes	ECUT (P)	.12	92
46	McCandless and O'Laughlin (2007)	8.24	70	94	Between	Parent & teacher report	No	No	EREG (P)(T)	.65	70
47	McKenzie and Lee (2014)	7.86	N/A	55	Between	Parent & teacher report, diagnostic interview	Yes	Yes	ECUT (M)	.70	221
48	McMahon, Witkiewitz, and Kotler (2010)	13.42	58	54	Within	Diagnostic interview	No	No	ECUT (P)	.56	754
49	Melnick and Hinshaw (2000)	9.11	100	55	Between	Parent & teacher report, diagnostic interview	Yes	Yes	EREG (O) ERNL (O)	.52 .22	79
50	Musser et al. (2011)	8.02	47	67.84	Between	Parent & teacher report, diagnostic interview	No	Yes	EREG (B)	.47	66
51	Musser, Galloway-Long, Frick, and Nigg (2013)	7.60	57	88	Between	Parent & teacher report, diagnostic interview	Yes	Yes	EREG (B)	.16	150
52	Norvilitis, Casey, Brooklier, and Bonello (2000)	10.27	64	69	Between	Previous records	No	Yes	ERU (O)	.48	80
53	Pardini and Fite (2010)	10.70	100	44.8	Within	Diagnostic interview	Yes	No	ECUT (P)	.12	1517
54	Pelc, Kornreich, Foisy, and Dan (2006)	8.1	77	N/A	Between	Previous records	No	No	ERU (O)	1.25	60
55	Posner et al. (2011)	13.45	N/A	N/A	Between	Parent ratings, diagnostic interview	No	Yes	ERNL (O)	.98	30
56	Rosen and Factor (2012)	9.29	70	59	Within	Diagnostic interview	No	No	EREG (P)	.80	27
57	Scime and Norvilitis (2006)	9.65	58	87	Between	Previous records	No	Yes	EREG (S) ERNL (S)	.82 .49	64
58	Semrud-Clikeman et al. (2010)	10.25	60	78	Between	Parent & teacher report, diagnostic interview	No	No	EREG (P)	1.12	96
59	Seymour et al. (2012)	11.66	57	54	Between	Parent & teacher report, diagnostic interview	No	Yes	EREG (M)	.82	69
60	Seymour, Chronis-Tuscano, Iwamoto, Kurdziel, and MacPherson (2014)	11.00	56	49	Within	Parent report	No	No	ERNL (P)	1.58	277
61	Singh et al. (1998)	8.6	68	32	Within	Previous records	No	No	ERU (O)	.58	50
62	Sinzig, Morsch, and Lehmkuhl (2008)	12.75	85	N/A	Between	Diagnostic interview	No	Yes	ERU (O)	.45	59
63	Sjöwall et al. (2013)	10	45	N/A	Between	Parent & teacher report, diagnostic interview	Yes	Yes	EREG (P) ERU (O)	1.35 .52	204
64	Sjöwall, Backman, & Thorell (2015)	5.6	65	N/A	Between	Parent & teacher report, diagnostic interview	Yes	Yes	EREG (P)	.70	104
65	Sobanski et al. (2010)	10.6	65	N/A	Between	Parent & teacher report, diagnostic interview	Yes	Yes	ERNL (P)	.10	3013
66	Stringaris and Goodman (2009)	13.60	52	N/A	Between	Diagnostic interview	No	No	ERNL (M)	1.15	4911
67	Stringaris, Maughan, and Goodman (2010)	3.17	51	N/A	Between	Parent report, diagnostic interview	Yes	No	ERNL (P)	.12	7140
68*	a) Haas et al. (2011) b) Woodworth and Waschbusch (2008) c) Waschbusch, Carrey, et al. (2007) d) Waschbusch, Craig, et al. (2007)	9.66	78	85	Between	Parent & teacher report, diagnostic interview	Yes	Yes	ERU (O) ECUT (M)	−.04 .45	183
69	Walcott and Landau (2004)	9.17	100	94	Between	Parent report	No	No	EREG (O)	.80	49
70	Wählstedt et al. (2008)	6.67	45	N/A	Between	Parent & teacher report	No	Yes	EREG (P)	1.12	87
71	Waller et al. (2014)	3.45	51	86	Within	Parent & teacher report	Yes	Yes	ERU (O) ECUT (P)	.24 .43	240
72	Waschbusch et al., (2004)	8.13	52	N/A	Within	Parent & teacher report	Yes	No	ECUT (P)(T)	.08	1579
73	Waschbusch and Willoughby (2008)	8.38	50	N/A	Within	Teacher report	No	No	ECUT (T)	1.67	214
74	Waschbusch, Graziano, Willoughby, and Pelham (2014)	8.14	54	N/A	Within	Teacher Report	Yes	No	ECUT (T)	.58	648
75	Wheeler Maedgen and Carlson (2000)	10.2	70	79	Between	Parent & teacher report, diagnostic interview	No	Yes	EREG (O) ERNL (O)	.63 .63	47
76	Williams et al. (2008)	13.44	100	N/A	Between	Parent report	No	Yes	ERU (O)	.63	102
77	Yuill and Lyon (2007)	8.92	100	N/A	Between	Previous records	No	Yes	ERU (O)	1.91	38

Note. *One effect size derived from multiple studies using overlapping sample, N/A = not available in article, (P) = parent report, (T) = teacher report, (S) = self-report, (M) = multiple reporters combined, (O) = observational, (B) = biological marker of emotion regulation: RSA withdrawal during a challenging task.

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