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Anxiety and Callous-Unemotional Traits: Physiological and Behavioral Responses to Others' Distress

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ANXIETY AND CALLOUS-UNEMOTIONAL TRAITS: PHYSIOLOGICAL AND BEHAVIORAL RESPONSES TO OTHERS' DISTRESS

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Kathleen Isabel Crum

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

This dissertation, written by Kathleen Isabel Crum, and entitled Anxiety and Callous-Unemotional Traits: Physiological and Behavioral Responses to Others' Distress, having been approved in respect to style and intellectual content, is referred to you for judgment.

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

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Florida International University, 2016

DEDICATIONS

To my loving family, a team I would never trade; to my dear friend Tiffany, who crosses this finish line with me in my heart; and to everyone in the arena, wondering how much they dare to achieve.

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ABSTRACT OF THE DISSERTATION

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Professor Jonathan S. Comer, Major Professor

Research documents considerable anxiety-related heterogeneity in youth with callous-unemotional traits (CU), a pattern of callousness and shallow emotionality (Frick & Ellis, 1999) associated with lasting impairment (Fontaine et al., 2011). This heterogeneity may relate to behavioral differences, with the presence of both CU and anxiety associated with increased questionnaire-based reports of aggression and/or historical documentations of past aggression (Kahn et al., 2013). Anxiety in CU youth is associated with greater attention to others' distress cues (Kimonis et al., 2012) compared to CU-only counterparts, in contrast to the decreased distress-cue attentiveness thought to contribute to aggression in CU youth (Dadds et al., 2011). Through its association with improvements in CU youths' ability to detect others' distress, anxiety may heighten autonomic activity associated with emotional processing, in contrast to the dampened autonomic activity observed in CU youth (de Wied et al., 2012). It is possible that CU associations with distress-cue recognition and parasympathetic-based emotion-regulation vary as a function of anxiety, and in turn are associated with aggression. The present study, conducted with a sample of youth ages 7-13 (*N*=45), incorporated laboratory tasks and self- and caregiver-report questionnaires to assess the extent to which child anxiety, traumatic stress, CU, and their interactions, predict observed aggressive behavior toward other children and perceptions of others' emotions while experimentally manipulating distress-cue salience. Exploratory analyses considered parasympathetic activity that may associate with observed relationships. Overall, results align with non-experimental research suggesting that CU is associated with greater aggression in the presence of anxiety (Fanti et al., 2013), and clarify that anxiety moderates the effect of CU on aggression, but only in the absence of distress cues from a potential victim. Results also hint that relationships between anxiety and parasympathetic responses to others' distress may help explain anxiety-related heterogeneity in CU youths' aggression. Findings suggest that children with CU and anxiety may benefit from emotional training to anticipate others' distress and identify distress cues. In aggressive situations involving these youth, increasing others' distress-cue salience may attenuate violence. Future research must further investigate emotional processing deficits, and their role in the development of aggression, among CU youth with anxiety.

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American Psychiatric Association	APA
Antisocial behavior	AB
Attention Deficit-Hyperactivity Disorder	ADHD
Callous-unemotional traits	CU
Central nervous system	CNS
Child PTSD Symptom Scale	CPSS
Conduct problems	CP
Electrocardiogram	EKG
Full-scale Intelligence Quotient	FSIQ2
Hierarchical linear modeling	HLM
Hostile attribution bias	HAB
Inventory of Callous-Unemotional Traits	ICU
Lower limit of 95% confidence interval	LLCI
Medium	Med
Missing completely at random	MCAR
Multidimensional Anxiety Scale for Children, Second Edition	MASC
Parasympathetic nervous system	PNS
Peer Perception Scale	PPS
Posttraumatic Stress Disorder	PTSD
Respiratory sinus arrhythmia	RSA
Standard deviation	SD
Standard error	SE
Statistical Package for the Social Sciences	SPSS

Upper limit of 95% confidence interval	UCLI
Wechsler Abbreviated Scale of Intelligence, Second Edition	WASI-II

I. INTRODUCTION

Research documents considerable heterogeneity in youth presenting with callous-unemotional (CU) traits, a pattern characterized by callousness, shallow emotionality, and a lack of guilt following transgressions (CU; Frick & Ellis, 1999). Empirical work suggests that anxiety-related heterogeneity in youth showing CU traits may be related to meaningful differences in associated aggressive behavior, with the presence of both CU traits and anxiety associated with a specific pattern of emotional processing deficits and *higher* levels of aggression than children with just CU traits (Docherty, Boxer, Huesmann, O'Brien, & Bushman, 2015; Euler et al., 2015; Fanti, Demetrious, & Kimonis, 2013; Humayun, Kahn, Frick, & Viding, 2014; Kahn et al., 2013; Kimonis, Skeem, Cauffman, & Dmitrieva, 2011; Lee, Salekin, & Iselin, 2010; Rosan, Frick, Gottlieb, & Fasicaru, 2015). However, much of this research has relied exclusively on questionnaire reports of aggressive behavior rather than observed aggressive behavior (e.g., Kimonis et al., 2011; Lee et al., 2010), and has not examined how anxiety and CU traits predict child aggression in the context of experimentally manipulated distress cue salience from potential victims. Much remains to be learned about the processes underlying observed associations between anxiety, CU traits, and aggressive behavior among youth in order to optimally inform taxonomy questions and intervention efforts.

CU Traits

Considerable evidence documents the occurrence of children with serious behavior problems who exhibit callousness, shallow emotionality, and a lack of guilt following transgressions (i.e., CU traits; Frick & Ellis, 1999). Such CU traits constitute a profile now recognized in leading psychiatric taxonomies (e.g., American Psychiatric Association [APA], 2013), affect roughly one-third of youth with behavior problems (Christian et al., 1997), and are associated with significant social and behavioral impairment across the lifespan (Fontaine et al., 2011; Lynam et al., 2007; Obradovic, Pardini, Long, & Loeber, 2007), and although they have been traditionally conceptualized in the context of conduct disorder, emerging empirical work supports consideration of CU traits as a transdiagnostic construct (Herpers, Rommelse, Bons, Buitelaar, & Scheepers, 2012; Herpers, Klip, Rommelse, Greven, & Buitelaar, 2016; Moran et al., 2009).

There is now strong evidence that children showing CU traits differ in important ways from children with behavioral problems who do not show CU traits, and from children without behavioral problems. For example, relative to peers, CU youth exhibit antisocial behavior (AB) that is more severe, stable, and varied in nature (Frick, Kimonis, Dandreaux, & Farell., 2003b; Frick & Dantagnan, 2005), show higher levels of reactive (lashing out in response to perceived provocation) and proactive (calculated, goal-directed aggression in the absence of anger; Dodge & Coie, 1987) aggression (Fanti, Frick, & Georgiou, 2009; Lozier, Cardinale, VanMeter, & Marsh, 2014; Marsh et al., 2013; Waschbusch et al., 2004), and show diminished or varied responsiveness to traditional behavioral treatments targeting AB (Hawes, Price, & Dadds, 2014b; McDonald et al., 2011; Waschbusch et al., 2007) relative to children without CU traits.

Heterogeneity in CU

Much remains to be learned about pathways leading to AB among youth showing CU traits. Given physiological, temperamental, and cognitive differences associated with

CU, it has been proposed that the AB of children with CU arises from a separate pathway relative to the AB of children without CU (Frick et al., 2003a). Moreover, it is unclear whether the same mechanisms underlie AB development for all children with CU, or whether multiple distinct pathways systematically eventuate in CU profiles. Through its relationship with causal pathways to AB, heterogeneity associated with underlying processes in CU likely contributes to mixed intervention response.

CU and Anxiety

Evidence suggests that children with CU constitute a heterogeneous population, with some but not all susceptible to anxiety, which in turn is associated with increased dysfunction and impairment. Importantly, analogous to primary and secondary variants of psychopathy in adults (Karpman, 1948; Skeem, Poythress, Edens, Lilienfeld, & Cale, 2003), whereas the majority of youth showing CU traits do not show elevated levels of anxiety, a subset of CU youth do, and elevated anxiety appears to alter the presentation of CU traits in several key ways. Among children with CU, anxiety has been associated with greater questionnaire-based reports of impulsivity and externalizing behavior problems, as well as higher reports of aggression and delinquency (Kahn et al., 2013; Rosan et al., 2015; Vaughn et al., 2009), especially reactive aggression (Fanti et al., 2013), a more extensive criminal offense record (Kimonis et al., 2011), and increased reports of depressive and psychotic symptoms (Docherty et al., 2015; Vaughn et al., 2009) relative to CU youth without anxiety. These anxiety-related differences hold true despite comparable levels of CU traits, although some studies have noted increased (Kimonis et al., 2011; Lee et al., 2010) or decreased (Euler et al., 2015) CU trait severity among youth who show anxiety symptoms relative to CU youth without anxiety. Anxiety may interact with CU in important ways, but the nature of such interactions and their impact on youth aggressive behavior remain unclear, impeding the identification of tailored treatment targets, and hindering efforts to address the unique needs of children at various points on these continua. Moreover, and importantly, research examining interactions between CU and anxiety and their effects on AB has relied almost exclusively on questionnaire reports of child aggressive behavior (e.g., Fanti et al., 2013; Kahn et al., 2013, Rosan et al., 2015), and the studies that used criminal records did not assess aggression in an experimental context (e.g., Kimonis et al., 2011; Lee et al., 2010), which limits interpretations and cannot rule out issues related to reporter biases, shared method variance, and external circumstances.

Of note, several studies have observed greater trauma exposure among CU youth experiencing anxiety symptoms relative to their counterparts without anxiety (Euler et al., 2015; Kahn et al., 2013; Kimonis et al., 2012; Tatar et al., 2012). Trauma is central to theory underlying origins of primary and secondary variants in psychopathy (e.g., Porter, 1996), and may be a particularly relevant factor in the affective and behavioral characteristics of children with CU and anxiety, considering research suggesting that traumatic stress-related emotional numbing symptoms link violence exposure and delinquency (Allwood, Bell, & Horan, 2011), and often co-occur with hypervigilance/hyperarousal symptoms (Weems, Saltzman, Reiss, & Carrion, 2003). Furthermore, trauma-exposed youth show a specific pattern of emotional processing abnormalities, including an attentional bias towards threat (Dalgleish, Moradi, Taghavi, Neshat-Doost, & Yule, 2001), enhanced identification of fearful faces (Masten et al., 2008), and heightened sympathetic nervous system activity (see Teicher, Andersen, Polcari, Anderson, & Navalta, 2002). It is worthwhile to assess the degree to which the aggressive reactivity and internalizing symptoms (e.g., Docherty et al., 2015; Fanti et al., 2013) reported by CU youth experiencing anxiety symptoms may actually represent traumatic stress symptoms. Thus far, trauma exposure and traumatic stress symptoms have been examined as clinical correlates differentiating variants of CU youth with respect to anxiety (e.g., Humayun et al., 2013; Kimonis et al., 2012); the potential for traumatic stress to moderate the link between CU and observed aggression in the context of experimentally manipulated distress cues has not been explored.

Anxiety and Emotional Processing in CU

Anxiety-related variations in CU presentation may be a result of differences in emotional processing across affected youth, as deficits in emotional processing are thought to facilitate the development of AB, including aggression, in CU youth (Blair et al., 2006). Child CU traits are associated with deficits in distress cue detection and recognition, as well as emotional responding (e.g., Blair et al., 2005; Muñoz, 2009; Woodworth & Waschbusch, 2008) that are susceptible to correction via increases in distress cue salience (Dadds et al., 2006; Dadds, El Masry, Wimalaweera, & Guastella, 2008; van Baardewijk et al., 2009). Child CU traits have also been associated with deficits in physiological reactions to distress-related cues as indexed by correlates of parasympathetic and sympathetic activity, an important factor in emotional responding (e.g., Blair et al., 2005; de Wied, van Boxtel, Matthys, & Meeus, 2012). These deficits in recognizing and responding to others' emotions correspond with reported deficiencies in cognitive and affective empathy (e.g., Dadds et al., 2009)—the ability to identify and match others' emotional states, respectively (see Hoffman, 1984).

Attention to, and interpretation of, others' emotions influences affective matching of emotional states and, ultimately, emotional responding (Eisenberg et al., 2009; 2010). In addition to deficiencies in cognitive empathy—that is, accurately identifying others' distress-related emotions (Eisenberg & Fabes, 1990; Hoffman, 1984)—CU youth show a pattern of hostile social cognition (see Frick, Ray, Thornton, & Kahn, 2014 for a review). Youth with CU traits downplay the effects of their aggression on victims in hypothetical conflict situations, reporting less concern for victims' suffering, and endorsing social goals focused on dominance and forced respect (Pardini, 2011; Pardini & Byrd, 2012). When children with CU experience anxiety symptoms, they may be particularly at risk for difficulties accurately identifying others' emotions, as anxiety is associated with its own unique pattern of social-cognitive biases, including biased attention towards threat-related stimuli (Taghavi, Moradi, & Neshat-Doost, Yule, & Dalgleish, 2000) and a tendency to interpret neutral stimuli as negative or threatening (Reid, Salmon, & Lovibond, 2006). Although Kimonis and colleagues (2012) examined attention to distress cues among children with CU and anxiety using distressing pictures in a dot-probe task, the extant literature on anxiety in children with CU traits has not investigated perceptions of peer emotion in experimental tasks approximating social interactions.

Understanding these emotional deficits is essential to prevention of AB among children with CU traits, and research has shown the importance of potential victims' distress cue salience in reducing emotion recognition deficits and altering aggressive behavior in CU youth. Increased salience of others' emotional cues has been linked to increased accuracy of emotion recognition among CU youth, perhaps as a function of attention to distress cues (Dadds et al., 2012). Indeed, when children are specifically instructed to attend to emotional cues indicating others' distress, and when distress cue salience itself is increased (Blair, Colledge, Murray, & Mitchell, 2001), discrepancies in distress-related emotion recognition between youth with and without CU traits are reduced (Dadds et al., 2008). Increases in others' distress cue salience have also been associated with a decrease in the strength of the relationship between CU traits and aggression (van Baardewijk et al., 2009). However, it remains unclear how anxiety-based heterogeneity may affect associations between CU, aggression, others' distress cue salience, and physiological and behavioral responses to others' emotions, as well as perceptions of others' emotions.

Impact of anxiety on attention biases in CU.

By signaling the potential for a variety of links between emotional processing and CU traits, anxiety-based differences in attention to others' distress cues may have important implications for understanding links between CU and aggressive behavior, and for developing informed treatment targets. Indeed, evidence suggests that anxiety in CU youth alters emotional processing, and points to variation in the processes underlying the cognitive, temperamental, and behavioral styles typical to CU traits. Among youth with high levels of CU, anxiety is associated with *greater* attention to others' distress cues (Kimonis, Frick, Cauffman, Goldweber, & Skeem, 2012) than CU-only counterparts, in contrast to the decreased attentiveness to these cues thought to contribute to AB in CU youth (Dadds et al., 2011). Only one existing study has examined attention to others' distress cues as a function of CU and anxiety (Kimonis et al., 2012), and while Kimonis and colleagues' findings provide preliminary information on patterns of emotional deficits among CU youth, further research incorporating observational paradigms is needed to examine how such anxiety-CU interaction patterns may influence corresponding *behavioral* heterogeneity.

Links between anxiety and physiological response in CU.

Attentional differences accompanying anxiety in children with CU may be directly associated with corresponding differences in physiological processes, which may in turn affect clinical presentation and intervention response. Despite the lack of research in this area, anxiety in CU youth may result in distinct physiological profiles in response to others' distress. As anxiety is associated with improvements in the ability of CU youth to detect others' distress cues (Kimonis et al., 2012), anxiety may indirectly heighten related autonomic activity associated with emotional processing, in contrast to the dampened parasympathetic and sympathetic activity typically observed in CU youth (e.g., Anastassiou-Hadjicharalambous & Warden, 2008b; Blair, 1999; de Wied et al., 2012; Muñoz, Frick, Kimonis, & Aucoin, 2008). Further, neural abnormalities in the form of limited amygdala function (e.g., Blair et al., 2006; Jones, Laurens, Herba, Barker, & Viding, 2009; Lozier et al., 2014) are associated with the "fearlessness" commonly ascribed to youth with high levels of CU (e.g., Pardini, 2006). Fearlessness is contradictory, however, to the worry and fears associated with chronic, trait-like anxiety in youth with CU (e.g., Fanti et al., 2013). It may be that anxiety lessens these CU-related abnormalities, reducing the blunted parasympathetic and sympathetic activity observed in non-anxious children with CU traits. Thus far, no research has explored relationships between CU, anxiety, and physiological response to others' distress.

Impact of anxiety on behavioral and physiological responses to others' distress in CU.

Considering the potential and observed alterations in emotional processing associated with anxiety in children with CU, it is possible that CU associations with distress cue recognition and with physiological correlates of emotional response and regulation vary as a function of anxiety, and in turn are associated with aggressive behavior in important ways. Emotional processing and physiological correlates appear to play a central role in driving behavioral responses to fear or distress in other individuals. Indeed, accurate emotion identification and optimal levels of affective arousal—facilitated by matching of affective states—are required to elicit prosocial responses to others' distress such that a lack of affective arousal—that is, an affective response to others' distress, thought to be facilitated by physiological activity—precludes prosocial behavior (Eisenberg & Fabes, 1990; Eisenberg et al., 2010). On the other hand, overly high levels of affective arousal are associated with personal distress, which may even encourage aggressive behavior towards the perceived cause of distress, or withdrawal from the distressing stimulus (Eisenberg & Eggum, 2009; Eisenberg et al., 2010). If anxiety enables children with CU to attend to and recognize others' distress more easily, or enables children with CU to experience heightened physiological response to others' distress, differences in behavior should be apparent; however, the manner in which differences in emotional processing associated with anxiety are linked to aggressive behavior is thus far unexamined. Importantly, existing research on relationships between CU, anxiety, and aggression has relied almost exclusively on questionnaire measures, rather than observed measures of aggression (e.g., Rosan et al., 2015), and no existing research has examined these relationships in an experimental context; thus the complex interplays between these factors remain unclear.

Improved understanding of the potential pathways by which emotional processing is linked to aggression among children with CU and anxiety may lie in investigating the role of distress cue salience (e.g., Kimonis et al., 2012). By intensifying others' emotional cues and reducing their ambiguity, increases in the salience of distress cues may influence the manifestation of aggression among children with CU and anxiety. Experimental manipulation of distress cues in the context of social interaction is needed to clarify the role of emotional processing in the heightened aggression documented in children with CU and anxiety. Given this theoretical and empirical background, it is possible that anxiety significantly alters the relationship between CU and empathy-related responding, shaping underlying processes that contribute to behavioral and social impairment.

Project Aims and Hypotheses

The overall goal of this work is to examine the complex interplays between child CU and anxiety in predicting aggressive behavior, to examine how the salience of others' distress cues affects links between CU, anxiety, and aggression, and to consider physiological processes—specifically, parasympathetic activity associated with emotion regulation—that may correlate with such associations. The research incorporated an experimental manipulation in a sample of youth ages 7 to 13 (N=45), incorporating laboratory tasks and self- and caregiver-report questionnaires to assess the extent to which child anxiety, traumatic stress symptoms, CU traits, and their interactions, predict observed aggressive behavior toward other children and perceptions of others' emotions while experimentally manipulating the salience of distress cues from the other child. Observations of aggressive behavior were collected in the context of a competitive game simulation in which, unbeknownst to participating youth, the opponent child against whom participants could aggress was in fact a programmed computer simulation. Exploratory analyses further considered parasympathetic functioning and regulation that may associate with observed relationships. By enhancing the field's understanding of anxiety-related heterogeneity and its interaction with CU, and examining the intricate relationships between underlying attentional and physiological processes and aggression in children, the current study can meaningfully advance theoretical models of CU and lay an empirical foundation for targeted treatment development. Further, the current study can lay the groundwork for future translational investigations of physiological processes mediating emotional processing abnormalities in CU youth.

•Aim Ia: Elucidate the interactive effects of CU and anxiety on behaviorally observed aggression in an experimental context. Hypothesis: Given the growing body of literature documenting a subset of children with CU traits who show significant anxiety and increased questionnaire-based reports of aggression (e.g., Docherty et al., 2015, Rosan et al., 2015) and more extensive criminal records (Kimonis et al., 2011), it was hypothesized that child anxiety will moderate the impact of CU severity on behaviorally observed aggression (regardless of distress cue salience), such that higher levels of child anxiety would be associated with a stronger link between CU and observed aggression.

•Aim Ib: Elucidate the interactive effects of CU and traumatic stress symptoms on behaviorally observed aggression. Hypotheses: Given research documenting more extensive trauma histories among children with CU and anxiety than their CU-only counterparts (e.g., Euler et al., 2015), along with literature indicating potential overlap between callousness and posttraumatic emotional numbing symptoms (Allwood et al., 2011), it was hypothesized that among trauma-exposed youth, traumatic stress symptom severity will moderate the impact of CU severity on behaviorally observed aggression (regardless of distress cue salience), such that higher levels of traumatic stress would be associated with a stronger link between CU and observed aggression.

•Aim IIa: Investigate the extent to which the interactive effects of CU and anxiety on observed aggression vary relative to the salience of a potential victim's distress. Hypotheses: It was expected that CU severity would be strongly associated with observed aggression when the salience of a potential victim's distress is manipulated to be absent, but would not be associated with observed aggression when the potential victim's distress was manipulated to be salient (van Baardewijk et al., 2009). It was expected that the predictive value of the interaction between CU and anxiety would differ in the presence versus absence of others' distress cues, given the unique pattern of emotional deficits observed among youth with CU and anxiety (Kimonis et al., 2012).

•Aim IIb: Investigate the extent to which the interactive effects of CU and traumatic stress symptoms on observed aggression vary relative to the salience of a potential victim's distress. Hypotheses: It was expected that the predictive value of the interaction between CU and traumatic stress symptoms would differ in the presence versus absence of others' distress cues, given the trauma histories reported among youth with CU and anxiety (e.g., Kahn et al., 2013), and the emotional deficits observed among youth with posttraumatic stress (e.g., Dalgleish et al., 2001; Masten et al., 2008).

•Aim IIIa: Elucidate the main and interactive effects of CU and anxiety on perceptions of a potential victim's emotional state in an experimental context. Hypothesis: Given research documenting reductions in emotion recognition deficits (e.g., Dadds et al., 2006) with increased distress cue salience among CU youth, it was expected that CU severity would not be associated with ratings of the simulated opponent's affect ratings in the absence of a distress cue, but that in the presence of a distress cue, CU severity would be associated with increased ratings of the simulated opponent's negative affect, and decreased ratings of the simulated opponent's neutral and positive affect. It was further expected that anxiety would moderate the effect of CU severity on ratings of the simulated opponent's distress-related emotions. Specifically, it was predicted that higher levels of child anxiety would be associated with a stronger link between CU and ratings indicating the simulated opponent's negative affect, such that greater anxiety was associated with higher ratings of these emotions, given literature indicating increased attention to distress cues (Kimonis et al., 2012) among children with CU and anxiety. It was also expected that CU severity would be associated with changes in ratings of the opponent's negative affect, but that anxiety would moderate the effect of CU severity on such changes. Specifically, it was predicted that higher levels of child anxiety would be associated with a stronger link between CU and changes in perceptions of opponents' negative affect, given the increased attention to distress cues (Kimonis et al., 2012) observed among children with CU and anxiety.

•Aim IIIb: Investigate the main and interactive effects of CU and traumatic stress on perceptions of a potential victim's emotional state in an experimental context. Hypothesis: Given literature documenting enhanced identification of fearful faces among trauma-exposed youth (Masten et al., 2008), it was expected that traumatic stress would moderate the effect of CU severity on ratings of the simulated opponent's negative affect. Specifically, it was predicted that higher levels of child traumatic stress would be associated with a stronger link between CU and ratings of the simulated opponent's negative affect, such that greater traumatic stress was associated with higher ratings of these emotions. It was also expected that child traumatic stress would moderate the effect of CU severity on changes in ratings of the opponent's negative affect, such that higher levels of traumatic stress would be associated with a stronger link between CU and changes in perceptions of opponents' negative affect, given literature linking child traumatic stress to enhanced identification of others' fear-related cues (Masten et al., 2008).

•Aim IVa: Elucidate the interactive effects of CU and anxiety on parasympathetic-based regulation in response to others' distress. Hypothesis: It was expected that CU will be associated with blunted parasympathetic response to others' distress similar to previous findings (e.g., Anastassiou-Hadjicharalambous & Warden, 2008b; de Wied et al., 2012), but that anxiety would alter this relationship by increasing parasympathetic response to this stimulus, given that anxiety has been associated with increased attention to distress cues among CU youth (Kimonis et al., 2012).

•Aim IVb: Elucidate the interactive effects of CU and traumatic stress on parasympathetic response to others' distress. Hypothesis: It was expected that traumatic stress would alter the relationship between CU and blunted parasympathetic regulation by increasing parasympathetic response to others' distress, given that traumatic stress has been associated with both increased attention to distress cues (e.g., Masten et al., 2008)—

an emotional processing pattern observed among CU youth (Kimonis et al., 2012)—and heightened autonomic activity (Teicher et al., 2002).

Gaining a better understanding of the relationships between child anxiety, traumatic stress, CU, and observed aggressive behavior in the context of experimentally manipulated distress cue salience is critical to informing individualized treatment strategies and offsetting future difficulties. As a whole, these efforts can contribute valuable information to assessment and intervention science, reducing the heavy burden that CU places on affected individuals, their families, and society at large.

II. METHODOLOGY

Participants and Recruitment

All study activities were approved by the Florida International University Institutional Research Board. A conduct problems (CP)-enhanced community sample was recruited, given the relatively low rate of CU in the general community (Rowe et al., 2010). Specifically, community recruitment of youth included—in addition to broad school-based and flyer-based recruitment—strategic recruitment outreach at clinics offering behavioral treatments for child behavior problems. Phone screens were administered to interested caregivers of potential participants to assess whether children met the following eligibility criteria: 1) age of seven to thirteen years, inclusive; 2) no reported history of autism spectrum disorder or severe mental or physical impairments (e.g., intellectual disability, deafness, blindness); and 3) no current psychotropic treatment, except for stimulant medications which could be easily discontinued for study participation. Eligible families were invited to a laboratory visit to complete the following: 1) informed consent and assent, 2) child laboratory tasks and rating scales, and

3) caregiver rating scales. Prior to the visit, families of children taking stimulant medication were asked to forgo medication administration for a 48-hour washout period. This period is considered sufficient to preclude stimulant medication effects on tasks (Greenhill et al., 2001), and has been used in previous research on children's cognitive task performance (e.g., Wilson, Mitchell, Musser, Schmitt, & Nigg, 2011).

Participants were 45 children between the ages of seven and thirteen (*M*=9.89, *SD*=1.58; 71.1% boys, 28.9% girls) and their caregivers. Caregivers (90.9% mothers, 6.8% fathers, 2.3% grandmothers) reported on child participants' emotions and behavior, as well as demographic information. Regarding race/ethnicity, per caregiver report, 75.6% of child participants were Hispanic, 13.3% were non-Hispanic White, and 11.1% were non-Hispanic Black. Among families for whom income was reported, 50% of caregivers reported an annual income of $48,000 or lower, 25% of caregivers reported an income between $50,000 and $97,000, and 25% of caregivers reported an annual income of $100,000 or higher. Children recruited from clinics showed no differences from children recruited from other community sources with regard to gender ($\chi^2(1)=0.65$, $p=.42$), race/ethnicity ($\chi^2(2)=1.38$, $p=.50$), age ($t(43)=-0.33$, $p=74$) and household income ($t(34)=0.13$, $p=.90$).

Procedures and Measures

During the laboratory visit, informed consent and assent was obtained from caregivers and child participants, respectively. Next, caregivers completed questionnaires on children's emotion and behavioral characteristics, while children participated in several experimental tasks and completed self-report questionnaires. Two laboratory tasks were used to measure child responses to others' distress, and task order was counterbalanced to control for any potential task sequence effects. The order in which the laboratory tasks were administered was chosen using a counterbalance sheet, such that the task order was reversed from the preceding participating, allowing approximately 50% of children to participate in one task first, and 50% of children to participate in the other task first. Following participation in the laboratory tasks, an intelligence test was administered to child participants, and then children completed self-report questionnaires. Lastly, children were de-briefed on the use of deception (as described below) in the laboratory tasks. Caregivers were compensated with a $25 gift card, and children received a toy, following completion of all study activities and measures.

Child callous-unemotional traits. Caregiver ratings on the Inventory of Callous Unemotional Traits (ICU; Essau, Sasagawa, & Frick, 2006) were used to measure child CU traits. The ICU is a well-established measure of CU traits in this age group, and is comprised of 24 items rated on a scale from 0 (“Not at all true”) to 3 (“Definitely true”). Using the original scoring, Kimonis, Fanti, and Singh (2014) found children with a parent-rated ICU total score of 24 or above would benefit from services tailored towards CU traits. Numerous studies support the reliability and validity of the ICU, particularly in distinguishing between CP behaviors and CU (e.g., Fanti et al., 2009; Kimonis et al., 2008; Kimonis et al., 2014; Roose et al., 2009). Hawes and colleagues (2014a) used exploratory factor analysis to identify an alternative scoring method that improved the psychometric properties of the measure. Total scores obtained using Hawes’ et al.’s alternative scoring method were used in the present analyses. Internal consistency was acceptable in the current sample (α=.81).

Child anxiety. Child anxiety was measured by caregiver ratings on the Multidimensional Anxiety Scale for Children, Second Edition (MASC; March, Parker, Sullivan, Stallings, & Conners, 1997; March, 2013). The MASC is comprised of 39 items on a scale from 0 ("Never true about me") to 3 ("Often true about me"). The MASC assesses several domains of anxiety that are summed to yield a total anxiety score. The test-retest reliability and predictive validity of the MASC have been demonstrated by past research (e.g., Muris, Merckelbach, Ollendick, King, & Bogie, 2002; Wei et al., 2014). Internal consistency was very strong in the current sample (α=.92).

Prior child trauma exposure and posttraumatic stress symptoms. In keeping with previous studies exploring the role of anxiety in CU (e.g., Kimonis et al., 2012), children completed a self-report measure of trauma exposure and corresponding posttraumatic stress symptoms. The Child PTSD Symptom Scale (CPSS; Foa et al., 2001) was used to measure child posttraumatic stress symptoms. First, children were administered a preliminary trauma exposure questionnaire. A list of the following potentially traumatic events was provided: a) anything really terrible or upsetting, like being very sick or badly hurt; b) seen anyone die or badly hurt; c) been in a really bad accident or fire where you could have died; d) been in anything like a really bad hurricane, flood, or earthquake or had a tornado near where you lived; e) been robbed or attacked; f) been touched on parts of your body that you really didn't want to be touched; g) been made to touch someone else in places that you didn't want to; h) been hit over and over or hurt very badly by someone; i) anything else that someone has done to you, or made you do, that you didn't like. Children were asked to select "Yes" or "No" if they had experienced any of these events (regardless of which, or how many, events they had experienced). If children selected “Yes,” they were asked to complete the CPSS. The CPSS is composed of 17 symptom-severity items rated from 0 (“Not at all or only at one time”) to 3 (“5 or more times a week/almost always”), and 7 impairment “Yes” or “No” items. The symptom severity items comprise several subscales—including re-experiencing, avoidance, and hyperarousal—that are summed to create a total score. The test-retest reliability and construct validity of the CPSS have been demonstrated in past research (Foa et al., 2001; Gillihan, Aderka, Conklin, Capaldi, & Foa, 2013; Nixon et al., 2013). Internal consistency of the CPSS was very strong in the current sample for the symptom-severity (α=.92) items.

Child distress-response. The distress-response task was designed to assess parasympathetic nervous system (PNS) regulation of physiological arousal in response to the distress of others. Respiratory sinus arrhythmia (RSA; the high-frequency component of the heart-rate variability spectrum) is an indicator of PNS regulation of physiological arousal (Hayano et al., 2001; Appelhans & Luecken, 2006). During the task, children were seated in a comfortable chair and connected to psychophysiological equipment. Specifically, heart rate was measured using EKG leads applied to the upper right clavicle and lower left rib, as well as a grounding electrode on the lower right rib. Impedance cardiography allowed assessment of RSA and respiration using four electrodes. One electrode was applied over the clavicle close to the neck, and another electrode was applied to the back of the neck in a corresponding location. Additionally, one electrode was applied over the xiphoid process, with another electrode applied to a corresponding location over the spine.

Child participants were told they would listen to two recordings, including one recording of nature sounds, and one recording of another child who was very upset. Initial recording occurred for five minutes, during which a relaxation soundtrack was played, to establish a resting baseline. Immediately following the relaxation soundtrack audio recording, a five-minute audio recording of a distressed child crying was played. Data collection and analysis occurred through equipment and software from MindWare Technologies, Ltd. (Gahanna, OH). Respiration and heart rate were used to calculate heart-rate variability, from which RSA was assessed using spectral analysis. Lower resting RSA and parasympathetic-based regulation in response to distress cues reflects reduced parasympathetic activity, a response observed in CU youth in comparison to youth with behavior problems and healthy controls (Anastassiou-Hadjicharalambous & Warden, 2008b; de Wied et al., 2012) and ADHD youth with low prosocial behavior, a proxy for CU traits (Musser, Galloway-Long, Frick, & Nigg, 2013), in comparison to ADHD youth without low prosocial behavior. Given high correlations across $RSA_{Resting}$ epochs (*r*s=.68-.90) and $RSA_{DistressExposure}$ epochs (*r*=.78-.90), $RSA_{Resting}$ was calculated by averaging RSA across the five 60-second epochs of data collection during the relaxation phase, and $RSA_{DistressExposure}$ was calculated by averaging RSA across the five 60-second epochs of data collection during the distress phase. $RSA_{Reactivity}$ was calculated by subtracting $RSA_{DistressExposure}$ from $RSA_{Resting}$.

Child aggression. Aggression assessment consisted of a game simulation task (SuperBuilder) modeled after the FastKid! task developed by Thomaes and colleagues (2008), and a well-validated protocol used in adults with psychopathy (Giancola & Zeichner, 1995). The task was designed for the present study to offer a standardized and observational assessment of aggression, as well as changes in aggression with respect to experimentally manipulated distress cue salience. Participants were told they were going to play a computer game against another child situated out of sight in a nearby room. In reality, the experimenter controlled all events, and there was no real child opponent. Prior to the game, children were told that the goal of the game was to press a specific keyboard button very quickly to construct buildings at a faster rate than their “opponent”, and that there are two rounds with several trials each. First- and third-round winners earned the opportunity to send the opponent a text message. Second- and fourth-round winners earned the opportunity to “blast” the opponent with white noise. The “opponent” was rigged to win the first and third round. Figures 1 -3 present several screen shots from the computer task.

Distress cue salience was manipulated within subjects, with participants receiving a neutral text message from the competitor following the first round (i.e., “This game is crazy fast! #JustDoIt” accompanied by a neutral emoticon), and a text message expressing distress following the third round (i.e., “Super worried about that blast!” accompanied by a sad emoticon). To ensure that child participants were able to read the message received from their fictitious opponent, participating youth were asked to read each message aloud immediately following receipt. Participants were rigged to win the second and fourth round, were given an example of the noise they could use against their opponent, with intensities ranging from no noise (level 0) to 100 dB (level 10; intensity of a smoke alarm), and were told that levels 7 and above are extremely loud. Observed aggression was measured by noise levels chosen; noise levels from round 2 represent child aggression in the absence of a distress cue, noise levels from round 4 represent aggression in the presence of a distress cue, and the sum of these noise levels represents total observed aggression. Participants entered noise levels chosen using the keyboard, and typed responses were recorded directly into a document. The first response typed was considered the noise level chosen. Immediately following their entry, children were asked to confirm the noise level they chosen; each child accurately related his or her typed choice (r=1.00, p<.001).

Following each round of SuperBuilder, children were administered a peer perception scale (PPS), in which they rated their perceptions of the intensity of emotions (i.e., sad, scared, angry, calm, happy) experienced by the fictitious competitor on a scale from 0 ("Not at all") to 4 ("Extremely").

Child intelligence. The Wechsler Abbreviated Scale of Intelligence, Second Edition (WASI-II; Wechsler, 1999; 2011) was used to measure children's intelligence. While the instrument is comprised of four subtests—Block Design, Vocabulary, Matrix Reasoning, and Similarities, a full-scale IQ (FSIQ2) may be calculated using the Matrix Reasoning and Vocabulary subtests. The factor structure and validity of the WASI have been supported (Canivez, Konold, Collins, & Wilson, 2009; Sakolfske, Caravan, & Schwartz, 2000).

Analytic Plan

Means, SDs, and zero-order correlations among study variables were first computed. A check was conducted examining the success of tasks' manipulation of others' distress salience. Paired-samples t-tests were conducted examining differences between the distress and no distress salience conditions with regard to participant reports on the PPS of how "calm," "happy," "angry," "sad," and "scared" their opponent was.

Regression techniques were used to assess relationships between CU, anxiety, and physiological, as well as behavioral, responses to others' distress. Prior to conducting the main analyses, data were checked for normality and other assumptions of regression models; given the skewed distribution of several study variables and sample size, bootstrap estimations of population distributions were used to increase confidence in results (Efron, 1979; Efron & Tibshirani, 1993). Bootstrapping resampling techniques produce robust standard errors and confidence interval estimates when assumptions of regression are not met (Bollen & Stine, 1990; Russel & Dean, 2000).

Hierarchical linear regression models were used to assess moderation for study Aims I-III. Figure 4 depicts the analytical models examined to predict aggression, changes in child ratings of peer emotions between the neutral and distress messages, and parasympathetic responses to distress. Moderation analyses were conducted using the PROCESS macro for SPSS (Hayes, 2012). For each model predicting behavioral or parasympathetic response outcomes, the main effects of child CU traits and anxiety were entered, as well as the product term of CU traits and anxiety; parallel models were created by entering the main effects of child CU traits and traumatic stress, as well as the product term of CU traits and traumatic stress. Significant moderation is defined by a significant interaction (product) term of the predictor (CU traits) and proposed moderator (anxiety or traumatic stress) after accounting for main effects (Baron & Kenny, 1986; Holmbeck, 1997; Kendall & Comer, 2011). In bootstrapped regression, 95% bias-corrected confidence intervals, rather than *p*-values, are used to assess significance; specifically, the null hypothesis is rejected if zero does not fall within the confidence interval (Rasmussen, 1987). Variables were mean-centered prior to entry in analyses.

Additional moderation analyses predicting parasympathetic responses further examined whether clinical characteristics differentially predicted participants' parasympathetic responses to others' distress unfolding across time. Specifically, hierarchical linear modeling (HLM) was used to examine whether CU, anxiety, traumatic stress, and their interactions predicted changes in $RSA_{Distress}$ across time during prolonged exposure to others distress. Separate, parallel models predicting $RSA_{Distress}$ across the 5 individual distress-condition epochs (i.e., $RSA_{Distress1}$ through $RSA_{Distress5}$) were created for anxiety and traumatic stress moderators, such that time, CU, anxiety, and their interactions were entered as predictors in one model, and time, CU, traumatic stress, and their interactions were entered as predictors in a second model. $RSA_{Resting}$ was entered as a covariate in both models.

Missing values analyses found no significant differences among participants with and without missing data on study variables, suggesting that data were missing completely at random, $\chi^2(168)=190.75$, $p=.11$ (MCAR; Little & Rubin, 1987). Given the random nature and small overall percentage (1.7%) of missing data, listwise deletion was used to handle missing observations.

III. RESULTS

Table 1 presents descriptive data for study variables and participant demographics. Nearly half (45.5%, N=20) of this CP-enhanced community sample showed significant CU traits according to Kimonis and colleagues' (2014) criteria (i.e., ICU $\geq$ 24). Roughly 31% (N=14) of the sample showed anxiety in the high-average range or above (i.e., MASC *t* score $\geq$ 55), with approximately 20% (N=9) showing clinically elevated anxiety (i.e., MASC *t* score $\geq$ 60; March, 2013). With regard to trauma, 55.6%

(N=25) of the sample experienced a traumatic event; of these children, approximately 31% (N=14) met symptom severity criteria for PTSD (Foa et al., 2001; Hawkins & Radcliffe, 2006).

Youth were fairly aggressive overall, with only 4.4% (N=2) of children choosing not to aggress against their opponent at all following receipt of the neutral message, and only 8.9% (N=4) choosing not to aggress against their opponent at all following receipt of the distress message. Roughly 71% (N=32) of youth delivered a “blast” at level 7 or above, which was explained to the participants as “extremely loud” during the game instructions; this percentage remained the same following receipt of both neutral and distress messages from the opponent. The number of children selecting the highest blast—level 10—increased from 23 (approximately 51%) following receipt of a neutral message to 27 (60%) following receipt of a distress message. Table 2 provides zero-order correlations for main study variables.

Manipulation checks indicated the task was successful in manipulating the salience of the opponent distress. A paired-samples t-tests manipulation check revealed children’s ratings of how “scared” and “sad” they perceived their opponent to be indeed increased from the no distress/neutral message condition to the distress salience condition ($t(43)=7.75$, $p<.001$, $t(43)=5.03$, $p<.001$, respectively). Children’s ratings of how “angry” they perceived their opponent to be also increased from the no distress/neutral message condition to the distress salience condition ($t(43)=5.90$, $p<.001$). Similarly, children’s ratings of how “calm” and “happy” they perceived their opponent to be decreased from the no distress/neutral message condition to the distress salience condition ($t(42)=-2.50$, $p=.02$, $t(43)=-7.37$, $p<.001$, respectively).

Addressing Aim Ia: Elucidating the interactive effects of CU and anxiety on aggression

Table 3 presents results from hierarchical regression analyses examining the main and interactive effects of CU traits and anxiety on total observed child aggression exhibited during the SuperBuilder game. The overall model was significant in the prediction of total aggression pooled across the two conditions, $F(3, 40)=3.03$, $p=.04$; $R^2=0.18$. However, neither CU traits nor anxiety significantly predicted total aggression pooled across the two conditions. Similarly, the product term examining the interactive effect between CU traits and anxiety did not significantly predict total aggression pooled across the two conditions.

Addressing Aim Ib: Elucidating the interactive effects of CU and traumatic stress on aggression

Table 4 presents results from hierarchical regression analyses examining the main and interactive effects of CU traits and traumatic stress on total observed child aggression exhibited during the SuperBuilder game. The overall model was not significant in the prediction of aggression, with $F(3, 19)=0.27$, $p=.85$, $R^2=0.05$.

Addressing Aim IIa: Investigating the interactive effects of CU and anxiety on aggression in the presence versus absence of distress cues

Table 3 also presents results from hierarchical regression analyses examining the main and interactive effects of CU traits and anxiety on child aggression exhibited during the SuperBuilder game, broken down by condition (i.e., presence versus absence of others' distress salience).

Observed aggression in the absence of a distress cue. The overall model was significant, $F(3, 40)=4.41$, $p=.01$; $R^2=0.34$. Anxiety and CU traits each significantly predicted aggression in this condition—explaining 16.2% and 6.5%, respectively, of the variance in aggression in the absence of a distress cue. As a main effect, CU positively predicted observed aggression, whereas anxiety as a main effect negatively predicted observed aggression. In addition, the product term examining the interactive effect between CU traits and anxiety contributed additional, unique predictive value ($F(1, 40)=4.54$, $p=.04$; $R^2\Delta=0.12$), indicating that the association between CU traits and aggression in the absence of a distress cue was not uniform across varying levels of anxiety.

Follow-up analyses examined simple slopes associated with high, medium, and low levels of anxiety. High was defined as one standard deviation above the centered mean anxiety total score, medium was defined as within one standard deviation of the centered mean anxiety total score, and low was defined as one standard deviation below the centered mean anxiety total score. Analyses revealed that CU traits were significantly predictive of increased aggression in the absence of a distress cue among children with medium and high levels of anxiety (β=0.16, SE=0.06, 95% CI=0.03-0.29 and β=0.37, SE=0.14, 95% CI=0.10-0.65, respectively). In contrast, CU traits were not predictive of increased aggression in the absence of a distress cue among children with low levels of anxiety (β=-0.05, SE=0.09, 95% CI=-0.24-0.14). Figure 5 presents a graphical depiction of the interactive relationship between CU and anxiety when predicting aggression in the absence of a distress cue.

Observed aggression in the presence of a distress cue. The overall model was not significant in the prediction of aggression in the presence of a distress cue, $F(3, 40)=0.31$, $p=.82$; $R^2=0.04$. Similarly, neither CU, anxiety, nor their interaction significantly predicted observed aggression in the presence of a distress cue.

Addressing Aim IIb: Investigating the interactive effects of CU and traumatic stress on aggression in the presence versus absence of distress cues

Table 4 also presents results from hierarchical regression analyses examining the main and interactive effects of CU traits and traumatic stress on child aggression exhibited during the SuperBuilder game, broken down by condition (i.e., presence versus absence of others' distress salience).

Aggression in the absence of a distress cue. The overall model was not significant in the prediction of aggression, with $F(3, 19)=0.36$, $p=.79$, $R^2=0.05$.

Aggression in the presence of a distress cue. The overall model was not significant in the prediction of aggression, with $F(3, 19)=0.25$, $p=.86$, $R^2=0.04$.

Addressing Aim IIIa: Elucidating the main and interactive effects of CU and anxiety on perceptions of a potential victim's emotional state in an experimental context

Tables 5 and 6 present results from hierarchical regression analyses examining the main and interactive effects of CU traits and anxiety on child ratings of opponent emotions in neutral and distress cue conditions (respectively) in the SuperBuilder game.

Ratings of opponent emotions in the absence of a distress cue. The overall models were not significant in predicting child ratings of opponent "calm" ($F(3, 38)=0.12$ $p=.95$; $R^2=0.01$), "happy" ($F(3, 39)=1.01$, $p=.40$; $R^2=0.06$), "angry" ($F(3, 39)=1.49$,

p=.23; R^2 =0.11), "sad" (F(3, 39)=0.77, p=.52; R^2 =0.04), and "scared" (F(3, 39)=0.20, p=.90; R^2 =0.03) feelings.

Ratings of opponent emotions in the presence of a distress cue. The overall models were not significant in predicting child ratings of opponent "calm" (F(3, 39)=1.89, p=.15; R^2 =0.11), "happy" (F(3, 39)=2.04, p=.12; R^2 =0.12), "angry" (F(3, 39)=2.17, p=.11; R^2 =0.08), "sad" (F(3, 39)=0.07, p=.97; R^2 =0.01), and "scared" (F(3, 39)=1.69, p=.19; R^2 =0.09) feelings.

Change in ratings of opponent emotions between neutral- and distress-cue conditions. Table 7 presents results from hierarchical regression analyses examining the main and interactive effects of CU traits and anxiety on change in child ratings of opponent emotions between neutral and distress cue conditions in the SuperBuilder game. Overall models were not significant in predicting change in ratings of opponent "calm" (F(3, 38)=1.59, p=.21; R^2 =0.09), "scared" (F(3, 39)=0.79, p=.51; R^2 =0.07), and "sad" (F(3, 39)=0.05, p=.98, R^2 =0.01) feelings. The overall model was significant in the prediction of change in ratings of opponent "angry" feelings, F(3, 39)=3.49, p=.02; R^2 =0.15. However, neither CU traits nor anxiety significantly predicted change in ratings of opponent "angry" feelings between the two conditions. Similarly, the product term examining the interactive effect between CU traits and anxiety did not significantly predict change in ratings of opponent "angry" feelings between the two conditions. The overall model was significant in the prediction of change in ratings of opponent "happy" feelings was significant, F(3, 39)=3.73, p=.02; R^2 =0.19. Neither anxiety nor its interaction with CU traits significantly predicted change in ratings of opponent "happy" feelings between the two conditions. However, CU traits were a significant negative predictor in this model. Specifically, the greater the child's CU severity, the less change in ratings between the neutral- and distress-cue conditions.

Addressing Aim IIIb: Investigating the main and interactive effects of CU and traumatic stress on perceptions of a potential victim's emotional state in an experimental context

Tables 8-9 present results from hierarchical regression analyses examining the main and interactive effects of CU traits and traumatic stress on child ratings of opponent emotions in neutral and distress cue conditions in the SuperBuilder game.

Ratings of opponent emotions in the absence of a distress cue. The overall models were not significant in predicting child ratings of opponent "calm" (F(3, 17)=0.39, p=.76; R^2 =0.07), "happy" (F(3, 18)=0.63, p=.61; R^2 =0.09), "angry" (F(3, 18)=1.04, p=.40; R^2 =0.20), "sad" (F(3, 18)=1.09, p=.38; R^2 =0.13), and "scared" (F(3, 18)=0.36, p=.78; R^2 =0.12) feelings.

Ratings of opponent emotions in the presence of a distress cue. The overall models were not significant in predicting child ratings of opponent "happy" (F(3, 18)=1.07, p=.39; R^2 =0.12), "angry" (F(3, 18)=0.41, p=.75; R^2 =0.10), and "sad" (F(3, 18)=0.37, p=.77; R^2 =0.07) feelings. The overall model was significant in the prediction of ratings of opponent "scared" feelings, F(3, 18)=7.91, p=.001; R^2 =0.36. Child CU was a significant negative predictor, and child traumatic stress was a significant positive predictor, of ratings of opponent "scared" feelings. Specifically, greater traumatic stress was associated with higher ratings, and greater CU was associated with lower ratings, of opponent "scared" feelings. The overall model was also significant in the prediction of ratings of opponent "calm" feelings, F(3, 18)=4.18, p=.02; R^2 =0.46. Child CU was a significant positive predictor of ratings of opponent “calm” feelings. Specifically, greater CU was associated with higher ratings of opponent “calm” feelings.

Change in ratings of opponent emotions between neutral- and distress-cue conditions. Table 10 presents results from hierarchical regression analyses examining the main and interactive effects of CU traits and traumatic stress on change in child ratings of opponent emotions between neutral and distress cue conditions in the SuperBuilder game. The overall models were not significant in predicting change in ratings of opponent “calm” ($F(3, 17)=0.87$, $p=.48$; $R^2=0.24$), “happy” ($F(3, 18)=1.95$, $p=.16$; $R^2=0.27$), “angry” ($F(3, 18)=0.20$, $p=.90$; $R^2=0.03$), and “sad” ($F(3, 18)=0.23$, $p=.88$; $R^2=0.08$) feelings. The overall model was significant in the prediction of change in ratings of opponent “scared” feelings, $F(3, 18)=6.97$, $p=.003$; $R^2=0.28$. However, neither CU traits nor traumatic stress significantly predicted change in ratings of opponent “scared” feelings between the two conditions. Similarly, the product term examining the interactive effect between CU traits and traumatic stress did not significantly predict change in ratings of opponent “scared” feelings between the two conditions.

Addressing Aim IVa: Elucidating the main and interactive effects of CU and anxiety on parasympathetic response to others’ distress

Table 11 presents results from hierarchical regression analyses examining the main and interactive effects of CU traits and anxiety on baseline parasympathetic functioning ($RSA_{Resting}$) and on parasympathetic response exhibited during the Distress Task ($RSA_{Reactivity}$). Models were not significant in the prediction of $RSA_{Resting}$, $F(3, 39)=0.98$, $p=.41$, $R^2=0.09$, nor in the prediction of $RSA_{Reactivity}$, $F(3, 39)=0.75$, $p=.53$, $R^2=.03$.

Table 12 presents results from HLM analyses examining the main and interactive effects of CU, anxiety, and their interaction associated with minute-to-minute changes in $RSA_{Distress}$ across time. $RSA_{Resting}$, entered as a covariate, was a significant positive predictor of $RSA_{Distress}$ across time, and the interaction between time and child anxiety was a significant negative predictor of $RSA_{Distress}$. Time, CU, anxiety, and the interactions between Time and CU, and Time and the product term of CU and anxiety, were not significant predictors of in $RSA_{Distress}$.

Follow-up analyses probing the significant AnxietyXTime interaction in the prediction of $RSA_{Distress}$ across time examined $RSA_{Distress}$ across time among the subgroups of youth with high versus low levels of anxiety. High anxiety was defined as above the mean MASC total score, and low anxiety was defined as below the mean MASC total score. Among youth with high anxiety, analyses indicated that $RSA_{Resting}$ (the covariate) and Time were significant predictors of $RSA_{Distress}$ (B=0.99, SE=0.05, $t(120)=20.45$, $p<.001$ and B=-0.09, SE=0.04, $t(120)=-2.16$, $p=.03$, respectively). Specifically, among youth with higher anxiety, $RSA_{Distress}$ declined in a linear fashion from minute 1 through minute 5 during exposure to others' distress. In contrast, among youth with low anxiety, while $RSA_{Resting}$ (the covariate) was a significant predictor of $RSA_{Distress}$ (B=0.90, SE=0.05, $t(100)=18.83$, $p<.001$), Time was not a significant predictor (B=-0.004, SE=0.04, $t(100)=-0.11$, $p=.91$). That is, among youth with higher anxiety severity, RSA patterns suggest progressive parasympathetic suppression across time during exposure to others' distress, whereas exposure to others distress is not associated with progressive parasympathetic suppression across time in youth with lower anxiety severity.

Figure 6 presents a graphical depiction of the relationships between anxiety and $RSA_{Distress}$ across time.

Addressing Aim IVb: Elucidating the interactive effects of CU and traumatic stress on parasympathetic-based response to others' distress

Table 13 presents results from hierarchical regression analyses examining the main and interactive effects of CU traits and traumatic stress on baseline parasympathetic functioning ($RSA_{Resting}$) and on parasympathetic response exhibited during the Distress Task ($RSA_{Reactivity}$). Models were not significant in the prediction of $RSA_{Resting}$ $F(3, 19)=0.38$, $p=.77$, $R^2 =0.03$, nor in the prediction of $RSA_{Reactivity}$, $F(3, 19)=0.71$, $p=.56$, $R^2 =.05$.

Table 14 presents results from HLM analyses examining the main and interactive effects of CU, anxiety, and their interaction associated with minute-to-minute changes in $RSA_{Distress}$ across time. Time, CU, traumatic stress, and their interactions were not significant predictors of $RSA_{Distress}$ changes across time.

IV. DISCUSSION

Overview

The present study examined complex relationships between youth CU traits, observed aggression, anxiety, trauma, perceptions of others' emotions, and physiological and behavioral responses to other's distress. Overall, these results derived from observational child aggression data are consistent with previous research that has only utilized questionnaire-based data on child aggression (e.g., Fanti et al., 2013; Humayun et al., 2013; Rosan et al., 2015) in suggesting that CU traits are associated with greater aggression in the presence of higher levels of anxiety, and further clarify specific conditions under which this relationship applies. Specifically, the present findings obtained with an experimental paradigm indicate that anxiety moderates the effect of CU on child aggression, but only in the absence of salient distress cues from a potential victim. These findings extend research suggesting that children with CU traits and anxiety are more aggressive than children with elevated CU but not anxiety, as well as children low on both CU traits and anxiety (Fanti et al., 2013; Kahn et al., 2012). Collectively, findings have both theoretical implications for CU traits as a construct, and clinical relevance in the prevention and situational attenuation of aggression.

Aggression

The present work also adds to an increasing body of research documenting a strong relationship between CU traits and aggression (e.g., Fanti et al., 2009; Waschbusch et al., 2004), given that CU traits—and not just their interaction with anxiety—positively predicted observed aggression towards the opponent when the opponent's distress was not apparent. Results further supported the findings of van Baardewijk and colleagues (2009), who observed in a similar task that the relationship between CU traits and aggression changes when distress is made salient; however, the present study was the first to consider the role of anxiety in this relationship.

Theoretical distinctions between children with CU traits and anxiety versus children with CU traits but no anxiety are supported by the observed interaction. It appears that anxiety provides useful predictive information on the clinical presentation of CU traits, particularly in ambiguous social situations during which potential victims' distress is unclear. Interestingly, although anxiety by itself predicted *reduced* aggression under such ambiguous circumstances, anxiety actually sensitized youth with CU to aggress *more* than seen in CU youth without anxiety. It is possible that the increased attention to distress cues noted among CU youth experiencing anxiety represents a sensitivity to negative emotional cues in general, similar to the attentional biases towards negative- and threat-related cues (Mogg & Bradley, 2005; Reid et al., 2006), and bias towards interpreting ambiguous information negatively (Taghavi et al., 2000) documented among anxious children. While CU traits have not previously been associated with a hostile attribution bias (HAB; Dodge, Price, Bachorowski, & Newman, 1990; Frick et al., 2003a; Helseth, Waschbusch, King, & Willoughby, 2015), perhaps the combination of cognitive biases associated with anxiety and the callousness of CU traits yields the impulsive, aggressive reactivity documented in these youth (e.g., Fanti et al., 2013; Kahn et al., 2013).

Perceptions of Peer Emotions

Indeed, it appears that CU traits are associated with difficulty understanding others' emotions, even when distress is made apparent. Youth CU traits were associated with lower ratings of opponent fear and higher ratings of calm in the presence of a distress cue from the opponent, as well as less change in participant ratings of perceived opponent happiness from the neutral to distress message during the SuperBuilder task. These findings support previous literature documenting that increased distress cue salience reduces—but does not eliminate—emotion recognition deficits associated with CU, as well as a tendency for CU youth to minimize victim distress resulting from aggression (Pardini & Byrd, 2012). Importantly, in the present experimental study, distress was salient enough to reduce the impact of CU on observed aggressive *behavior*, regardless of perceived opponent emotion. The reduced impact of CU on aggression, regardless of perceived emotion of the opponent, suggests the potential for effecting change on a behavioral level relatively quickly, by increasing the “visibility” of a potential victim’s distress—while supporting long-term reductions in aggressive behavior through training to not only recognize, but also anticipate, others’ distress and respond with prosocial behavior.

Physiological Responses

With regard to physiological responses to others’ distress, findings did not support the hypothesized interactive relationship between CU and anxiety in predicting resting RSA and RSA reactivity. The lack of effects was in contrast to the results of previous studies showing that CU traits are associated with blunted parasympathetic activity at rest (e.g., de Wied et al., 2012) and in response to threat and distress cues (e.g., Anastassiou-Hadjicharalambous & Warden, 2008b). Given the relatively small sample size of the present study, and the relatively small nature of psychohysiological effects in studies comparing CNS activity of youth with and without CU traits (e.g., Anastassiou-Hadjicharalambous & Warden, 2008b; de Wied et al., 2012; Musser et al. 2013), power to detect moderation effects may have been compromised. Interestingly, anxious youth showed greater parasympathetic suppression across time with extended exposure to another child’s distress; the same was not true of non-anxious children. Existing literature indicates that high RSA reactivity in response to distressing stimuli may be a biomarker of reduced emotion regulation capabilities (Beauchaine, 2015). While sample size may have precluded detection of effects related to CU and its interaction with anxiety across time (as suggested by the trending effects noted in Table 9), findings related to anxiety and RSA reactivity over time hint that the specific parasympathetic response pattern associated with anxiety may explain anxiety-related heterogeneity in aggressive behavior among CU youth. As research both specific to CU traits and on empathy in general suggests that blunted parasympathetic and sympathetic activity may be partially responsible for deficits in empathy-related responding, rather than solely the failure to detect and understand emotional cues (e.g., Blair et al., 2006; Shirtcliff et al., 2009), further investigation is needed to identify whether physiological responses contribute to anxiety-related heterogeneity among CU youth—particularly given the increased attention to distress cues observed in CU youth experiencing anxiety symptoms (Kimonis et al., 2012). Future studies would do well to investigate specific profiles of parasympathetic response to others' distress across time in larger samples.

Trauma-related Findings

Statistical power may also have interfered with detection of trauma-related moderation effects, as traumatic stress data were available only for the part of the sample that experienced a traumatic event (N=25). However, among these youth, traumatic stress symptom severity still predicted increased ratings of opponent fear in the presence of a distress cue, in line with literature documenting enhanced identification of fear-related cues among trauma-exposed youth (e.g., Masten et al., 2008). Child CU traits were also positively correlated with traumatic stress—but not anxiety—indicating a potential relationship between CU and traumatic stress that is not accounted for by trauma-related anxiety. The high rate of trauma exposure in this CP-enhanced community sample sheds light on the overall need to understand potential trauma responses—particularly given evidence that traumatic stress influences perceptions of others' fear—and the observed correlation between CU traits and traumatic stress suggests the need for further exploration of how these constructs co-occur in trauma-exposed youth.

Clinical Implications

Important clinical and practical implications follow from study findings as a whole. Children with CU traits may benefit from training to anticipate situations that may cause others' distress, to attend to, and accurately identify, distress cues (and cues to the potential for distress) and to alter behavior accordingly with contingency management and prosocial behavior training. Given that high anxiety levels increase the likelihood for aggression in the absence of salient distress cues (and the presence of neutral, ambiguous cues), identifying children with high levels of CU traits and anxiety for emotional training-based intervention may be particularly important. In potentially aggressive situations involving children with CU traits, increasing the salience of others' distress cues (and/or potential for distress) may attenuate aggressive outcomes. Interestingly, the widely encouraged practice of ignoring, or remaining confident/neutral when facing aggression and provocation may not apply to victims of aggressors with CU—and especially aggressors with CU and anxiety. In these situations, it may be best for victims to make their distress salient to the aggressor in order to reduce aggression.

Limitations

Conclusions should be interpreted in light of several study limitations. The first set of limitations relates to the nature of the study sample. The sample size may have yielded inadequate statistical power to detect small-to-medium effects, particularly low-magnitude psychophysiological effects, and trauma-related effects that were, by necessity, examined in an even smaller participant subset. Sample size precluded investigation of the relationships of interest while controlling for demographic factors relevant to aggression, such as age and gender (Baillargeon et al., 2007; Costello, Mustillo, Erklani, & Angold, 2003; Loeber & Hay, 1997). Future research would do well to investigate physiological responses—including indices of both parasympathetic and sympathetic activity, given research indicating blunted parasympathetic and sympathetic responses in CU youth (e.g., Blair et al., 1999; de Wied et al., 2012)—to others' distress in larger samples, as well as the potential role of trauma in differences between CU youth with and without anxiety in a trauma-exposed sample. In addition, the CP-enhanced sample yielded data that did not conform to normality standards for typical linear regression analyses. While bootstrapping techniques allowed for correction and increased confidence in results, future research should investigate relationships in larger clinical samples, so that statistical techniques geared towards analyzing skewed data (e.g., Poisson regression) may be used. Relatedly, as CU traits are typically conceptualized in the context of child behavior problems, conducting further study in a clinical sample would allow more in-depth analysis of the CU construct. However, the practice of blending community recruitment with recruitment of youth with serious behavior problems in order to yield a CP-enhanced sample is not unprecedented in the CU and anxiety literature (e.g., Docherty et al., 2015). Third, the sample included mostly Hispanic youth, with few African American children and few non-Hispanic Caucasian children. Although this sample is fairly representative of the ethnic demographics of the city in which data were collected (70% Hispanic, 11.9% White non-Hispanic, 16.3% Black or African American non-Hispanic; U.S. Census Bureau, 2010), results may not generalize to other populations and cultures.

A second set of limitations relates to the nature of data collected, including measures in the SuperBuilder task and information on traumatic exposure. Although data were collected on child perception of peer emotions, data were not collected on child perception of peer intentions, precluding the assessment of interpretive biases and social goals during the SuperBuilder task. Given the reactive profile of children with CU and anxiety (e.g., Fanti et al., 2013), and the potential for interactive social-cognitive biases associated with both CU (e.g., Pardini, 2011) and anxiety (e.g., Taghavi et al., 2000), future research would do well to assess the role of cognition more extensively. Moreover, children displayed relatively high aggression overall during the SuperBuilder task, reducing the variability of aggression that could be predicted. Perhaps the aggression task evoked competitive behavior that interfered with the emotional matching theorized to underlie empathy (Eisenberg & Eggum, 2009), as observed in adult research (e.g., Cikara, Bruneau, & Saxe, 2011; Weyers, Mühleberger, Kund, Hess, & Pauli, 2009). With regard to traumatic exposure, information on exposure to specific trauma types experienced (e.g., physical abuse, witnessing community violence, natural disaster exposure) was not collected. As a result, it was not possible to examine how trauma-related findings may vary across various forms of traumatic exposure. Given previous investigations indicating more extensive trauma histories among CU youth with anxiety in comparison to their non-anxious counterparts (e.g., Humayun et al., 2015; Kimonis et al., 2012), and research suggesting that emotional numbing symptoms link violence exposure and delinquency (Allwood et al., 2011), it is possible that specific forms of traumatic exposure (e.g., violence exposure) are more strongly associated with aggression and aspects of emotional processing among youth with CU traits than other forms of traumatic exposure (e.g., exposure to a natural disaster). Future studies would do well to collect information on youths' exposure to specific forms of trauma.

A final limitation relates to study time period. Given the short-term nature of the laboratory-based task, long-term conclusions cannot be drawn. Similarly, long-term predictions of behavior and outcomes cannot be made, given the absence of longitudinal follow-up data. While practice effects may preclude the administration of the SuperBuilder task as-is at regular intervals, perhaps further task development and sophistication (e.g., randomization of task conditions) would allow for more long-term comparison. Longitudinal reports and records-based (e.g., school disciplinary records) data would allow future researchers to examine the long-term predictive value of observed responses to others' distress among children with CU and anxiety.

Future Directions

In addition to the specific considerations for future research noted above, further investigation is needed in general to identify potential mechanisms by which CU and anxiety symptoms interact to increase aggression in the absence of distress cues. While study findings suggest that emotional processing plays a role in this relationship, research may do well to assess whether increases and decreases in aggression under these conditions are mediated by physiological responses, social cognitive processes (such as a HAB or perceptions of dominance), or both.

Summary and Conclusions

Despite the limitations noted above, the present study was the first to examine relationships between CU traits, anxiety, and observed aggression in an experimental task allowing manipulation of distress cue salience, and the first to examine relationships between CU traits, anxiety, and parasympathetic responses to others' distress. Findings extend existing research by highlighting the role of emotional cues in the observed aggressive responses of children with CU traits, particularly CU youth experiencing anxiety symptoms. Although previous research has equated CU traits with a lack of anxiety (see Frick & White, 2008), the present study joins a growing body of work indicating that these two constructs are not mutually exclusive, but rather may interact to predict some of the most concerning outcomes. The distinction between subset of children with CU traits with and without anxiety appears to have significant clinical and theoretical utility in predicting the heterogeneity of behavior among youth with CU traits, as well as pointing to potential treatment targets; future research must further investigate the nature of emotional processing deficits, and their role in the development of AB, among children with CU traits and anxiety.

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APPENDICES

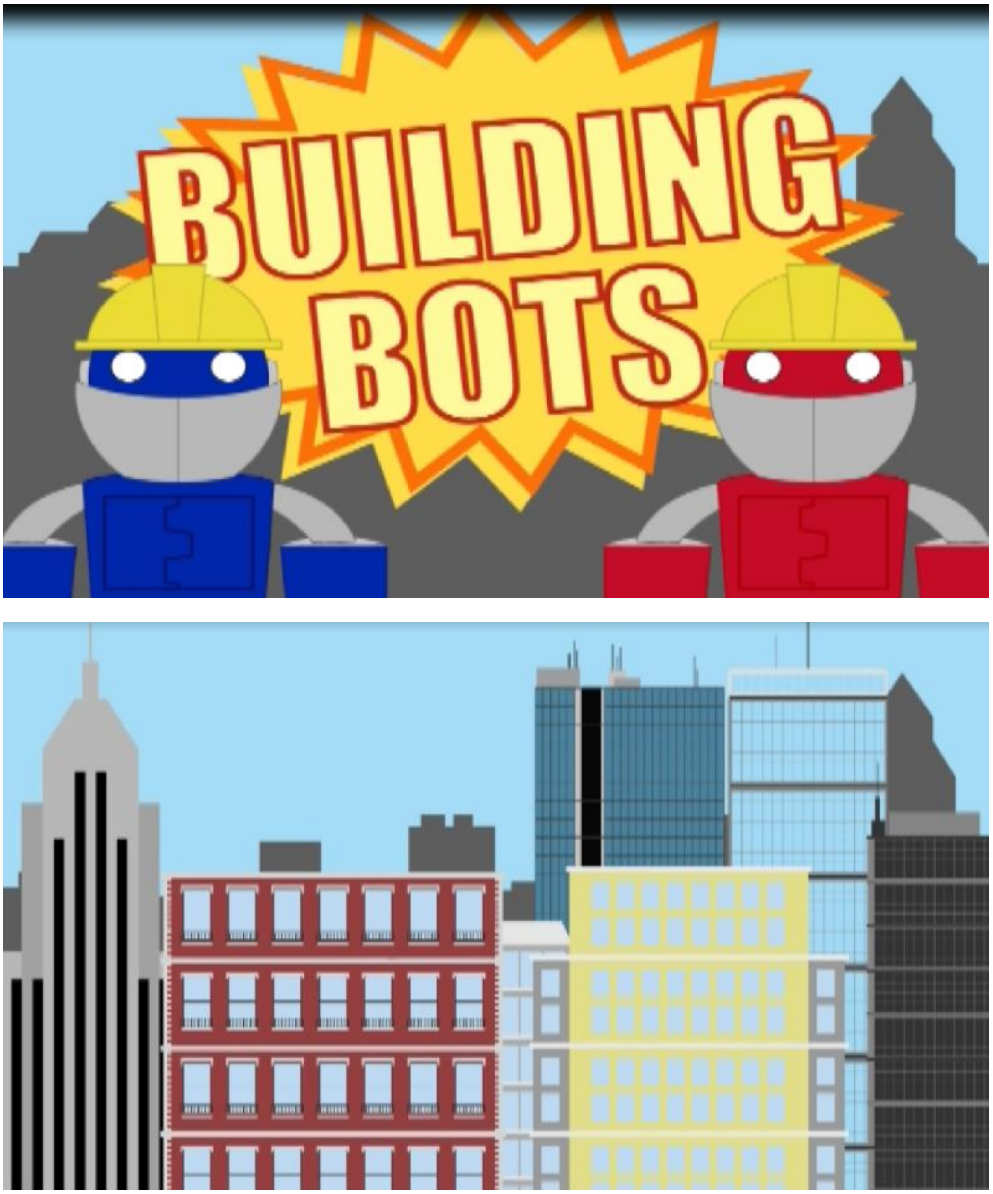


Figure 1. Excerpts from the SuperBuilder game play simulation. Participants were told they were building the red brick skyscraper, while their opponent was building the yellow skyscraper.

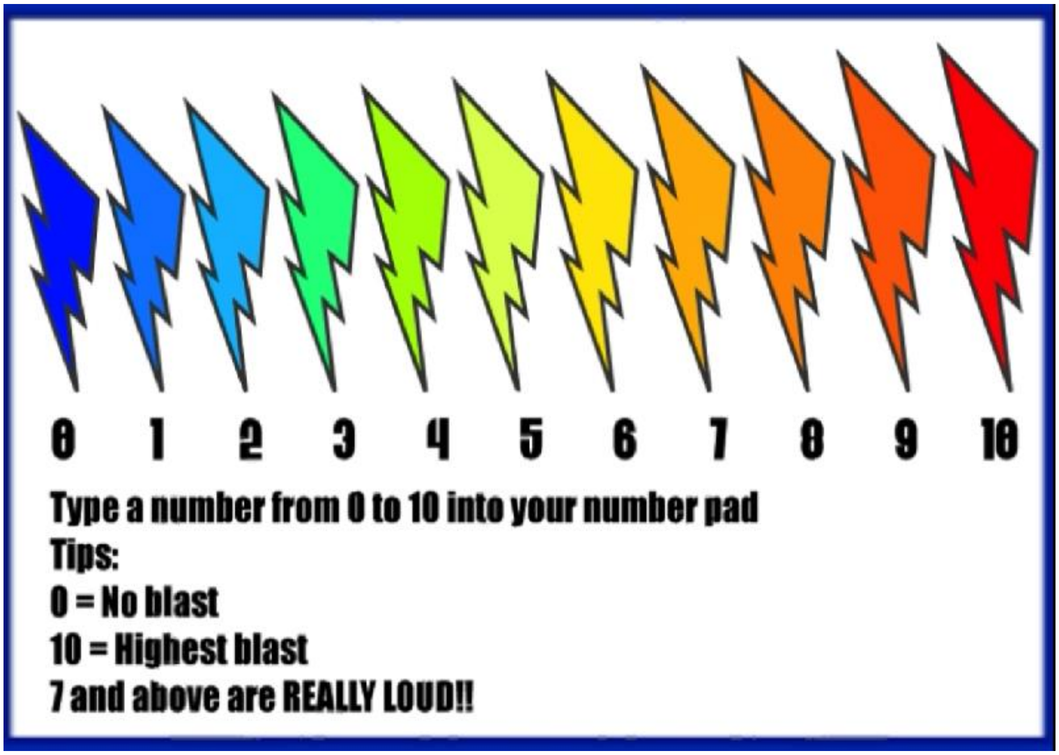


Figure 2. Explanation of SuperBuilder sound blast levels presented to the child participant.

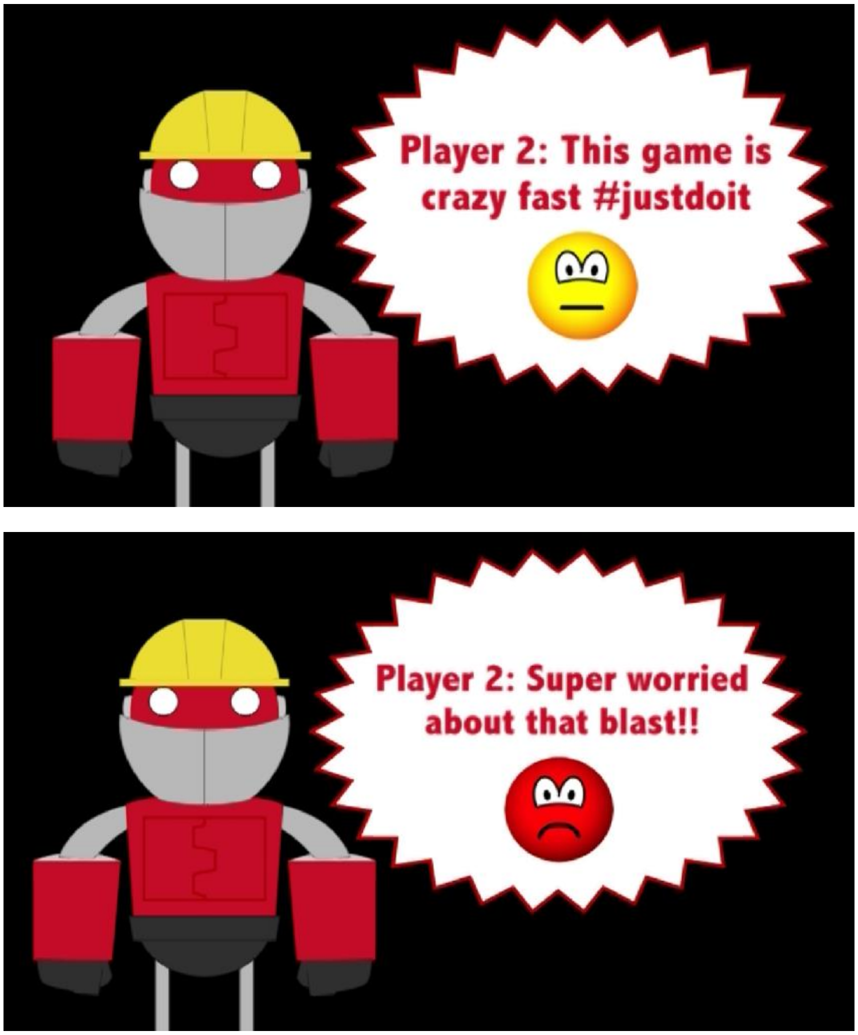


Figure 3. Neutral and distress messages, respectively, sent from the SuperBuilder simulated opponent to the child participant.

Table 1. Descriptive statistics

	M	*SD*	Range
Child Age	9.89	1.58	7-13
Family Income	72.19	49.60	17-200
Child FSIQ	107.70	13.42	64-132
$RSA_{Baseline}$	6.65	1.23	3.67-8.92
$RSA_{DistressExposure}$	6.74	1.24	3.51-9.06
$RSA_{Distress1}$	6.83	1.32	2.89-9.33
$RSA_{Distress2}$	6.83	1.34	3.60-9.37
$RSA_{Distress3}$	6.72	1.31	3.63-9.07
$RSA_{Distress4}$	6.69	1.34	3.16-9.09
$RSA_{Distress5}$	6.65	1.29	3.67-9.18
$RSA_{Reactivity}$	-0.09	0.42	-0.89-0.90
MASC	46.96	18.30	10-91
ICU	8.34	5.45	0-19
Aggression—Distress Cue Absent	8.00	2.81	0-10
Aggression—Distress Cue Salient	7.71	3.40	0-10
Aggression—Total	15.71	5.40	0-20
CPSS	18.87	12.32	1-51

Note: SD=Standard Deviation;RSA=respiratory sinus arrhythmia; $RSA_{Reactivity}$= $RSA_{Baseline}$ minus $RSA_{DistressExposure}$; MASC=caregiver-reported child anxiety; ICU=caregiver-reported child CU traits; CPSS=child-reported traumatic stress. Family Income is in thousands of dollars.

Table 2. Zero-order correlations between study variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Age	-												
2. Gender	-.01	-											
3. Ethnicity	.08	.07	-										
4. Income	-.21	.13	-.33*	-									
5. RSA$_{Baseline}$	-.03	.30	-.01	-.25	-								
6. RSA$_{DistressExposure}$	.09	.23	.06	-.34*	.94**	-							
7. RSA$_{Reactivity}$	.19	.17	-.19	.30	.13	-.21	-						
8. MASC	.10	-.20	-.17	.21	-.23	-.26	.08	-					
9. ICU	.15	.05	.20	-.25	.05	.03	.08	-.11	-				
10. Aggression$_{Neutral}$	-.31*	.04	.05	-.18	.23	.23	-.01	-.37*	.32*	-			
11. Aggression$_{Distress}$	-.39**	-.07	.04	.003	-.05	-.07	.05	-.09	.13	.51**	-		
12. Aggression$_{Total}$	-.42**	-.03	.05	-.10	.09	.08	.03	-.25	.25	.84**	.89**	-	
13. FSIQ	-.07	.16	-.24	.39*	.01	-.02	.10	.02	-.32*	-.25	-.11	-.19	
14. CPSS	.05	.13	.002	-.18	.04	-.03	.23	-.28	.43*	.11	.11	.12	-.32

Table 3. Coefficients for the SuperBuilder hierarchical regression models predicting Aggression, with Anxiety as a moderator

	Predicting Aggression—Distress Cue Absent			
	β	SE	LLCI	ULCI
MASC	-0.065	0.024	-0.113	-0.016
ICU	0.162	0.064	0.033	0.291
MASC x ICU	0.011	0.005	0.001	0.022
	Predicting Aggression—Distress Cue Present			
	β	SE	LLCI	ULCI
MASC	-0.020	0.039	-0.098	0.058
ICU	0.081	0.105	-0.131	0.294
MASC x ICU	0.006	0.009	-0.012	0.024
	Predicting Aggression—Total			
	β	SE	LLCI	ULCI
MASC	-0.085	0.048	-0.182	0.013
ICU	0.244	0.148	-0.056	0.543
MASC x ICU	0.017	0.011	-0.006	0.039

Note: β=Beta coefficient; SE=standard error; LLCI=lower limit of 95% confidence interval; ULCI=upper limit of 95% confidence interval; MASC=caregiver-rated total anxiety; ICU=caregiver-rated total CU traits. MASC x ICU = interaction between caregiver-rated total anxiety and total CU traits.

Table 4. Coefficients for the SuperBuilder hierarchical regression models predicting Aggression, with traumatic stress as a moderator

	Predicting Aggression—Distress Cue Absent			
	β	SE	LLCI	ULCI
CPSS	0.0001	0.059	-0.124	0.124
ICU	0.099	0.137	-0.187	0.385
CPSS x ICU	0.001	0.010	-0.020	0.022
	Predicting Aggression—Distress Cue Present			
	β	SE	LLCI	ULCI
CPSS	0.019	0.074	-0.136	0.173
ICU	0.085	0.164	-0.259	0.429
CPSS x ICU	-0.005	0.016	-0.039	0.028
	Predicting Aggression—Total			
	β	SE	LLCI	ULCI
CPSS	0.019	0.124	-0.240	0.277
ICU	0.184	0.271	-0.383	0.752
CPSS x ICU	-0.004	0.024	-0.054	0.046

Note: β=Beta coefficient; SE=standard error; LLCI=lower limit of 95% confidence interval; ULCI=upper limit of 95% confidence interval; CPSS=child-rated total traumatic stress; ICU=caregiver-rated total CU traits. CPSS x ICU = interaction between child-rated total traumatic stress and total CU traits.

Table 5. Coefficients for the hierarchical regression models perceptions of simulated opponent's emotions in the absence of a distress cue, with anxiety as a moderator

	Predicting "Calm" Ratings—Distress Cue Absent			
	β	SE	LLCI	ULCI
MASC	-0.001	0.010	-0.021	0.020
ICU	-0.018	0.031	-0.081	0.044
MASC x ICU	0.0002	0.001	-0.003	0.003
	Predicting "Happy" Ratings—Distress Cue Absent			
	β	SE	LLCI	ULCI
MASC	-0.006	0.010	-0.027	0.016
ICU	-0.043	0.030	-0.104	0.018
MASC x ICU	-0.001	0.002	-0.005	0.003
	Predicting "Angry" Ratings—Distress Cue Absent			
	β	SE	LLCI	ULCI
MASC	0.013	0.008	-0.002	0.029
ICU	0.027	0.032	-0.038	0.092
MASC x ICU	-0.001	0.002	-0.005	0.002
	Predicting "Sad" Ratings—Distress Cue Absent			
	β	SE	LLCI	ULCI
MASC	0.007	0.008	-0.010	0.023
ICU	0.001	0.026	-0.052	0.054
MASC x ICU	-0.002	0.002	-0.006	0.001

	Predicting "Scared" Ratings—Distress Cue Absent			
	β	SE	LLCI	ULCI
MASC	0.006	0.010	-0.014	0.026
ICU	0.015	0.035	-0.057	0.087
MASC x ICU	0.001	0.002	-0.004	0.005

Note: β=Beta coefficient; SE=standard error; LLCI=lower limit of 95% confidence interval; ULCI=upper limit of 95% confidence interval; MASC=caregiver-rated total anxiety; ICU=caregiver-rated total CU traits. MASC x ICU = interaction between caregiver-rated total anxiety and total CU traits.

Table 6. Coefficients for the hierarchical regression models perceptions of simulated opponent's emotions in the presence of a distress cue, with anxiety as a moderator

	Predicting "Calm" Ratings—Distress Cue Present			
	β	SE	LLCI	ULCI
MASC	0.009	0.013	-0.016	0.035
ICU	0.070	0.033	0.004	0.137
MASC x ICU	0.001	0.003	-0.004	0.006
	Predicting "Happy" Ratings—Distress Cue Present			
	β	SE	LLCI	ULCI
MASC	0.008	0.010	-0.012	0.027
ICU	0.069	0.030	0.009	0.130
MASC x ICU	0.0004	0.002	-0.003	0.004
	Predicting "Angry" Ratings—Distress Cue Present			
	β	SE	LLCI	ULCI
MASC	-0.010	0.012	-0.035	0.015
ICU	-0.039	0.042	-0.124	0.047
MASC x ICU	-0.003	0.002	-0.008	0.001
	Predicting "Sad" Ratings—Distress Cue Present			
	β	SE	LLCI	ULCI
MASC	0.006	0.015	-0.024	0.037
ICU	0.009	0.047	-0.086	0.103
MASC x ICU	-0.001	0.004	-0.008	0.007

	Predicting "Scared" Ratings—Distress Cue Present			
	β	SE	LLCI	ULCI
MASC	-0.0003	0.014	-0.029	0.029
ICU	-0.064	0.030	-0.125	-0.003
MASC x ICU	0.001	0.003	-0.005	0.007

Note: β=Beta coefficient; SE=standard error; LLCI=lower limit of 95% confidence interval; ULCI=upper limit of 95% confidence interval; MASC=caregiver-rated total anxiety; ICU=caregiver-rated total CU traits. MASC x ICU = interaction between caregiver-rated total anxiety and total CU traits.

Table 7. Coefficients for the hierarchical regression models predicting changes in perceptions of simulated opponent's emotions, with anxiety as a moderator

	Predicting Change in "Calm" Ratings			
	β	SE	LLCI	ULCI
MASC	-0.010	0.016	-0.042	0.022
ICU	-0.088	0.052	-0.192	0.017
MASC x ICU	-0.001	0.003	-0.007	0.005
	Predicting Change in "Happy" Ratings			
	β	SE	LLCI	ULCI
MASC	-0.013	0.012	-0.037	0.011
ICU	-0.112	0.037	-0.188	-0.037
MASC x ICU	-0.001	0.002	-0.005	0.003
	Predicting Change in "Angry" Ratings			
	β	SE	LLCI	ULCI
MASC	0.024	0.014	-0.005	0.052
ICU	0.066	0.037	-0.009	0.142
MASC x ICU	0.002	0.002	-0.003	0.007
	Predicting Change in "Sad" Ratings			
	β	SE	LLCI	ULCI
MASC	0.0002	0.018	-0.035	0.036
ICU	-0.008	0.052	-0.112	0.097
MASC x ICU	-0.001	0.005	-0.011	0.008

	Predicting Change in “Scared” Ratings			
	β	SE	LLCI	ULCI
MASC	0.007	0.019	-0.031	0.044
ICU	0.079	0.054	-0.031	0.189
MASC x ICU	-0.0003	0.004	-0.008	0.007

Note: β=Beta coefficient; SE=standard error; LLCI=lower limit of 95% confidence interval; ULCI=upper limit of 95% confidence interval; MASC=caregiver-rated total anxiety; ICU=caregiver-rated total CU traits. MASC x ICU = interaction between caregiver-rated total anxiety and total CU traits.

Table 8. Coefficients for the hierarchical regression models perceptions of simulated opponent's emotions in the absence of a distress cue, with traumatic stress as a moderator

	Predicting "Calm" Ratings—Distress Cue Absent			
	β	SE	LLCI	ULCI
CPSS	-0.017	0.032	-0.084	0.050
ICU	0.043	0.072	-0.109	0.194
CPSS x ICU	-0.001	0.006	-0.014	0.011
	Predicting "Happy" Ratings—Distress Cue Absent			
	β	SE	LLCI	ULCI
CPSS	0.014	0.026	-0.041	0.067
ICU	-0.059	0.065	-0.196	0.078
CPSS x ICU	0.002	0.008	-0.015	0.018
	Predicting "Angry" Ratings—Distress Cue Absent			
	β	SE	LLCI	ULCI
CPSS	0.020	0.038	-0.060	0.100
ICU	0.043	0.071	-0.106	0.193
CPSS x ICU	0.002	0.013	-0.026	0.030
	Predicting "Sad" Ratings—Distress Cue Absent			
	β	SE	LLCI	ULCI
CPSS	0.027	.027	0.332	-0.030
ICU	-0.005	0.050	0.929	-0.110
CPSS x ICU	-0.003	0.008	0.735	-0.019

	Predicting “Scared” Ratings—Distress Cue Absent			
	β	SE	LLCI	ULCI
CPSS	-0.007	0.033	0.846	-0.077
ICU	0.063	0.073	0.404	-0.091
CPSS x ICU	0.003	0.012	0.803	-0.022

Note: β=Beta coefficient; SE=standard error; LLCI=lower limit of 95% confidence interval; ULCI=upper limit of 95% confidence interval; CPSS=child-rated total anxiety; ICU=caregiver-rated total CU traits. CPSS x ICU = interaction between child-rated total traumatic stress and caregiver-rated total CU traits.

Table 9. Coefficients for the hierarchical regression models perceptions of simulated opponent's emotions in the presence of a distress cue, with traumatic stress as a moderator

	Predicting "Calm" Ratings—Distress Cue Present			
	β	SE	LLCI	ULCI
CPSS	-0.058	0.030	-0.121	0.006
ICU	0.165	0.048	0.064	0.266
CPSS x ICU	0.009	0.005	-0.002	0.019
	Predicting "Happy" Ratings—Distress Cue Present			
	β	SE	LLCI	ULCI
CPSS	0.003	0.028	-0.056	0.062
ICU	0.069	0.057	-0.050	0.189
CPSS x ICU	-0.001	0.005	-0.011	0.009
	Predicting "Angry" Ratings—Distress Cue Present			
	β	SE	LLCI	ULCI
CPSS	0.034	0.031	-0.031	0.010
ICU	-0.005	0.075	-0.161	0.152
CPSS x ICU	0.002	0.008	-0.016	0.019
	Predicting "Sad" Ratings—Distress Cue Present			
	β	SE	LLCI	ULCI
CPSS	0.012	0.038	-0.067	0.091
ICU	0.023	0.086	-0.158	0.203
CPSS x ICU	0.005	0.0007	-0.010	0.019

	Predicting "Scared" Ratings—Distress Cue Present			
	β	SE	LLCI	ULCI
CPSS	0.073	0.023	0.024	0.121
ICU	-0.136	0.056	-0.254	-0.018
CPSS x ICU	-0.005	0.007	-0.020	0.011

Note: β=Beta coefficient; SE=standard error; LLCI=lower limit of 95% confidence interval; ULCI=upper limit of 95% confidence interval; CPSS=child-rated total anxiety; ICU=caregiver-rated total CU traits. CPSS x ICU = interaction between child-rated total traumatic stress and caregiver-rated total CU traits.

Table 10. Coefficients for the hierarchical regression models predicting changes in perceptions of simulated opponent's emotions, with traumatic stress as a moderator

	Predicting Change in "Calm" Ratings			
	B	SE	LLCI	ULCI
CPSS	0.049	0.039	-0.033	0.131
ICU	-0.144	0.103	-0.362	0.074
CPSS x ICU	-0.010	0.010	-0.031	0.012
	Predicting Change in "Happy" Ratings			
	β	SE	LLCI	ULCI
CPSS	0.010	0.025	0.064	-0.043
ICU	-0.128	0.064	-0.263	0.006
CPSS x ICU	0.003	0.006	-0.010	0.016
	Predicting Change in "Angry" Ratings			
	β	SE	LLCI	ULCI
CPSS	-0.014	0.035	-0.088	0.059
ICU	0.048	0.066	-0.090	0.186
CPSS x ICU	0.001	0.008	-0.016	0.017
	Predicting Change in "Sad" Ratings			
	β	SE	LLCI	ULCI
CPSS	0.015	0.048	-0.087	0.116
ICU	-0.027	0.107	-0.252	0.198
CPSS x ICU	-0.007	0.012	-0.033	0.019

	Predicting Change in “Scared” Ratings			
	β	SE	LLCI	ULCI
CPSS	-0.079	0.052	0.030	-0.189
ICU	0.199	0.116	-0.045	0.442
CPSS x ICU	0.008	0.019	-0.033	0.048

Note: β=Beta coefficient; SE=standard error; LLCI=lower limit of 95% confidence interval; ULCI=upper limit of 95% confidence interval; CPSS=child-rated traumatic stress; ICU=caregiver-rated total CU traits; CPSS x ICU= interaction between child-rated total traumatic stress and caregiver-rated total CU traits.

Table 11. Coefficients for hierarchical regression models predicting parasympathetic responses, with anxiety as a moderator

	Predicting $RSA_{Resting}$			
	β	SE	LLCI	ULCI
MASC	-0.019	0.012	-0.044	0.007
ICU	0.010	0.037	-0.065	0.085
MASC x ICU	0.003	0.003	-0.003	0.009
	Predicting $RSA_{Reactivity}$			
	β	SE	LLCI	ULCI
MASC	0.003	0.004	-0.006	0.011
ICU	0.006	0.010	-0.014	0.026
MASC x ICU	-0.001	0.001	-0.002	0.001

Note: Note: β=Beta coefficient; SE=standard error; LLCI=lower limit of 95% confidence interval; ULCI=upper limit of 95% confidence interval; MASC=caregiver-rated total anxiety; ICU=caregiver-rated total CU traits; MASC x ICU = interaction between caregiver-rated total anxiety and total CU traits; RSA = respiratory sinus arrhythmia.

Table 12. Coefficients for HLM predicting $RSA_{Distress}$ scores across time, with CU and anxiety as moderators

	$RSA_{Distress}$			
	B	SE	*t*(215)	*p*
$RSA_{Resting}$	0.936	0.035	27.064	<.001
Time	-0.046	0.029	-1.605	.110
MASC	0.006	0.005	1.194	.234
ICU	0.021	0.018	1.186	.237
Time x ICU	-0.009	0.005	-1.676	.095
Time x MASC	-0.003	0.002	-2.138	.034
Time x ICUxMASC	0.0003	0.0001	1.793	.074

Note: Note: B=coefficient estimate; SE=standard error; MASC=caregiver-rated anxiety; ICU=caregiver-rated total CU traits; MASC x ICU= interaction between caregiver-rated total anxiety and caregiver-rated total CU traits; Time x ICUxMASC=interaction between time and the product term of caregiver-rated total anxiety and caregiver-rated total CU traits; RSA = respiratory sinus arrhythmia.

Table 13. Coefficients for hierarchical regression models predicting parasympathetic responses, with traumatic stress as a moderator

	$RSA_{Resting}$			
	β	SE	LLCI	ULCI
CPSS	0.015	0.025	-0.039	0.068
ICU	-0.036	0.068	-0.179	0.107
CPSS x ICU	-0.003	0.005	-0.014	0.008
	$RSA_{Reactivity}$			
	β	SE	LLCI	ULCI
CPSS	0.008	0.012	-0.017	0.032
ICU	0.001	0.023	-0.047	0.048
CPSS x ICU	<.001	0.002	-0.004	0.004

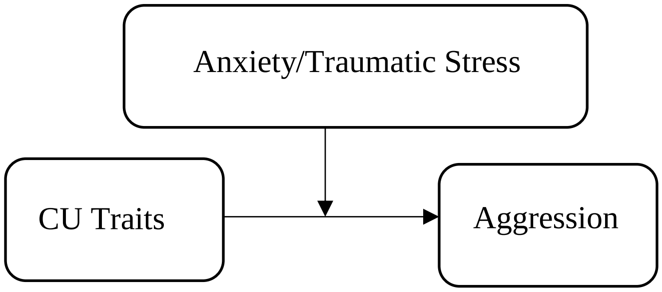
Note: β=Beta coefficient; SE=standard error; LLCI=lower limit of 95% confidence interval; ULCI=upper limit of 95% confidence interval; CPSS=child-rated traumatic stress; ICU=caregiver-rated total CU traits; CPSS x ICU= interaction between child-rated total traumatic stress and caregiver-rated total CU traits; RSA = respiratory sinus arrhythmia.

Table 14. Coefficients for HLM predicting $RSA_{Distress}$ across time, with CU and traumatic stress as moderators

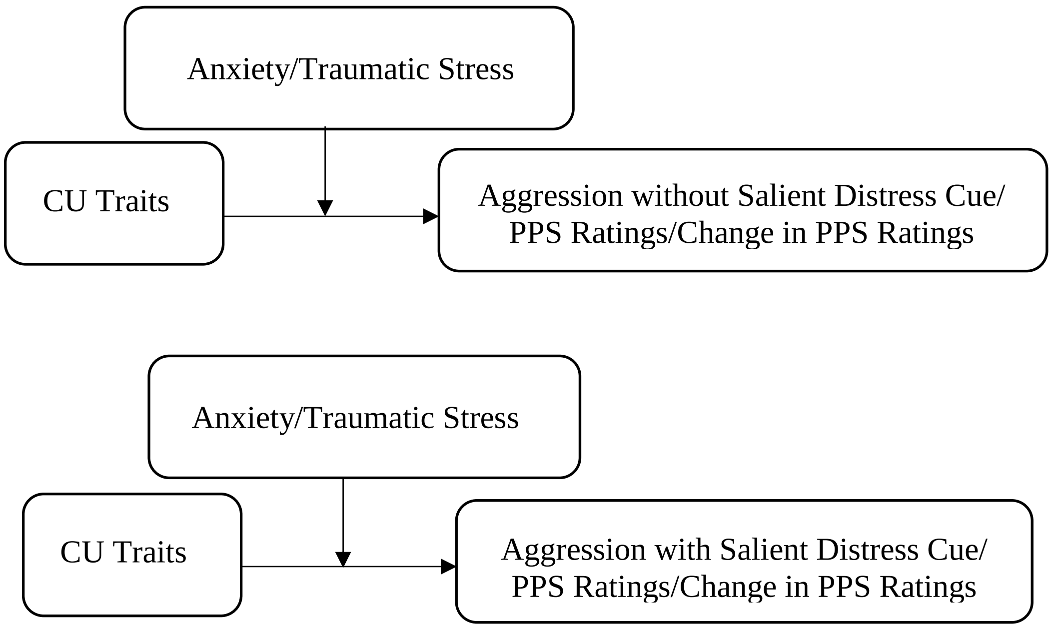
	Predicting $RSA_{Distress}$			
	B	SE	*t*(115)	*p*
$RSA_{Resting}$	0.867	.037	23.196	<.001
Time	-0.043	0.037	-1.178	.241
CPSS	0.009	0.011	0.863	.390
ICU	-0.011	0.024	-0.447	.656
Time x ICU	0.001	0.007	0.134	.893
Time x CPSS	-0.004	0.003	-1.320	.189
Time x ICUxCPSS	-0.0004	0.0003	-1.414	.160

Note: β=Beta coefficient; SE=standard error; LLCI=lower limit of 95% confidence interval; ULCI=upper limit of 95% confidence interval; CPSS=child-rated traumatic stress; ICU=caregiver-rated total CU traits; CPSS x ICU= child-rated total traumatic stress and interaction between caregiver-rated total CU traits; Time x ICUxCPSS=interaction between time and product term of caregiver-rated total CU traits and child-rated total traumatic stress; RSA=respiratory sinus arrhythmia.

Aim I/b.



Aim II/b.



Aim III/b.

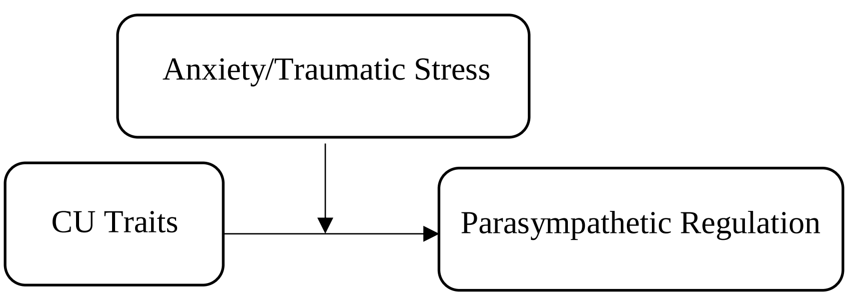


Figure 4. Visual depiction of statistical models.

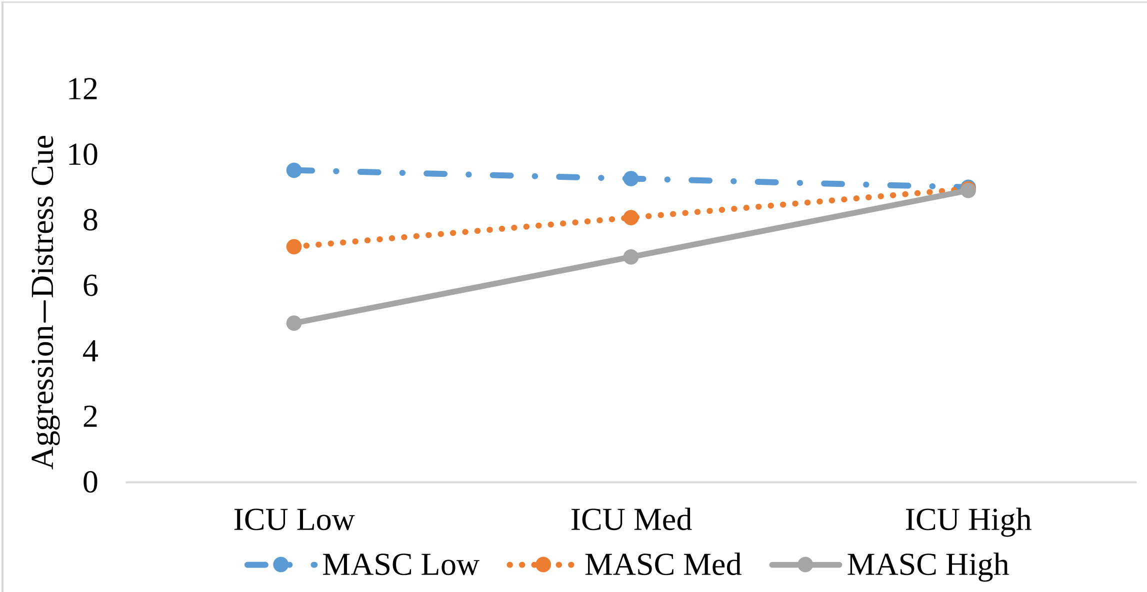


Figure 5. Graph depicting the interactive relationship between CU and anxiety when predicting aggression in the absence of a distress cue.

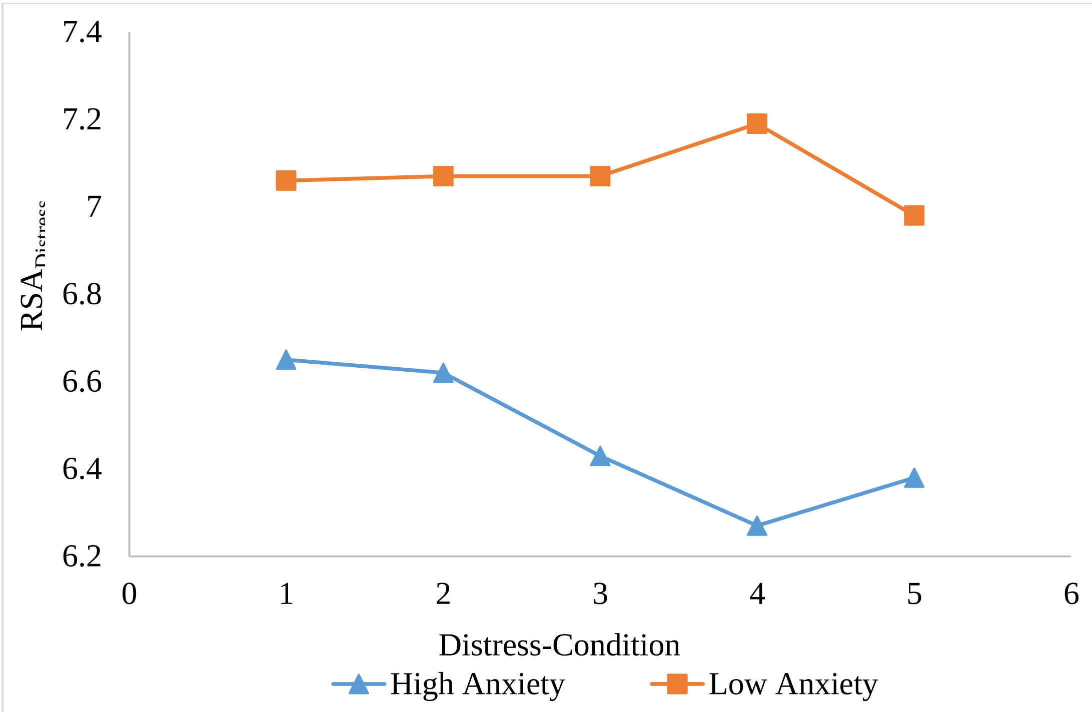


Figure 6. Graph depicting the relationships between respiratory sinus arrhythmia and caregiver-reported child anxiety scores on the MASC across the five distress-condition epochs in the Distress Response task.

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