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Attentional Orienting to Emotional Faces Moderates the Association Between Callous-Unemotional Traits and Peer-Nominated Aggression in Young Adolescent School Children

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Abstract Callous-unemotional (CU) traits are associated with aggressive behavior but preliminary research suggests this relationship is modified by patterns of emotional processing. This study examined whether attentional orienting to emotional faces moderated the association between CU traits and peer-nominated aggression in 251 middle school students (53% females, mean age = 13.24 years, *SD* = 0.73). Attentional orienting was assessed using an emotional faces (i.e., angry, fearful, happy, sad, and neutral) variant of the dot-probe task. Students also completed a self-report measure of CU traits and their classmates made peer nominations of aggression. Logistic regression analyses showed that peer-nominated aggression was positively related to CU traits at low levels of attentional orienting to angry faces, whereas aggression was unrelated to CU traits at high levels of attentional orienting to angry faces. That is, peer-nominated aggression was greatest for youth high on CU traits who were not engaged by angry faces. These findings support the importance of considering different patterns of emotional responding when studying the association between CU traits and aggressive behavior in youth.

Keywords Aggressive behavior · Attentional orienting · Callous-unemotional traits · Social development

Aggressive behavior occurring at school can result in harm to fellow students, is highly disruptive for teachers, and is a risk factor for later life maladjustment for the aggressive student (Cole and Deater-Deckard 2009). While a large number of factors have been identified as increasing risk for childhood aggression (Dodge and Pettit 2003), a consistent finding is that aggressive children experience problems regulating their displays of anger (Röll et al. 2012) and they can show a host of social information processing deficits (Crick and Dodge 1996; Dodge and Crick 1990). The most consistently reported social processing deficit associated with aggression is a hostile attribution bias whereby aggressive children tend to selectively attend to threat cues (e.g., angry faces) and to attribute hostile intent to innocuous or ambiguous cues in interactions with peers (see De Castro et al. 2002; Dodge and Pettit 2003). This attributional bias can be linked to the failure to regulate angry behavior, since it is likely to evoke angry responses to peers. Based on this work, most theories for the development of aggressive behavior place a strong emphasis on the role of the deficits in social cognition and accompanying problems in emotional dysregulation (Fontaine and Dodge 2009). Further, teaching children to regulate anger and overcome the associated social cognitive deficits are critical to many interventions for aggression in the schools (Lochman et al. 2015).

Although past work clearly supports the importance of emotional dysregulation and social information processing

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deficits for theories of aggression, these findings need to be reconciled with research suggesting that some aggressive individuals show an opposite pattern of emotional responding characterized by low levels of emotional arousal and deficient attentional orienting to negative emotional stimuli (Blair et al. 2014; Frick et al. 2014a; Kimonis et al. 2017). In fact, some of the most highly aggressive individuals who show the most severe and diverse patterns of aggression (i.e., showing both reactive and proactive forms of aggression) are characterized by low levels of emotional reactivity to peer provocation (Hubbard et al. 2002; Muñoz et al. 2008). Further, children (Ciucci et al. 2014; Crapanzano et al. 2010) and adolescents (Marsee et al. 2014) who are most likely to show this combined pattern of reactive and proactive aggression often show elevated levels of callous-unemotional (CU) traits.

CU traits refers to lack of empathy and guilt, a lack of concern about performance in important activities, and shallow or deficient affect (Frick and Ray 2015). Antisocial children with elevated levels of CU traits show reduced emotional reactivity (see Blair et al. 2014 and Frick et al. 2014a for reviews) using self-report measures of physiological arousal to threat (Marsh et al. 2011), cognitive tasks assessing attentional orienting to negative emotional pictures (Kimonis et al. 2006, 2017), psychophysiological responses to fearful faces (Fanti et al. 2016) or emotionally evocative films (de Wied et al. 2012), and amygdala responses to fearful faces (Viding et al. 2012).

Thus, theoretical models that attempt to explain the emotional correlates to aggression must consider how very different and potentially opposing patterns of emotional processing (i.e., hyper- and hypo- responses to negative stimuli) could both lead to aggressive behavior. Further, past research suggests that these explanations need to consider the potential role of CU traits (Frick et al. 2014a). In particular, the emotional correlates to aggression may differ depending on the child's level of CU traits. For example, Muñoz et al. (2008) investigated behavioral and psychophysiological responses to peer provocation in a sample of adolescents who were detained for a delinquent offense. They reported that youth who self-reported the highest level of aggression showed a very different pattern of physiological reactivity (i.e., skin conductance reactivity) to peer provocation depending on their level of CU traits. Specifically, only aggressive adolescents high on CU traits showed reduced psychophysiological responses to provocation. This finding would be consistent with past work using functional brain imaging that has suggested that adolescents high on CU traits show less reactivity to threats and other provocation from peers (Hwang et al. 2016; White et al. 2015).

Based on this finding, it appears that the child's level of CU traits may be important for explaining the various patterns of emotional responding that have been associated with aggression, just as it has been important for explaining divergent emotional correlates to conduct problems more generally (Blair et al. 2014; Frick et al. 2014a). To begin to merge the larger research literature on CU traits and conduct problems with this emerging research on childhood aggression, we propose a theoretical model in which there are two pathways that differ in the type of emotional dysfunction that can lead to the child's aggressive behavior. One pathway is through hypervigilance to negative and hostile (i.e., anger) stimuli that can lead to emotionally dysregulated behavior including aggression. This pathway is proposed to be independent of CU traits because such reactivity would lead to aggressive behavior, irrespective of the child's level of these traits. Further, this pathway is consistent with a host of past theoretical models linking problems in emotional hyper-reactivity and emotional dysregulation to aggressive behavior (Dodge and Pettit 2003; Fontaine and Dodge 2009). However, our model is unique in proposing the presence of a second pathway to aggression that is specific to youth with elevated CU traits, as would be suggested by the findings of Muñoz et al. (2008). That is, we propose that youth with elevated CU traits are characterized by a temperament that involves reduced responding to various types of negative emotional stimuli, especially fear, sadness, and other forms of distress in others, which makes it difficult for the child to recognize the effects of his or her behavior on others (Frick et al. 2014b). In the current study, we tested the key prediction of this model that different patterns of emotional responding would interact with CU traits in predicting aggression. However, our methodology allowed us to make several other important advances to past work on the emotional correlates to aggressive behavior in children.

First, most research to date on the link between emotional hyper-reactivity and aggression has focused specifically on angry reactivity (Morris et al. 2002). In contrast, with a few exceptions discussed above (Muñoz et al. 2008; White et al. 2015), most studies assessing the association between hypo-reactivity and aggression, or the association between emotional deficits and elevated CU traits, have largely focused on deficits in response to distress cues among others, such as sadness (Blair 1999) and fear (Marsh et al. 2008). Thus, it is not clear if the differences in emotional correlates to aggression are more related to the valence of emotions being studied, or to the pattern of reactivity to the emotions (i.e., hyper vs. hypo-reactivity). Thus, in the current study, we include measures that are linked to several different types of emotions to determine their link to aggression.

Second, past research has often focused on problems regulating emotional behavior or effortful deficits in biased processing of social information (i.e., responses to vignettes of social interactions) to detect hostile attribution biases that may be related to aggression (Dodge 2006). In contrast, research on the hypo-reactivity to distress in others often associated with CU traits has more frequently used measures of automatic reactivity using a variety of psychophysiological or

neurocognitive tasks (see Blair et al. 2014 for a review). Thus, it is not clear if differences in the emotional correlates to aggression might also be due to the focus on different stages of the child's emotional response. Thus, in the current study, we focus on a single paradigm that has proven to be a reliable method for experimentally studying the automatic emotional reactivity to stimuli of varying valences: the dot-probe task (MacLeod et al. 1986; Mathews and MacLeod 2005). The dot-probe procedure is a spatially oriented selective attention task that is able to capture automatic attentional bias toward emotional cues, providing an indirect index of emotional reactivity (Schippell et al. 2003; Susa et al. 2014). This task has been widely employed in studies of anxious individuals, evidencing that both non-clinical high trait-anxious individuals and clinically anxious patients exhibit automatic (hyper)vigilance to stimuli pertaining to their current concerns (Mogg et al. 1990, 1995; Mogg and Marden 1990). In the current study, we employed a variant of the dot-probe task using facial stimuli (Bradley et al. 1999, 2000) to explore attentional orienting to the different types of emotions of interest: anger versus other negative emotions (i.e., sadness and fear). Further, although the primary study aims focused on comparing the responses to angry (relative to neutral) faces relative to the two types of distress (fearful and sad) faces (again relative to neutral), responses to happy faces were included to determine if, as would be predicted by past research, any effects were limited to negative emotions (Kimonis et al. 2006).

Third, the current study explicitly tested whether the association between emotional reactivity and aggression was similar for boys and girls. This is important based on past work suggesting that the link between emotional dysregulation and aggression may be stronger in girls (Bowie 2010; Hill et al. 2006) and that the link between emotional hypo-reactivity and CU traits may not be found in adult female samples (Sutton et al. 2002; Vitale and Newman 2001). Further, when girls behave aggressively, they often exhibit indirect or relational forms of aggression (e.g., spreading rumors, attempts to harm ones relationships with others), whereas physical forms of aggression are more common among boys (e.g., attempts to physically harm others; Crapanzano et al. 2010). The indirect forms of aggression displayed by girls may go undetected by parents, teachers, and other authority figures and may be underreported by the child when using self-report measures (Pakaslahti and Keltikangas-Jarvinen 2000). Thus, in the current study we used a peer nomination procedure to measure aggressive behavior in the school setting by asking children to identify classmates that fit a behavioral description that could include both direct and indirect forms of aggression (Pellegrini and Bartini 2000).

In summary, the primary aim of the current study was to test predictions from the theoretical model proposed above that there are two distinct pathways to aggressive behavior that differ on the type of emotional processing deficits that can lead to the aggression. Specifically, we hypothesized that children showing reduced attentional orienting to angry and distressed (sad or fearful) faces would display high levels of peer-nominated aggression, but only if they were high on CU traits. It was further hypothesized that hypervigilance to angry faces would be positively associated with peer nominated aggression, irrespective of CU trait levels, consistent with the dual pathway model to aggression proposed above. We explored potential sex differences in the investigated associations, using a peer nomination procedure that was chosen specifically to capture potential sex differences in how aggression may be manifested. Because we used peer nominations encompassing a diversity of aggressive acts that can include indirect aggression, we did not expect there to be sex differences in these findings. Finally, we tested these predictions in a community sample of children at the transition from childhood into adolescence. The choice of a community sample allowed us to test associations with the full range of aggressive behavior as it is manifested in a typical school setting. The age of the sample was selected as it is a period of rapid biological, psychological and relational changes that have important implications for the development of stable patterns of emotional responding and behaviors (Soto et al. 2011).

Method

Participants

Participants were 251 students (53% females) between the ages of 11 and 15 ($M = 13.24$, $SD = 0.73$) years recruited from 17 classes (7th grade, $n = 8$; 8th grade, $n = 9$) in two Italian middle schools. In each classroom, approximately 80% of all students participated. Exclusionary criteria included: absence from school during data collection, severe learning disabilities and/or psychological disorders (i.e., mental delay and severe mood disorders), and unfamiliarity with the Italian language; the last two exclusionary criteria were based on teacher reports and they were conditions that made it impossible for the student to understand the study measures. The majority (91.63%) of students were Italian. The sample was diverse in regards to parental educational level but representative of families in the school district: more than half of fathers (56.57%) and mothers (67.73%) had earned a high school or university degree.

Procedure

Institutional Review Boards and the School Deans (i.e., principals) of the two involved schools approved all procedures. Written parental consent was obtained for all participants, and all students provided assent before completing the study

measures. Trained research assistants collected data from students during school hours, at three different times in order to avoid fatigue. Questionnaires were individually administered to students within classrooms and took approximately one hour to complete; the order of administration of the instruments was randomized within classrooms. Trained research assistants individually administered the dot-probe task to students in a quiet room free of distractions within the schools in groups of five, while the rest of the class attended regular school activities. Eight students were absent on the day that the self-reported questionnaires were administered and they were not included in the study. All other students provided complete data.

Measures

Callous-Unemotional Traits The Inventory of Callous-Unemotional Traits (ICU, Kimonis et al. 2008) is a 24-item self-report questionnaire that is widely used to assess CU traits (Frick and Ray 2015). Students indicate how much they agree with each item using a 4-point Likert-type scale, from *not at all true* (0) to *definitely true* (3). In the present study, the mean item score on the ICU total scale was used, as recommended from past studies that have questioned the usefulness of the subscales (Frick and Ray 2015). The reliability and construct validity of this total score has been supported in multinational samples using a variety of language translations (Essau et al. 2006; Kimonis et al. 2008; Roose et al. 2010) including the Italian version of the ICU that was used in the present study (Ciucci et al. 2014). Further, the ICU total score correlates positively with antisocial behavior and negatively with prosocial behavior across these translations (Ciucci et al. 2014; Essau et al. 2006; Kimonis et al. 2008). Consistent with past studies (Kimonis et al. 2008), items 2 and 10 were excluded from the ICU total score due to low item-to-total correlations, which resulted in an internally consistent total score (Cronbach's α = 0.81) in the current sample. The mean item total score found in this sample (M = 0.81; SD = 0.36) is similar to the mean item total score reported in the validation study of Italian version of the ICU (M = 0.82; SD = 0.37) from a sample of 540 preadolescent middle school students (Ciucci et al. 2014).

Attentional Orienting to Emotional Faces An emotional faces variant of the traditional word version of the dot probe task was used to assess attentional orienting. Angry faces are categorized as threat-related stimuli, sad and fearful faces as negative non-threat distressing stimuli, and happy faces as positive stimuli. Thus, this task allowed us to determine if the various emotions led to different associations with aggression using the same paradigm across emotions. The task presents a series of picture pairs of frontal-views of children's faces (1 male, 1 female) selected from the Dartmouth Database of Children's Faces (Dalrymple et al. 2013). To our knowledge, there are no other published validation studies with children for these picture sets used in a dot-probe task, although the use of facial depictions of emotions has been validated extensively in adult samples (Bar-Haim et al. 2007; Bradley et al. 1999, 2000; Susa et al. 2014). For each trial, a neutral face was paired with a face displaying one of four emotional expressions: anger, fear, happiness or sadness. The task consisted of one block of practice stimuli (three neutral-neutral picture pairs) followed by six experimental blocks, each containing 40 face-pairs (eight angry-neutral, eight fearful-neutral, eight happy-neutral, eight sad-neutral, and eight neutral-neutral) for a total of 240 face-pairs. Angry, fearful, sad, happy, and neutral face pairs were pseudo-randomly presented within the blocks.

Each picture presentation consisted of three sequential components: (1) a 500 millisecond fixation cross appearing in the center of the screen, (2) a 500 millisecond simultaneous presentation of two faces located immediately on the left and on the right of the fixation cross, and (3) an asterisk (i.e., dot-probe) appearing in either the left or right location immediately after the offset of the faces. A 500 *ms* stimulus duration was selected based on prior studies using the facial stimuli variant of the dot-probe task (Bradley et al. 1999, 2000) and assessing attentional orienting using other types of stimuli within a school-aged sample (Kimonis et al. 2006). The number and spatial position of face-pairs were counterbalanced across test trials in order to assure an equal number of emotional and neutral stimuli appeared in both left and right positions. There were also an equal number of emotional and neutral faces that were replaced versus not replaced by a dot-probe stimulus.

Participants were requested to press a key on the keyboard corresponding to the location on the screen (left or right) where the dot-probe appeared, as quickly as possible. If no key was pressed within 5000 milliseconds, the response was recorded as incorrect. Latency data for incorrect trials, and when reaction times (RTs) were <100 *ms* or >5000 *ms,* were not included in the calculation of facilitation indices. A facilitation index was computed for each emotion type by subtracting the average RT to dot-probes replacing emotional faces in emotional- neutral face-pairs from the average RT to dot-probes replacing neutral faces in neutral–neutral face-pairs: $\text{Facilitation}_{\text{emotion}}$ = [(neutral-neutral-LEFT {probe LEFT} - emotional-neutral LEFT {probe LEFT}) + (neutral-neutral RIGHT {probe RIGHT} - emotional-neutral RIGHT {probe RIGHT})]/2. The measures of facilitation indices for each emotion were standardized. Faster reaction times on the dot-probe paradigm index greater attentional orienting to emotional relative to neutral stimuli. Thus, positive facilitation scores reflect the normative response for emotional stimuli to capture individual's attention to a greater extent than neutral stimuli.

Peer Nominated Aggression Peer nominations were used to determine classmates' perceptions of peers' aggression. Peer nominations are a widely used approach to assess children's and adolescents' behaviors in the school setting by asking students to identify classmates that fit specific behavioral descriptions, including aggression (e.g., Coie et al. 1982; Ladd 2006). Using a time frame of the previous two to three months, students were asked to nominate up to six classmates who best fit the descriptor "does cruel/mean actions without worrying about the suffering they inflict on others". This descriptor was chosen because it encompasses a diversity of aggressive acts intending to harm others that can be either direct or indirect (Pellegrini and Bartini 2000). Participants were provided classroom rosters to aid in peer nominations. Each child obtained a score for the number of received nominations and this was standardized within classrooms (i.e., z-score). Due to the highly skewed distribution of aggression scores, each child's score was dichotomized at the 75th percentile (separately for boys and girls) as thresholds for identifying low (0, i.e., below 75th percentile) and high (1, i.e., ≥ 75th percentile) levels of aggression. The 75th percentile was chosen based on past research using the cut-off, which reported that children above this cut-off at age eight showed poorer school adjustment at age 14 and more unemployment in adulthood (Kokko and Pulkkinen 2000). Similarly, children above the 75th percentile on peer rated aggression in grades 1st, 4th and 7th showed poorer adjustment later in development (Ledingham 1981). Using this cut-off, 29 boys and 35 girls constituted the group high in aggression, whereas 89 boys and 98 girls were categorized in the low aggression group.

Data Analysis

First, we examined descriptive statistics and zero-order correlations among the main study variables (i.e., Kendall's *tau-b* was used for the dichotomized measure of aggression and Pearson's *r* was used for the other variables). We also tested for sex and grade differences in CU scores and emotion facilitation indices using Univariate and Multivariate Analyses of Variance (ANOVA/MANOVA). Second, a series of hierarchical logistic regression analyses were conducted to examine the main and interactive effects of CU traits and emotional facilitation indices for discrete emotions in their association with the probability of being nominated by peers as aggressive. Sex, grade, CU traits, and facilitation indices (separately for the four emotions) were entered in step 1; next, a two-way interaction term for CU and emotional facilitation index was entered in step 2; two-way interactions for CU traits and sex, and for facilitation index and sex were entered in step 3; lastly, a three-way interaction term between CU traits, emotional facilitation index, and sex was entered in step 4. Scores were centered prior to computing interaction terms by subtracting the sample means from scores. Where results indicated significant interactions, the form was explored using post-hoc probing procedures recommended by Holmbeck (2002). Specifically, the regression equation derived from the full sample was used to estimate predicted values for the dependent variable at one *SD* below and one *SD* above the mean.

Results

Preliminary Analyses

Distributions and zero-order correlations between study variables are reported in Table 1. There was a small positive association between CU traits and aggression, but none of the emotional facilitation indices were associated with either CU traits or aggression. Results of a 2 × 2 (sex x grade) MANOVA exploring sex and grade differences in facilitation to discrete emotional expressions revealed no main effects for sex, Pillai's Trace = 0.01; F(4,244) = 0.61; η^2 = 0.01; p = 0.653, or grade, Pillai's Trace = 0.01; $F(4,244) = 0.74$; $\eta^2 = 0.01$; $p = 0.563$, and no sex x grade interaction, Pillai's Trace = 0.01; $F(4,244) = 0.64$; $\eta^2 = 0.01$; $p = 0.635$. Results of a 2 × 2 (sex x grade) ANOVA predicting CU traits revealed that boys scored higher ($M = 0.90$, $SD = 0.34$) than girls ($M = 0.72$, $SD = 0.35$), $F(1,250) = 14.81$; $\eta^2 = 0.06$; $p < 0.001$. There was no main effect for grade, $F(1,250) = 0.64$; $\eta^2 = 0.00$; $p = 0.425$, and no sex x grade interaction, $F(1,250) = 1.07$; $\eta^2 = 0.00$; $p = 0.302$).

Test of Main Study Hypotheses

Results of hierarchical logistic regression analyses are reported in Table 2. Consistent with correlational analyses, there was a positive association between CU traits and the probability of being nominated by peers as aggressive, but none of the facilitation indices were associated with aggression. However, there was a significant two-way interaction between CU traits and facilitation to angry faces in predicting peer-rated aggression. Post-hoc probing showed that the form of the interaction was consistent with predictions (see Fig. 1). That is, CU traits were associated with a higher probability of being nominated as aggressive at low levels of facilitation to angry faces ($B = 2.64$, $p < 0.001$) but not at high levels ($B = 0.61$, $p > 0.05$). Importantly, sex did not modify this association. For the other emotions, there were no significant interactions between facilitation indices and CU traits, and once again the potential moderating effects of sex did not emerge.

Table 1 Descriptive statistics and zero-order correlations between main study variables

	M	*SD*	*Skew.*	*Kurt.*	1	2	3	4	5	6
1 Mean aggression	–	–	–	–	–					
2 CU traits	0.81	0.36	0.49	0.09	0.18**	–				
3 EF happy	0.00	0.92	−0.23	1.04	−0.04	0.02	–			
4 EF sad	0.05	0.72	−0.56	1.88	−0.08	0.04	−0.12	–		
5 EF angry	0.02	0.89	−0.04	0.90	0.01	0.02	0.17*	0.10	–	
6 EF fear	0.01	0.87	−0.37	1.26	−0.02	0.12	0.26**	0.21**	0.27**	–

Correlations for the dichotomous (low = 0 [below 75th percentile]; high = 1 [≥ 75th percentile]) mean aggression variable are reported as point-biserial correlations

EF Emotion Facilitation, *CU* Callous-unemotional, *Skew.* Skewness, *Kurt.* Kurtosis

* $p < 0.01$, ** $p < 0.001$

Discussion

Past research has suggested that CU traits are associated with aggressive behavior in non-referred, clinic-referred, and forensic samples (Ciucci et al. 2014; Crapanzano et al. 2010; Marsee et al. 2014). Further, in these past studies, again across a diversity of ages and sample types, CU traits have been associated with a particularly severe pattern of aggression that results in substantial harm to others (see Frick et al. 2014a for a review). Importantly, the findings from the current study support past work in suggesting that the emotional correlates to aggression may differ depending on the child's level of CU traits. As shown in Fig. 1, the probability of being nominated by classmates as aggressive was quite high in those showing heightened attentional orienting to angry faces, irrespective of the child's level of CU traits. In contrast, children displaying low attentional orienting to angry faces were more likely to be nominated as high on aggression only if they were also high on CU traits.

This pattern of findings would be consistent with the theory that emotional dysregulation and its associated social cognitive deficits can lead directly to aggression (Röll et al. 2012). Although our ability to make causal interpretations are limited by the cross-sectional nature of our data, McLaughlin et al. (2011) provided longitudinal data showing that the heightened levels of angry reactivity predates aggressive behavior. Further, these data would be consistent with theories suggesting that low emotional reactivity can influence the development of aggression through another mechanism. Specifically, a temperament characterized by reduced emotional arousal and reactivity can make it difficult for a child to develop the prosocial emotions (i.e., empathy, guilt) that serve to inhibit aggressive behavior in normally developing children (Frick et al. 2014b).

Importantly, the interaction between attentional orienting to angry faces and CU traits was not moderated by the child's sex, suggesting that our findings were relatively consistent for boys and girls. This finding is relevant, given past research suggesting that girls and boys may differ in their emotional correlates to aggression (Bowie 2010; Hill et al. 2006). Our findings may have diverged from past work because we used peer nominations of aggressive behavior that relied on a definition that encompassed a wide range of potential ways of harming others. This methodology was important when studying potential sex differences because it allowed us to capture the different ways that both boys and girls may harm others;

Table 2 Logistic regression analyses predicting peer rated aggression

Step1	*B*				Pseudo R^2	Model χ^2 *(df)*
	Sex	Grade	CU traits	EFI		
Emotion facilitation happy	−0.39	−0.13	1.62**	−0.09	0.09	14.968(4)*
Emotion facilitation sad	−0.45	−0.06	1.70**	−0.56	0.12	21.974 (4)**
Emotion facilitation anger	−0.37	−0.13	1.61**	−0.04[a]	0.08	14.733 (4)*
Emotion facilitation fear	−0.40	−0.14	1.66**	−0.15	0.09	15.415 (4)*

CU Callous-unemotional, *EFI* Emotion Facilitation Index

*$p < 0.01$, **$p < 0.001$

[a] There was a significant 2-way interaction between CU traits and emotion facilitation to angry faces in Step 2 ($B = -1.14$, $p < 0.05$, Nagelkerke $R^2 = 0.11$, ΔNagelkerke $R^2 = 0.03$; Model $\chi^2 = 20.290$, $df = 5$, $p < 0.001$; Step $\chi^2 = 5.556$, $df = 1$, $p < 0.05$)

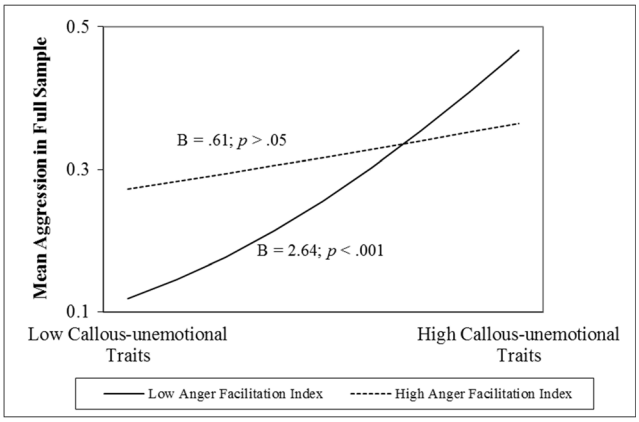

Fig. 1 The two-way interaction between callous-unemotional traits and facilitation to angry faces in the association with mean peer-nominated aggression in the full sample

that is, girls are more likely to show indirect forms of aggression that are not adequately captured by many existing rater measures of aggressive behavior that focus more on direct physical aggression towards others (Crapanzano et al. 2010). However, this methodology also means that our results showing no moderation by sex may not replicate when using other definitions of aggression, especially those that are limited to direct physical aggression.

Moreover, the only interaction between attentional orienting and CU traits was for anger. On the one hand, this finding is consistent with past research suggesting that deficient attentional orienting to emotional stimuli is limited to negative emotions (Kimonis et al. 2006), since there was no effect of happy faces as predicted. However, our findings were inconsistent with predictions and a significant amount of past work linking CU traits to deficient emotional arousal to fear and sad faces, using a number of different paradigms, including the dot-probe (see Blair et al. 2014 for a review). Importantly, much of the past work in this area has focused on the moderating role of CU traits in the emotional correlates to conduct problems in general, whereas our analyses focused specifically on peer-nominated aggression. Thus, our results may suggest that responses to anger-related stimuli may be particularly important for understanding the emotional correlates to aggression. This possibility would be consistent with previous work (Muñoz et al. 2008; White et al. 2015) showing that reduced physiological reactivity (i.e., skin conductance reactivity) and fMRI activation (i.e., periaqueductal gray/amygdala responsiveness) to peer provocation was only associated with aggression in both referred and community adolescents high on CU traits. Although these past studies used measures of emotional responsivity to peer provocation, rather than attentional-orienting to angry faces as was used in the current study, they both could be interpreted as involving emotional responses to hostile or provocative stimuli.

Our study had a number of methodological features that strengthen the interpretations that can be made from the results. Specifically, we used a multi-method approach that involved an objective laboratory task to assess attentional orienting to emotional faces, self-report of CU traits, and peer nominations of aggression. This methodology reduced the influence of shared method variance across the key study variables. Also, we used a method of assessing aggression that would be optimal for studying both direct and indirect ways to harm others that may be critical for detecting potential sex differences. However, it is also important to note that our data were cross-sectional, making it impossible to make causal interpretations from the associations. Further, participants, while representative of the school system from which they were recruited, were ethnically homogenous, which makes it unclear how well the findings may generalize to more ethnically diverse samples. Finally, our measures of emotional reactivity were limited to the child's attentional orienting to different emotional faces and it would be important to test how well our findings generalize to other ways of assessing emotional reactivity and arousal.

Within the context of these limitations, our findings support the importance of considering different patterns of emotional responding when studying aggressive behavior. That is, like theories for the development of conduct problems more generally (Frick et al. 2014a), theories for the etiology of aggression need to use research designs and statistical methods that can detect these multiple pathways that may involve opposing patterns of emotional responding (Frick 2012). Further, these results could have implications for treatment as well. As noted above, many treatments for aggressive youth focus on developing skills to regulate anger and overcome the associated social cognitive deficits (Lochman et al. 2015). However, if these skills are only needed for certain groups of aggressive youth, and this is not considered in the treatment trial, the effectiveness of these treatments may have been underestimated for those who require these skills. More importantly, those aggressive youth with lower levels of emotional reactivity and elevated CU traits may require alternative treatments. For example, there is an increasing focus on modifying existing evidence based treatments for youth with conduct problems and aggression by including components that aim to increase emotional literacy and prosocial emotions or that motivate the child to inhibit aggression without relying on concern for others (Kimonis et al. 2014). In short, our results suggest that because the emotional correlates to aggression can differ across youth, treatment likely needs to be tailored to these differences (Frick 2012).

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Compliance with Ethical Standards

Conflicts of Interest The authors declare that they have no conflict of interest.

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

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

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