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Are impairments in emotion recognition a core feature of callous–unemotional traits? Testing the primary versus secondary variants model in children

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Abstract

The role of environmental adversity in the development of high callous–unemotional (CU) traits in children is controversial. Evidence speaks to the traits being largely independent of adversity; however, recent data shows that those with high CU traits and high adversity and/or high anxiety might differ in important ways from those with no such history. We tested this using emotion recognition (ER) skills. We tested whether maltreatment history and anxiety levels moderated the relationship between level of CU traits and ER skills in $N = 364$ children with behavioral problems who were 3 to 16 years old. As hypothesised, in the full sample, the relationship between CU traits and ER differed according to maltreatment history, such that CU traits were associated with poorer recognition for those with zero or negligible history of maltreatment. This moderation of the CU-ER relationship by maltreatment was inconsistent across subgroups, however, and for the cohort utilizing youth self-report of maltreatment, high CU traits were associated with poor ER in those with lower anxiety levels. Maltreatment history and/or anxiety levels can identify different emotional impairments associated with high CU traits, and the impairments might be characteristic of "primary" high CU traits defined as occurring independently of maltreatment and/or high anxiety.

Research into callous–unemotional (CU) traits has been an important development in subtyping trajectories of antisocial behavior. An impairment in the fundamental propensity to recognize and respond to emotional cues from other people is a reliable characteristic of CU traits in children, and the emotional aspects of psychopathy in adults (Blair, Leibenluft, & Pine, 2014). Traditionally, the evidence and theoretical interest in this impairment has focused on the distress emotions of fear and sadness, and impaired recognition of these emotions has been demonstrated across a range of visual, especially facial-emotion, recognition tasks, as well as auditory and postural cues. A recent meta-analysis indicated that the impairment, while most robustly shown for fear and sadness, may extend across the full gamut of emotions (Blair et al., 2014; Dawel, O'Kearney, McKone, & Palermo, 2012). Thus, decades of research has indicated that an impairment in emotion recognition (ER) may be fundamental to, and perhaps an etiological driver of, the emotional deficits held to be a core characteristic of CU traits in children, the focus of this paper.

A major problem, however, with the idea that ER impairments are core to CU traits is that the impairment is only seen at a group level with small to moderate effect sizes (Blair et al., 2014). Thus, individual differences are the rule, and there is considerable heterogeneity in groups defined as having high CU traits with respect to ER impairments. There are several reasons why this might be the case. First, existing methods and measures for indexing ER, typically using static images on a computer screen, may only partially tap the ER impairment, or do so with variable validity and reliability (Marsh & Blair, 2008). Second, the measurement of CU traits may capture a range of cognate factors, again with less than perfect reliability (Lahey, 2014), that correlate differently with impairments in ER.

Notwithstanding these construct and measurement issues, it is possible that individual differences in impairments in ER might tell us something important about heterogeneity in the phenomenology and etiology of high levels of CU traits. This paper tests the idea that ER impairments are a characteristic of "primary" high CU traits. Two methods have been used in defining and identifying primary CU traits in the existing literature. The first is that they have arisen independently of environmental adversity: in this case, maltreatment. The second is they occur in the absence of internalizing psychopathology, namely, anxiety. In order to review these ideas, we will need to consult the existing literature on maltreatment, anxiety, and primary and secondary variants that has focused on psychopathy in adults. It should be noted that the focus of this paper is CU traits in children, and while these traits may increase risk for poor adult outcomes, they do not equate to "psychopathy," and care should be taken generalizing the adult literature and the term psychopathy to children.

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Recent research using a range of methodologies indicates that high CU traits can emerge through different and identifiable pathways. Primary CU traits are hypothesized to develop independently from (i.e., in the absence of) exposure or sensitivity to maltreatment, and in the presence of high biological/genetic risk. For example, a recent longitudinal study showed that children scoring high on CU traits and low on anxiety at age 13 years had no history of maltreatment but evidenced epigenetic modifications to the oxytocin receptor system, known to be implicated in a range of prosocial behaviors, that were present from birth onward (Cecil et al., 2014). In contrast, children showing high CU traits and high anxiety showed marked histories of maltreatment, normal or high levels of emotion responsiveness, and attract the descriptor "secondary" variants or phenocopies (Kahn et al., 2013; Kimonis, Skeem, Cauffman, & Dmitrieva, 2011).

The differentiation into primary versus secondary variants has been operationalized using either a history of maltreatment and/or concurrent levels of anxiety. The constructs of anxiety and trauma are clearly related and can be difficult to disentangle both conceptually and methodologically. For example, while the occurrence of extreme events such as maltreatment may be inherently "traumatic," they might only cause traumatic reactions in vulnerable individuals, typically those with high anxiety and emotionality. Conversely, highly emotional and anxious individuals are more likely to regard a range of events as traumatic and respond adversely to them (Breslau, Davis, Andreski, & Peterson, 1991).

The role of trauma in CU traits remains controversial. Karpman (1941) theorized the existence of a trauma-based pathway to psychopathy in adults. Since then, a wealth of studies have documented a link between psychopathic traits in adults and a history of childhood trauma (Koivisto & Haapasalo, 1996; Lang, Klinteberg, & Alm, 2002; Weiler & Widom, 1996). Similarly, developmental research shows that exposure to abuse and neglect during toddlerhood is associated with early affective deficits consistent with CU traits. In a recent review by da Silva Ferreira, Crippa, and de Lima Osório (2014), maltreated children were generally shown to be more responsive to emotional faces, but less accurate in identifying (labeling) them. Our own review of extant studies, some of which were not included in the da Silva Ferreira study, led us to conclude that a relationship between poorer ER and maltreatment is more evident in younger children and is not found in older maltreated children (see During & McMahon, 1991); maltreated children showed greater responsiveness to negative emotions, and required lower emotional intensity to recognize emotions (da Silva Ferreira et al., 2014). In addition, several studies have found improved ER for negative emotions in maltreatment (Leist & Dadds, 2009; Masten et al., 2008; Pollack, Cicchetti, Hornung, & Reed, 2000; Pollak & Sinha, 2002) or that impairments only occur for positive emotions (Koizumi & Takagishi, 2014).

Thus, some studies show maltreatment impairs ER, but others show that children exposed to maltreatment can become hyperresponsive, faster, and more accurate in recognizing emotional stimuli. This is a pattern similarly observed in anxious individuals (Bishop, 2008; Yiend, 2010), further supporting the difficulty in disentangling the influences of maltreatment and anxiety in causal pathways to impaired ER and high CU traits. Pollak et al. (2000) suggest that there may be a U-shaped function to emotional expression, such that exposure to heightened levels of anger and hostility as in the case of physical abuse, and minimal exposure to appropriate emotional expression as in the case of neglect, both lead to suboptimal emotional learning. Thus, it may be important to identify subtypes of maltreatment on the premise that intact or increased ER is associated with "active" emotional and physical abuse whereas neglect is more often associated with impairments in ER (e.g., Pollak et al., 2000, 2002).

If the characteristics of children with high CU traits can be better understood with regard to their histories of maltreatment and concurrent anxiety levels, it follows that one or both of these variables may explain individual differences in ER skills in children with high levels of CU traits. Little research has examined this question; however, preliminary research suggests that the group showing high (but secondary) CU traits associated with a history of abuse may not show deficits in responding to others' distress cues, a core characteristic of primary CU traits (Kimonis, Frick, Cauffman, Goldweber, & Skeem, 2012). Unfortunately, deficits in ER have yet to be examined with respect to primary versus secondary CU traits.

In summary, the role of maltreatment in the development of CU traits and its characteristic features remains a major unanswered question. Our review indicates that the existing literature suggests that a history of maltreatment and/or high levels of concurrent anxiety might moderate the relationship between CU traits and impaired ER in children. Specifically, it is proposed that impaired ER is only characteristic of primary CU traits, marked by low maltreatment and/or normative anxiety. Exposure to a history of active maltreatment, and/or concurrent high anxiety, might characterize a "secondary" pathway to high CU traits in children in which impaired ER is not a feature. We had no specific hypotheses about the independence or overlap of the constructs of maltreatment and anxiety in differentiating primary versus secondary variants of CU traits with regard to ER. Rather, we aimed to conduct a first test of whether either or both of these constructs would interact with levels of CU traits to predict ER.

We tested these hypotheses in sample of clinic-referred children presenting with a variety of behavioral and emotional problems, using multi-informant ratings of exposure to maltreatment. Specifically, we tested the following hypotheses: (a) increased exposure to maltreatment (all forms) would be associated with high CU traits and levels of anxiety; (b) a history of active maltreatment (emotional/physical abuse) would predict enhanced ER whereas a history of neglect would predict poor ER; (c) CU traits would predict poor recognition of all emotion types; and (d) a history of active maltreatment and/or high anxiety problems would moderate the CU traits–ER relationship, such that CU traits

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will show greater associations with poor ER for all emotions in the absence of maltreatment and/or anxiety problems.

Methods

Ethics approval was obtained from the University of New South Wales (UNSW), and informed consent was obtained from all subjects. Participants ($N = 364$, 72% male) were referrals to the Child Behaviour Research Clinic at the UNSW and Royal Far West child health center in Sydney, Australia. These services specialize in parent-based management of behavioral problems, generally consistent with a diagnosis or features of oppositional defiant disorder (ODD) or conduct disorder (CD), attention-deficit/hyperactivity disorder (ADHD), autism spectrum disorder (ASD), anxiety, or depressive disorder using DSM-IV criteria (American Psychiatric Association, 1994). Diagnoses were as follows: primary: ODD or CD: full diagnosis 37.7%, features (i.e., subclinical symptoms) 18.1%; ADHD: full diagnosis 25.3%, features 5.5%; anxiety or depression (internalizing): full diagnosis 7.7%, features 1.7%; ASD: features 1%; other diagnoses 3%; secondary: ODD/CD: full diagnosis 15.9%, features 2.5%; ADHD: full diagnosis 9.9%, features 2.5%; anxiety or depression (internalizing): full diagnosis 4.7%, features 1.6%; ASD: features 1.1%. Occurrences of full diagnoses anywhere in the profile were ODD/CD 53%, ADHD 35.6%, and internalizing 13.2%. Comorbidity was common; 48.4% had two diagnoses and 14.3% had three or more. Thirty-one percent of the sample was on a medication, mostly for ADHD and antidepressants. Given some evidence that medications, especially selective serotonin reuptake inhibitors can improve ER (e.g., Harmer & Cowen, 2013), the effects of medication status were included in the data analytic plan.

Children were aged 3–16 years ($M = 8.93$, $SD = 3.28$). Inclusion and exclusion criteria were functional English; no major neurological/physical illness; IQ >70, no full clinical-level diagnosis of ASD given its established link with ER deficits (Harms, Martin & Wallace, 2010); availability of the Maltreatment Index completed by at least one reporter (teacher, clinician, or child self-report); and complete data on the UNSW Family and Child Experiences Survey ER task. Ethnic ancestry was measured by having parents nominate the ancestry of each grandparent as Anglo European (Caucasian), Asian/Indian, Middle Eastern/North African, Indigenous, Oceanic/Pacific, or other. The majority of the sample was Caucasian (64.6%), categorized by three or more grandparents known and coded as Caucasian. Table 1 shows characteristics of the sample.

Measures

Data collection occurred between 2007 and 2015. Diagnoses were made using DSM-IV criteria by the assessing psychiatrist/psychologist using the Diagnostic Interview Schedule for Children, Adolescents and Parents diagnostic interview with parents, and the child for those older than 8 years. Diagnoses were made both categorically and using severity ratings on a 7-point scale where 0 = *no features*, 1–3 = *subclinical*, and 4–6 = *marked* to *very severe*. Diagnoses were checked by having a second diagnostic team make an independent diagnosis. Kappa agreements on primary and secondary diagnoses were always >0.7. Throughout the analyses, "anxiety" for each child was operationalized as the highest clinician severity score recorded for any DSM diagnosis or features of such.

Levels of CU traits were measured using the UNSW system for combining items from the CU traits subscale of the Antisocial Process Screening Device (Frick & Hare, 2001) and the prosocial subscale of the Strengths and Difficulties Questionnaire (Goodman, 1997). This system produces reliable indices and has been extensively validated. This system produces valid and stable measures of CU traits that predict the growth of conduct problems in children as young as 4 years (Dadds, Frost, Fraser, & Hawes, 2005). The measure is weighted toward the "callous" end of the CU traits spectrum with a focus on items such as "unkind," "lacks empathy," and "doesn't care about other's feelings." The DSM-5 CU specifier to the diagnosis of CD recommends that CU traits be evident across settings (American Psychiatric Association, 2013); thus, we collected reports from mothers, fathers, teachers, and self-reports for children >9 years (mothers 92.0%, fathers 58.2%, teachers 77.5%, and youth 40.7%). Scores from all sources had good reliability (α range = 0.77–0.90), and correlations of mothers to other raters were father ($r = .411$, $p < .001$), teacher ($r = .321$, $p < .001$), and youth ($r = .238$, $p < .01$).

Accuracy of ER was measured using the UNSW Family and Child Experiences Survey (Dadds, Hawes, & Merz, 2004), a well-established measure of facial ER (Dadds, El Masry, Wimalaweera, & Guastella, 2008; Dadds et al., 2006). Participants view sets of happy, sad, angry, fearful, disgusted, and neutral faces (two adult, two adolescent, and two child) that are presented on a computer monitor and are asked to identify the emotion from the list of five emotions that appears on the screen after the face. The child can use the computer keyword to select from the target list of emotions, or verbally label the emotion for recording by the experimenter. A practice phase is included to rehearse the child in the procedure, especially the labeling of the emotion stimuli. If the child gave the wrong emotion label during the rehearsal, the experimenter gently corrected them (e.g., child: "Happy!" Experimenter: "Do you think that is a happy face? I think it might be a bit sad"). Children are excluded if they are unable or unwilling to attend to and label the emotions, but not for providing incorrect labels even during the rehearsal phase. Each emotion was presented in a random order 10 times for a 500-ms duration. Overall accuracy scores were used in the analyses. Online-only supplementary Figure S.1 shows means and 95% confidence intervals for overall accuracy of ER for the sample broken down into five age groups: 3–5, 6–8, 9–11, 12–14, and 15–16 years. Correct ER rate by chance is 20%; accuracy rates approach 60% for overall emotion accuracy and 40% for the most dif-

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Table 1. *Demographic and diagnostic data split by Maltreatment Index source*

	Clinician ($n = 150$)		Teacher ($n = 148$)		Youth ($n = 141$)		Total ($N = 364$)	
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*
Age (years)	7.95*	2.77	8.59	3.41	11.70*	2.10	8.93	3.28
SEIFA rank	8.33*	2.14	7.71	2.49	6.69*	2.68	7.68	2.46
Maternal education	4.20*	1.05	4.11	1.03	3.77*	1.12	4.04	1.08
Severity								
CP	3.45*	1.30	3.16	1.82	2.91*	1.94	3.20	1.71
ADHD	1.86	1.93	1.80	1.99	2.19	1.93	1.99	1.96
Anxiety	0.60*	1.33	1.16*	1.76	1.01	1.65	0.91	1.59
ASD features	0.06	0.37	0.12	0.56	0.09	0.49	0.07	0.43
CU traits	6.47	2.93	6.36	3.16	6.58	3.19	6.43	3.05
Gender								
Male	109	72.7%	106	71.6%	95	67.4%	263	72.3%
Female	41	27.3%	42	28.4%	46	32.6%	101	27.7%
Caucasian	100	66.7%	91	61.5%	83	58.9%	235	64.6%

Note: SEIFA, Socio-Economic Indexes for Areas (Australian Bureau of Statistics, 2006); maternal education, 1 = primary, 2 = Year 10, 3 = Year 12, 4 = college/TAFE, 5 = university; CP, oppositional-defiant or conduct disorder; ADHD, attention-deficit/hyperactivity disorder; ASD, autism spectrum disorder; CU, callous–unemotional; Caucasian, at least three known Caucasian grandparents.
*$p < .05$ for comparison of each cohort (clinician, teacher, youth reports) to other cohorts.

ficult emotions of fear and disgust, in even the youngest children, and then show a gradual and linear increase in ER accuracy with age. The variance within age groups remains quite stable from 3 to 16 years. These data support the findings of Kimonis et al. (2015) and During and McMahon (1991) that ER can be reliably measured in children as young as 3 years.

Maltreatment reports were collected from either clinicians or teachers, and by youth for children over 8 years of age. The final data set includes maltreatment reports by clinicians, teachers, and youth as follows: clinicians, $n = 150$; teachers, $n = 148$; and youth, $n = 141$; both clinicians and youth, $n = 40$; both teachers and youth, $n = 35$; and all three reports, $n = 1$. Various changes to data collection protocols over the years of collection meant that generally one maltreatment informant was available for the majority of children, creating three separate cohorts in terms of maltreatment reports. These cohort differences are examined and considered during hypothesis testing in the Results section.

Maltreatment scores were collected using the Maltreatment Index (MI) completed by subsamples of clinicians who had assessed and were treating the case, the child's main teacher, and/or the child themselves for those 8 years and older. Teachers were nominated by parents as the child's main teacher and had known the child for at least 3 months. The MI is based on the Maltreatment Classification System by Barnett, Manly, and Cicchetti (1993) and uses a 4-point Likert scale (1 = *never*) for the reporter to rate the veracity of three statements pertaining to emotional abuse, physical abuse, and neglect, respectively. Sexual abuse was not included as a theoretical construct and was not measured in the study. The exact script is shown in the online-only supplementary materials. Overall MI ratings were produced by taking the highest score of all available reports for physical abuse, emotional abuse, and neglect. Teachers and clinicians also provided "confidence levels" on a 3-point scale reflecting their confidence in providing an accurate report on the MI (1 = *low confidence*, 3 = *high confidence*). For the statistical analyses, we combined physical and emotional maltreatment into a combined "active" abuse score by taking the highest score available for either. Ratings that indicated any current risk to the child were managed by clinicians and supervisors within the ongoing management of the case, according to the specific research and professional ethics protocols.

Participant's Socio-Economic Index for Areas score of relative socioeconomic disadvantage (Australian Bureau of Statistics, 2006) was determined using their residential postcode. This index ranks geographical areas on level of disadvantage (1 = *disadvantaged*, 10 = *advantaged*), based on a comparison of areas across Australia. IQ scores were available for $n = 291$ of the children and were assessed using the Wechsler Preschool and Primary Scale of Intelligence ($n = 57$; $M = 107.8$, $SD = 14.4$), the Wechsler Intelligence Scale for Children ($n = 68$; $M = 100.2$, $SD = 15.9$), the Peabody Picture Vocabulary Test ($n = 27$; $M = 109.5$, $SD = 14.7$), or the WebNeuro Language Index ($n = 139$; $M = –0.46$, $SD = 0.62$; Silverstein et al., 2007) according to the age of the child. IQ scores were standardized to form an IQ index for the whole sample.

Results

Table 1 shows demographic data for the cohorts with MI reports by clinicians, teachers, and youth. There were a number of differences between groups, with the youth-report sample being older, of lower socioeconomic status, and lower sever-

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ity of conduct problems than the clinician report cohort. There were also small but significant differences in anxiety problems such that the teacher report was higher than the clinician-report sample. These differences were considered in all analyses by checking age and anxiety levels as predictors and covariates.

Supplementary Table S.1 shows means, medians, standard deviations, ranges, and correlations between rater's scores on the dimensions of the MI for participants with multiple reports available. Convergence between raters is generally positive and low in size, ranging from 0 to .38; correlations were more often significant for emotional and physical maltreatment than neglect. In addition, the table shows confidence levels, which did not differ between teachers and clinicians. Table 2 shows correlations between CU, anxiety problems, and the MI, both as raw correlations and as partial correlations, controlling for child age, Socio-Economic Index for Areas rank, and concurrent level of conduct problems. Contrary to hypotheses, there were few significant associations between levels of CU traits, anxiety problems, and maltreatment by any reporter.

In order to test the hypothesis that levels of maltreatment and/or anxiety problems would moderate the relationship between CU traits and ER, generalized estimating equations (GEE) were used with mean accuracy of ER as the dependent variable, main effect predictors of child age, IQ Index, levels of CU traits, conduct problems, ADHD, anxiety problems, ASD, emotional/physical abuse, neglect, and the interaction of CU Traits × Emotional/Physical Abuse, and CU Traits × Anxiety Problems. In cases of correlated data with mixed dimensional and categorical data, GEE has many advantages over repeated-measures analyses of covariance or standard regression in that it accounts for correlations among repeated measurements, allows interactions terms to be modeled in the analysis specifications, using maximum likelihood estimation, and more effectively handles missing data and unbalanced designs (Gibbons, Hedeker, & DuToit, 2010). Although children with a diagnosis of ASD were excluded, some remaining children showed subclinical features, and given its known association with ER, we controlled for these features.

The results are shown in Table 3. Age, IQ Index, emotional/physical abuse, and CU traits were univariate predictors such that older children, those with higher IQ, less maltreatment, and low CU traits, showed more accurate ER. As hypothesized, there was also a significant interaction between CU traits and emotional/physical abuse in predicting ER, but no effects for level of anxiety problems as a main effect or in interaction with CU traits. The analysis was rerun excluding children on selective serotonin reuptake inhibitors, as this medication might have a positive impact on ER skills. The pattern of results was identical and significance levels for CU traits as a main effect, and in interaction with maltreatment, increased (supplementary Table S.2). The analysis was also rerun using all possible two-way interactions of age with CU traits, maltreatment, and anxiety, to ensure that age was not interacting with other predictors to confound the CU × Maltreatment interaction. The results are shown in supplementary Table S.3. Apart from a borderline result for the interaction of maltreatment and age, $p < .08$, there were no significant effect for interactions of the main predictors

Table 2. *Raw and partial correlations among CU, anxiety problems, and Maltreatment Index, controlling for child age, Socio-Economic Indexes for Areas rank, and concurrent level of conduct problems*

			CU Traits			
	Anxiety Problems		Mother Report		Teacher Report	
	r	Partial *r*	*r*	Partial *r*	*r*	Partial *r*
Youth report						
Emotional abuse	.07	.06	.19*	.18	.11	.01
Physical abuse	.09	.06	.07	−.02	.07	−.02
Neglect	−.04	−.08	.10	.16	.01	−.03
Clinician report						
Emotional abuse	.05	.01	.14	.13	.07	.06
Physical abuse	.12	.12	.13	.11	.11	.03
Neglect	.04	.03	.04	−.01	.06	.02
Teacher report						
Emotional abuse	−.16*	−.17	.12	.26*	.16	.21*
Physical abuse	−.14	−.13	.07	.04	.14	.16
Neglect	−.07	−.11	.05	.14	.07	.13
Combined						
Emotional/physical abuse	−.01	−.06	.14*	.10	.17*	.21*

Note: CU, Callous–unemotional. Partial *r* values are the correlation between CU traits and Maltreatment Index controlling for socioeconomic status, age, and level of conduct problems.
*$p < .05$.

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Table 3. *Regression results predicting accuracy of emotion recognition from child adjustment and maltreatment*

			95% CI		Hypothesis Test		
Predictor	*B*	*SE*	Lower	Upper	χ^2	*df*	*p*
Intercept	0.623	0.0696	0.487	0.760	80.188	1	<.001
Age	0.024	0.0028	0.018	0.029	71.830	1	<.001
IQ	0.036	0.0096	0.017	0.055	14.181	1	<.001
CU traits	−0.024	0.0080	−0.040	−0.008	9.045	1	<.003
Conduct problems	−0.003	0.0051	−0.013	0.007	0.336	1	<.562
ADHD	0.001	0.0053	−0.009	0.012	0.067	1	<.796
Anxiety	0.014	0.0113	−0.009	0.036	1.445	1	<.229
ASD	−0.013	0.0210	−0.054	0.028	0.379	1	<.538
EA_PA	−0.110	0.0531	−0.214	−0.007	4.338	1	<.037
Neglect	0.011	0.0278	−0.044	0.065	0.147	1	<.701
CU Traits × EA_PA	0.015	0.0053	0.005	0.025	7.978	1	<.005
CU Traits × Anxiety	−0.001	0.0017	−0.004	0.002	0.404	1	<.525

Note: CU, Callous–unemotional; ADHD, attention-deficit/hyperactivity disorder; ASD, autism spectrum disorder; EA_PA, emotional and physical abuse.

with age. The interaction of CU and maltreatment in predicting ER remained significant.

Next, we repeated the same GEE analyses using accuracy of recognition of each emotion type individually as the dependent variables. Age was a significant predictor for each emotion, and IQ Index was a significant predictor for all emotions except anger. The interaction between CU traits and maltreatment was significant for fear ($B = 0.02$, $p = .03$), anger ($B = 0.02$, $p = .03$), and disgust ($B = 0.03$, $p < .01$). For sadness, there was a main effect for CU traits ($B = –0.02$, $p = .03$). For happiness, both CU traits as a main effect ($B = –0.016$, $p = .05$) and in interaction with maltreatment ($B = 0.009$, $p = .06$) were marginal but in the same direction. Anxiety level, as a main effect or in interaction with CU traits, was not significant for any emotion type.

The above analyses indicated that CU traits interacted with maltreatment to predict overall ER accuracy, and this interaction was evident for the majority of the individual emotion types, the exception being sadness. We probed the form of the interaction for each emotion type using simple slopes analyses (O'Connor, 1998). A simple slope is defined as the regression of the outcome on the predictor at a specific value of the moderator. The program models the relationship between two levels, –2 and +2 *SD*, of the predictor (CU traits) and criterion variable (ER), at three levels of the moderator (maltreatment; –1 *SD*, mean, +1 *SD*). Figure 1 shows the interaction for each emotion type with regression weights for CU traits on ER at three levels of maltreatment.

As illustrated in Figure 1, across levels of CU traits and maltreatment, the lowest levels of accurate recognition were evident for disgust and fear, and the highest were seen for happiness. The pattern of the interaction between CU traits and ER recognition at zero or low levels of maltreatment. Slopes showing this negative relationship between CU traits and ER at low levels of maltreatment were significant for the individual emotions of disgust, fear, sadness, and anger, but not happiness. At levels of high maltreatment, there was no significant relationship between CU traits and ER for any emotion.

Our sample included a large age range, and as noted, there is tentative evidence that the effects of maltreatment on ER might be limited to younger children (During & McMahon, 1991). To test this, we repeated the GEE with the three-way interaction term of CU Traits × Maltreatment × Age, added as a predictor. The two-way interaction between maltreatment and age was also included as it had previously shown a borderline predictive effect of $p < .08$ when controlling for age interactions in supplementary Table S.3. The results showed no three-way interaction between age, CU traits, and maltreatment (see supplementary Table S.4).

Finally, it is important to recall that maltreatment scores were sourced from three different reporters with little overlap and several demographic and diagnostic differences between reporter cohorts. Thus, it is possible that statistical idiosyncrasies could have arisen from combining the reporters into one overall maltreatment index. We examined this by repeating the main analyses within each reporter cohort. The results for the main GEE analyses examining whether maltreatment and/or anxiety levels moderate the relationship between CU traits and ER are shown by reporter cohort in supplementary Tables S.5–S.7. It should be noted that the measures of CU traits, ER, and anxiety problems are the same across cohorts; the only difference is the source of the maltreatment reports. For the teacher maltreatment report cohort, the results are the same as for the full cohort. That is, maltreatment reports moderate the relationship between CU traits and ER as described above. For the clinician maltreatment rating cohort, there is no relationship between CU traits and ER. For the youth maltreatment report cohort, there are no effects for maltreatment. Rather, CU traits interact with anxiety level to predict the accuracy of ER.

The simple slopes analyses of this interaction for overall emotion accuracy and each individual emotion is shown in supplementary Figure S.2. For overall accuracy and each

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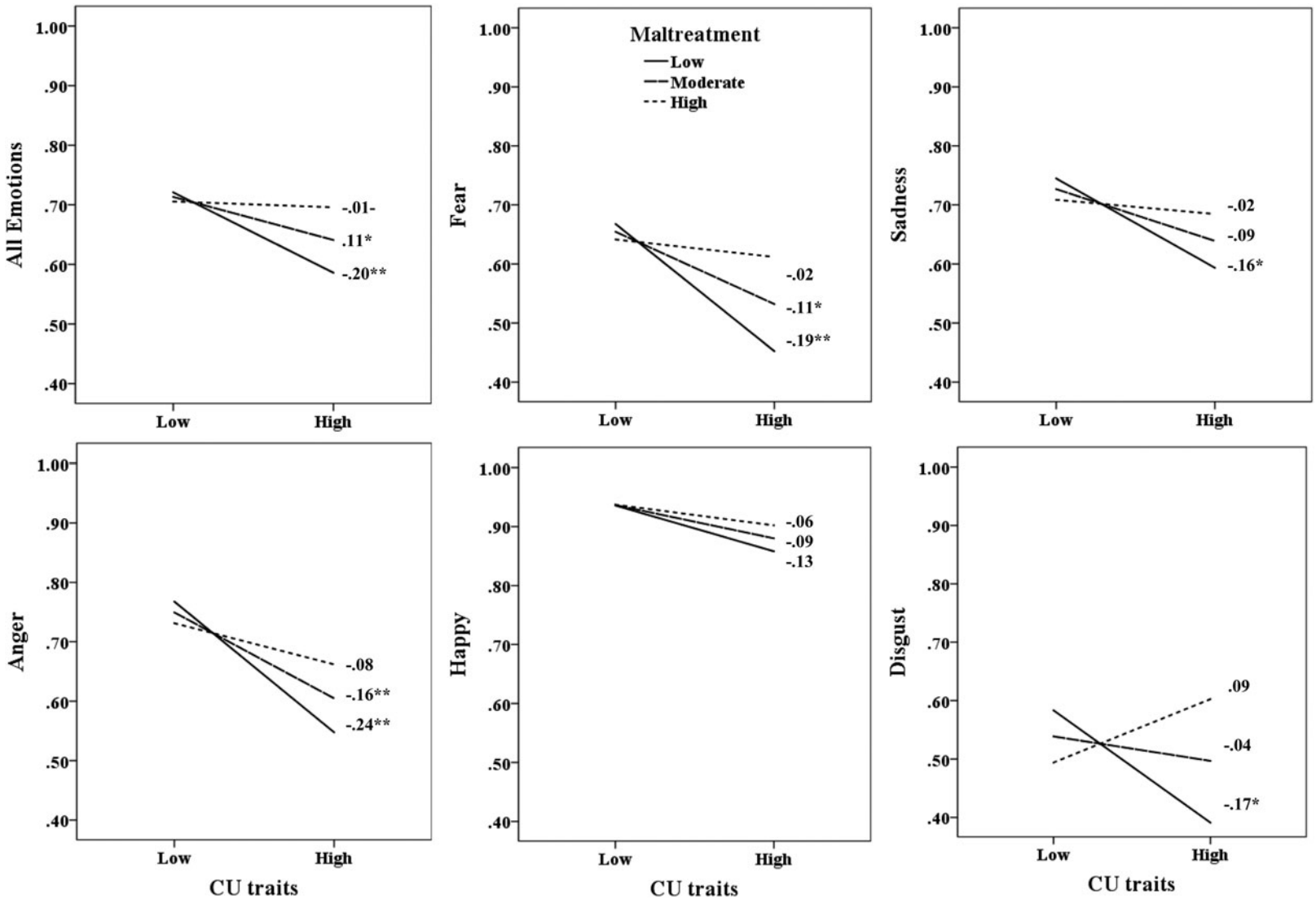

Figure 1. Simple slopes figures showing the interaction between callous–unemotional traits and maltreatment history for accuracy of emotion recognition for all emotions, fear, sadness, anger, happy, and disgust.

emotion except disgust, level of CU traits is unrelated to ER accuracy at high levels of anxiety, whereas high levels of CU traits predict low ER accuracy in those youth with low anxiety.

Discussion

We tested the idea that impairments in ER are a characteristic of primary CU traits, defined as high CU traits occurring in a child with no history of maltreatment and/or normative anxiety. This was tested by regressing level of CU traits, both as a main effect and in interaction with either level of maltreatment or anxiety problems, onto accuracy of ER, in children referred for disruptive behavior disorders. In interpreting the results, it is important to recall one design feature that informs the patterns of findings and their overall interpretation. Maltreatment reports were collected over several years and were available for three different reporters: teachers, clinicians (largely from interviewing parents), and from the children themselves for those over 8 years old. These reports were combined into an overall index of maltreatment; the results below are first discussed for the overall combined cohort index and then within each reporter cohort.

Using the full cohort, the results supported the moderation hypothesis for maltreatment but not for levels of anxiety problems. That is, poorer ER skills were associated with high CU traits only at zero or low levels of maltreatment. There is considerable heterogeneity in children showing high CU traits, and some of this heterogeneity may be understood in terms of ER impairments and maltreatment history. Specifically, an impairment in ER may be a specific characteristic of high CU traits in children that has developed independently of maltreatment.

Consistent with the meta-analysis by Dawel et al. (2012), the direct or moderated effect of CU on ER was not limited to fear or sadness, and was evident to some extent on most emotion types. We (Dadds et al., 2006, 2008; Leist & Dadds, 2009) have previously published several studies showing the impairment is most marked for fear cues; this is the first time we have tested and reported the impairment in our large clinic sample. As shown in Figure 1, the negative correlation between ER and CU traits is evident across all emotions, except perhaps happiness, where ceiling effects are a possibility, but only in the low maltreatment groups.

These results point to the importance of considering maltreatment in etiological and treatment models for conduct problems that occur in the presence of high CU traits. Much speculation and research has pointed to a relatively small role for environmental adversity in the development of CU traits, and conduct problems in the presence of high CU traits. This research has taken several forms, the most prominent being demonstrations of smaller associations between parenting and conduct problems in children with high CU traits (Wootton, Frick, Shelton, & Silverthorn, 1997), and higher genetic loading estimates for the heritability of CU traits and conduct problems in the presence of high CU traits (see Viding Blair, Moffitt, & Plomin, 2005; Viding, Jones, Paul, Moffitt, & Plomin, 2008). Both confirm that CU traits may have a strong genetic basis. In contrast, a growing body of research has found consistent associations between environmental variables, generally defined as parental warmth and harsh punishment, and CU traits and conduct problems in the presence of high CU traits (Kimonis, Cross, Howard, & Donoghue, 2013; Pardini, Lochman, & Powell, 2007; Pasalich, Dadds, Hawes, & Brennan, 2011; Waller, Gardner, & Hyde, 2013). The methods and issues involved in this controversy are too complex to comprehensively tackle here. Of critical importance, however, is that the phenomenology of high CU traits might vary when associated with environmental versus putative primary or biological causal pathways.

The above should be tempered by the divergence of findings for the subcohorts differentiated by who reported on the maltreatment. For those where maltreatment reports were provided by teachers, the results were identical to that described above for the full sample. For those where the maltreatment index came from clinicians, no relationship between CU traits and ER was found, and moderation by maltreatment or anxiety was not observed. This finding is inconsistent with a wealth of literature showing high CU traits predict poor ER, and we are unable to explain it. In the cohort where maltreatment reports were made by the (older) children themselves, the relationship between CU traits and ER was moderated by anxiety levels, such that high CU traits predicted poor ER in those with normative or low levels of anxiety. As noted, several important studies have previously supported a role for anxiety levels in moderating the relationship of CU traits to other biological and behavioral phenomena (e.g., Cecil et al., 2014), and much of this research has been conducted with older children and adolescents (e.g., Kimonis et al., 2012). There are many possible reasons why our findings differed across the subsamples, ranging from purely statistical issues like power, to cohort differences, to reporters having different knowledge of the children and their maltreatment history. Further research that specifies these possible sources of variation is needed to replicate our findings.

The current data indicate that in terms of ER, a history of active maltreatment and/or levels of anxiety may contribute to the differentiation of primary versus secondary variants of CU traits. The significance of maltreatment versus anxiety differed according to subgroups that were defined by youth versus teacher reports on the maltreatment index. These constructs have been used alternatively by different research groups in order to address the primary versus secondary distinction. As noted, they are conceptually and methodologically interlinked, as it is impossible to define psychological trauma without reference to its effects in vulnerable individuals, and similarly it is impossible to define vulnerability in individuals without reference to "traumatic" events. Notwithstanding this, many people are exposed to traumatic events and do not show trauma reactions, and others develop anxiety conditions largely independently of trauma. For

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example, in the adult literature, Cima, Smeets, and Jelicic (2008) showed that even though incarcerated adult psychopaths may have experienced high levels of trauma, these do not correlate with stress cortisol or aggression levels.

Notwithstanding the subgroup differences for CU traits–ER moderation, the results support the working hypothesis that ER deficits may only characterize one developmental pathway, and thus a subset of children with high CU traits. Attempts to assess and remediate these ER impairments as part of intervention for these children should be careful to consider levels of environmental adversity to which the child has been exposed, as well as the child's sensitivity to these experiences (anxiety), as the relevance of the treatment may not be universally applicable.

It should be noted that we were unable to replicate previous research showing significant associations between levels of CU traits and maltreatment, especially neglect, which is notoriously challenging to assess (Hornor, 2012). Several studies have attributed the link between maltreatment and CU traits to its antisocial behavior component, and there exists a wealth of research documenting that abuse is associated with the broader externalizing problems, impulsivity and antisocial behavior (Armstrong & Kelly, 2008; Bierer et al., 2003; Graham, Kimonis, Wasserman, & Kline, 2012; Horwitz, Widom, McLaughlin, & White, 2001). Thus, the experience of maltreatment in childhood clearly contributes to the development of externalizing behaviors, whereas its etiological significance is less clear in the development of the CU traits dimension. It should also be noted that the direction of influence between maltreatment and CU traits may operate through a complex interplay of heredity and environmental factors in which high CU traits can elicit harsher parenting and maltreatment (Hawes, Dadds, Frost, & Hasking, 2011) as well as result from it (Cecil et al., 2015).

Finally, the current data provided no support for the hypothesis that exposure to maltreatment would be associated with more accurate ER. As noted in the review above, several studies have found such a relationship, but overall findings are mixed. A problem is that studies have differed in how ER is measured; where the measure is based on rapid detection and responsiveness to emotion faces, there is some evidence that maltreatment (and again, associated anxiety) may predict higher scores, but in a test such as ours, based on relatively longer and effortful processing (500 ms) involving verbal labeling of the emotion, clear effects of maltreatment and anxiety have not been shown.

Several limitations of this study should be noted. The age range of the children covers a period in which changes in emotion processing and recognition occur. We controlled for age, checked its interaction with level of CU traits, and repeated the main analyses with the sample split into younger and older groups. The interaction of CU traits and maltreatment in predicting ER was evident across these analyses. Statistical control techniques cannot substitute, however, for longitudinal studies in which the development of these skills, CU traits, and maltreatment are mapped over time. Thus, the possibility remains that the relationships between CU traits, maltreatment, and ER might vary across childhood and adolescence. The sample was clinically referred with a range of comorbid diagnostic problems that may have influenced emotion processing. The ER task involved labeling of static faces on a computer screen. While this method has a strong lineage, how well it mimics real-world emotion processing is not fully known. Maltreatment reports were somewhat piecemeal with little overlap between clinicians and teachers, so it was difficult to examine their interrater convergence, or to test whether the moderated relationships varied according to the source of information about maltreatment history. Finally, our measure of anxiety was based on clinician ratings, and these are largely determined from parental report especially in the younger children. There is a large literature on convergence of child, parent, and clinician ratings of child anxiety, and while reassuring levels of convergence are the rule, child reports on standardized measures can add incrementally valuable information (e.g., Campbell & Rapee, 1996).

Conclusion

High CU traits in children are associated with impaired ER across a range of facial emotion types. In line with the hypothesis that the impairment is a specific characteristic of a primary variant of CU traits, we found evidence that the impairment was specific to high CU traits occurring in the context of zero or negligible history of active maltreatment and/or normative or low levels of anxiety. These data show that pathways to high CU traits are complex, may involve variable effects associated with environmental adversity, and influence characteristic features associated with the traits. Attempts to prevent or remediate high levels of CU traits through targeting emotion processing skills (e.g., Dadds et al., 2014; Dadds, Cauchi, Wimalaweera, Hawes, & Brennan, 2012) may best be focused on those children presenting with the primary features, or at least measuring characteristics thought to characterize primary versus secondary pathways.

Our key points are the following:

- There is some evidence that maltreatment history and/or anxiety levels might define different developmental pathways of high CU traits in children. Poor recognition of emotional stimuli may elucidate these differing pathways.
- In children with a range of behavioral and emotional problems, levels of CU traits were generally unrelated to maltreatment but predicted poor ER across a range of emotions.
- As hypothesized, the relationship between CU and ER differed according to maltreatment history and/or anxiety levels, such that CU was associated with poorer recognition only for those with zero or low levels of maltreatment and/or who had normative or low anxiety levels.
- The moderation of the CU-ER relationship by maltreatment and/or anxiety was not consistently observed across subgroups, and requires replication.

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- Impairments in ER and, thus, their targeted remediation, may apply specifically to children with high CU traits that occurs independent of environmental adversity and/or high anxiety.

Supplementary Material

To view the supplementary material for this article, please visit https://doi.org/10.1017/S0954579417000475.

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