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Facial reactions to emotional films in young children with conduct problems and varying levels of callous-unemotional traits

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Background: Elevated levels of callous-unemotional (CU) traits have proven useful for identifying a distinct subgroup of children whose conduct problems (CP) are early emerging, severe, persistent, and underpinned by aberrant emotional processing. The early childhood emotional experiences and expressions of CP subtypes are poorly understood, despite their importance to understanding the problematic attachments and atypical social affiliation experienced by children with elevated CU traits. The current study aimed to test for differences in facial emotional reactions to mood-inducing film clips in children with CP and varying levels of CU traits. **Method:** We compared facial emotional reactions during a developmentally appropriate mood induction task in a mixed-sex sample of clinic-referred preschool children (M_{age} = 3.64 years, SD = 0.63, 66.9% male) classified as CP with elevated levels of CU traits (CP + CU; n = 25) versus low CU traits (CP-only; n = 47), and typically developing children (TD; n = 28). **Results:** Relative to TD children, children with clinical CP showed less congruent and more incongruent facial emotional expressions to sad and happy film clips, controlling for child sex, age, and ethnicity. **Conclusions:** Consistent with older samples, young children with CP show atypical facial emotional expressions in response to positive and negative emotional stimuli. Findings have implications for developmental models of childhood antisocial behavior and can inform the development of targeted interventions. **Keywords:** Conduct problems; callous-unemotional traits; facial emotion reactions; emotional processing; empathy.

Introduction

Conduct problems (CP) emerge in early childhood; are considerably stable across development; and increase risk for poor mental health, educational and occupational outcomes, and criminality (Fairchild et al., 2019). One developmental pathway to CP involves elevated levels of callous-unemotional (CU) traits (i.e. lack of empathy, remorselessness, shallow affect). This pathway is associated with early starting, severe, and stable antisocial and aggressive behavior that is underpinned by multilevel emotional deficits in attention, recognition, and reactivity to distressed emotions (Frick, Ray, Thornton, & Kahn, 2014; Viding, Frick, & Plomin, 2007). However, much of this research has focused on the internal emotional experiences of school-aged children and adolescents, neglecting younger children. Moreover, the literature has placed little emphasis on outward expressions of shared emotions, which are critical in social–emotional communication and relationship formation. The purpose of this study was to test whether facial reactions to emotional cartoon film clips distinguish preschoolers with CP and varying levels of CU traits from typically developing (TD) children.

From a very young age, humans have a spontaneous and rapid tendency to mimic others' emotional facial expressions (Deschamps, Schutte, Kenemans, Matthys, & Schutter, 2012; Dimberg, Thunberg, & Elmehed, 2000). Studies using facial electromyography (fEMG) have consistently shown that TD children, from as young as 7 months old, mimic happy adult faces by showing greater activity in the zygomaticus (i.e. cheek muscles responsible for smiling) compared to when they view angry adult faces (Beall, Moody, Mcintosh, Hepburn, & Reed, 2008; Datyner, Henry, & Richmond, 2017). This emotional contagion response is thought to be an early indicator of affective empathy and is foundational to social cognition and the formation of the parent–child attachment relationship (Adolphs, 2003). Since children with CU traits show deficient affective empathy and emotional experience (Anastassiou-Hadjicharalambous & Warden, 2008; Jones, Happé, Gilbert, Burnett, & Viding, 2010), rapid facial reactions hold promise for distinguishing them from children with CP without CU traits and from TD peers.

To date, the majority of studies investigating rapid facial reactions to emotion in populations with

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elevated CU traits have been conducted with adolescents and adults. These fEMG studies find that individuals with elevated CU traits show reduced facial reactivity to emotional stimuli (de Wied, van Boxtel, Matthys, & Meeus, 2012; Fanti, Panayiotou, Lombardo, & Kyranides, 2016). For example, relative to TD youth, adolescents and young adults with CP + CU showed reduced corrugator activity to fear-inducing imagery scenarios and films depicting others' sadness or distress, with some evidence for reduced zygomaticus reactivity to films intended to evoke happiness. Since fEMG cannot discriminate well between specific emotions, Fanti et al. (2016) supplemented fEMG with facial coding software that measured activation of specific facial expressions. Results showed that young adults with elevated CU traits, relative to those low on CU traits, showed both reduced fEMG corrugator activity and fewer sad and disgusted facial expressions using facial coding software while viewing violent films depicting others' distress, but for comedy films there were no group differences in fEMG zygomatic activity or facial reactivity determined using facial coding software. To date, there has been little research into facial reactivity deficits in young children.

While studies using older samples have informed developmental models of CU traits, compelling evidence indicates that CU traits emerge prior to school age (Kimonis et al., 2016). That is, CU traits can be reliably measured by age 2 to 3 years (Bedford, Pickles, Sharp, Wright, & Hill, 2015; Wright, Pickles, Sharp, & Hill, 2021), are moderately stable over time (Brown, Granero, & Ezpeleta, 2017; Ezpeleta, de la Osa, Granero, Penelo, & Domènech, 2013; Flom & Saudino, 2017; Willoughby, Waschbusch, Moore, & Propper, 2011; Wright et al., 2021), and are distinct from but associated with similar correlates as in older populations (e.g. aggression, oppositionality; Waller et al., 2017; Waller, Hyde, Grabell, Alves, & Olson, 2015; Willoughby et al., 2011; Willoughby, Mills-Koonce, Gottfredson, & Wagner, 2014; Wright et al., 2021). These findings have sparked increasing interest in understanding the early childhood risk factors unique to the subgroup of children with CP + CU, with deficient emotional processing positioned as a key mechanism of interest.

The current study extends this nascent literature on emotional deficits among young children with elevated CU traits by examining differences in specific rapid facial reactions during a mood-induction film paradigm among clinic-referred children with CP and varying levels of CU traits and TD control children. Consistent with prior research with adolescents and adults, we expect results to demonstrate that differences in emotional contagion distinguish clinical and TD groups of young children. However, unlike prior research, findings pertaining to early childhood have potential to directly corroborate and refine developmental models of CU traits (e.g. Dadds & Frick, 2019; Waller & Wagner, 2019). These models propose what, when, and why normative developmental processes go awry in children with CU traits, identifying early childhood as a key period during which processes related to emotional processing emerge and solidify (Kochanska, Tjebkes, & Forman, 1998). Thus, differences in emotional processing as a function of level of CU traits should be identifiable by early childhood. Promisingly, the current study has potential to refine these developmental models by identifying the specific emotions associated with aberrant emotional processing among children with CU traits. However, the key contribution of the current study is in its potential to furnish our etiological understanding of severe and persistent CP and thus identify specific treatment targets for interventions specifically developed for young children with CP and CU traits. These novel interventions are implemented during the early childhood period and attempt to ameliorate emotional deficits by training children to focus on others' faces (Dadds, English, Wimalaweera, Schollar-Root, & Hawes, 2019) or more accurately recognize others' emotions (Dadds, Cauchi, Wimalaweera, Hawes, & Brennan, 2012; Kimonis et al., 2019), but the current study may refine these targets and techniques by identifying the specific emotions or expressions associated with differences in emotional processing as a function of CU traits. This has the potential to enhance the efficacy and efficiency of these novel interventions.

The current study

Aims and hypotheses

The current study tested whether children between 3 and 5 years old identified as TD, CP-only, and CP + CU differ in the pattern of facial emotional expressions they produce while viewing emotional films. It was hypothesized that children with CP + CU would exhibit more blunted and incongruent emotional expressions while viewing negative and positive stimuli (e.g. expressing positive emotion when viewing characters depicting negative emotions), relative to CP-only and TD children, who will display greater congruent emotional reactivity (e.g. expressing positive emotion when viewing characters depicting positive emotion).

Planned analyses

We tested our hypothesis that groups will differ in the level of congruent and incongruent emotional expressions using a multivariate analysis of variance (MANOVA). We created four sets of planned contrasts to examine differences in facial reaction intensity between groups, with three testing for pairwise differences (TD vs. CP-only; TD vs. CP + CU; CP-only vs. CP + CU) and one testing for differences between TD children and collapsed

clinical subgroups (TD vs. combined CP-only and CP + CU). For each of these four comparisons, we compared the mean intensity ratings of congruent expressions against those of incongruent expressions for each film condition. Thus, higher scores indicated greater intensity of congruent than incongruent emotions expressed. We report 95% simultaneous confidence intervals (CIs), partial eta-squared (η_p^2), and Cohen's d effect size coefficients where relevant (small: $\eta_p^2 = .01$, $d = 0.2$; medium: $\eta_p^2 = .06$, $d = 0.5$; large: $\eta_p^2 = .14$, $d = 0.8$; Cohen, 1988). Preliminary analyses examined group differences in sex, age, and ethnicity.

Methods

Participants

Participants were 133 children (66.9% male; $M_{age} = 3.64$ years, $SD = 0.63$) and their primary caregiver (85.7% mother). Participants were recruited from day-care centers ($n = 43$) or presented to clinics for the treatment of disruptive behavior problems ($n = 90$), as a subsample from larger ongoing clinical trials of parent training interventions registered with the Australian and New Zealand Clinical Trial Registry (ACTRN12616000280404, ACTRN12616000221459). Of the 103 parents who reported on their child's ethnicity, 65.0% were Caucasian, 12.6% Asian, 3.9% Middle Eastern, and 18.4% reported 'Other'. Parents completed questionnaire measures of child CP and CU traits, and children completed a computerized emotion induction task, prior to the clinic sample starting parent training treatment. The study was approved by the University of New South Wales (UNSW) Sydney (HC13234 and HC14297) and the State's Local Health District (HREC/13/LPOOL/459) Human Research Ethics Committees.

Children were classified into TD, CP-only, and CP + CU groups based on parent-reported CP and CU trait scores. Children with a T score ≥ 60 on the *Eyberg Child Behavior Inventory* (ECBI; Eyberg & Pincus, 1999) were classified into the high CP groups and those scoring $T < 60$ were classified into the TD group based on the recommended clinical cutoff score for the ECBI, derived using a large normative sample (Eyberg & Pincus, 1999). Using this classification method, nine children from day-care centers were classified as CP-only. The eight children from the clinic-referred sample who scored <60 on the ECBI were not included in the TD group since they were clinically identified. Within the high CP group, children scoring ≥31 on the *Inventory of Callous-Unemotional Traits* (ICU-preschool version; Kimonis et al., 2016) were classified into the CP + CU group and those scoring <31 were classified into the CP-only group. This ICU cutoff score equates to 1.5 standard deviations above the 24-item mean reported for TD young children ($N = 92$) using the parent-report, preschool version of the ICU, and corresponds to an average item rating falling between 'Somewhat true' and 'Very true' (Kochanska, Kim, Boldt, & Yoon, 2013).

Seventeen participants did not complete the mood-induction task, so were excluded from analyses. Since the *FaceReader* software used to measure facial reaction intensity is not well trained for 24–36-month-old children or children of East-Asian descent (Loijens, Krips, van Kuilenburg, den Uyl, & Ivan, 2015), only children aged 3 and older were included in the current study and a further eight of these participants with complete data who were of Asian descent were excluded from analyses. This resulted in a final sample of 100 participants. For this sample, the classification procedure resulted in 47 CP-only children, 25 CP + CU children, and 28 TD children. Table 1 reports group differences in demographic and clinical characteristics. Groups differed significantly in child sex and ethnicity, but not child age. Groups differed significantly in CP, CU traits, and aggression in the expected direction, TD < CP-only < CP + CU.

Procedure

Parents completed questionnaires assessing their child's CP, CU traits, and aggressive behavior (see Appendix S1 for details regarding measure of aggressive behavior). Children completed the mood induction task on a laptop computer (Dell XPS 15, 15″ screen, 60 Hz refresh rate) in a well-lit room. Children from the groups with clinical CP completed the experiment in a separate clinic room from their parent(s) with the experimenter present. Children from the TD group completed the experiment in a spare classroom at their day-care center while a teacher and the experimenter were present. Teachers sat on the side of the room out of children's direct visual field while the experimenter sat next to the child to administer the task. These rooms were isolated from other children and were set up to ensure minimal visual and auditory distractions. All children were seated approximately 40 cm away from the computer screen and were encouraged to keep their hands in their lap during the experiment. All children were encouraged to sit still while they watched the Lion King clips, for which they were rewarded with a sticker at the end of the experiment.

Measures

Questionnaire measures. Details regarding the administration, scoring, and established psychometric properties of each measure are provided in the Appendix S1.

Conduct problems: Conduct problems were assessed using the Intensity scale of the ECBI. In the present study, ECBI intensity total scores demonstrated excellent internal consistency (Cronbach's $\alpha = .94$). Higher scores indicated greater frequency CP.

CU traits: Callous-unemotional traits were assessed using the parent-report, preschool version of the ICU. In the present study, ICU total scores demonstrated good internal consistency (Cronbach's $\alpha = .84$). Higher scores indicated higher CU traits.

Mood induction task. Children viewed scenes from an animated children's film, *The Lion King*, which were intended to induce discrete emotional states (Figure S1). Each emotion clip was 2 to 3 min long, confined to the presentation of a single emotion, and presented in the same order to all participants: fear (violent hyenas chasing the film's protagonist, Simba the lion), sadness (Simba finding his father dead and crying for help), happiness (Simba singing a joyous song with friends), and anger (Simba fighting Scar the lion), with attachment-related themes depicted in the sad and happy film scenes (Dadds et al., 2016). A series of 30-s neutral clips with no specific emotional content were presented at the beginning, end, and in between each emotion clip to facilitate mood to baseline. The entire session lasted approximately 12 min. *The Lion King* clips were selected because of their developmental appropriateness for the children in this study, and their effective induction of mood regardless of children's viewing history (Gatzke-Kopp, Greenberg, & Bierman, 2015; Kalvin, Bierman, & Gatzke-Kopp, 2016). For example, children expressed significantly more observed sad affect and less happy affect during the sad clip relative to fear and neutral clips (Dadds et al., 2016). Greater self-reported sadness on a Facial Affective Likert Scale while viewing the sad film clip was also positively associated with preschoolers' empathy levels,

Table 1 Descriptive statistics for demographic and clinical variables between typically developing (TD), conduct problems and low callous-unemotional (CU) traits (CP-only), and conduct problems and high CU traits (CP + CU) groups

	TD (n = 28)	CP-only (n = 47)	CP + CU (n = 25)
Demographic			
Child age (months)	48.68 (7.76)$_a$	48.51 (7.98)$_a$	48.44 (8.23)$_a$
Sex (% boys)	42.90$_a$	70.20$_b$	76.00$_b$
Race/ethnicity (% Caucasian)	78.60$_a$	48.90$_b$	52.00$_b$
Clinical characteristics			
Conduct problems (ECBI intensity)	102.42 (15.31)$_a$	161.46 (18.22)$_b$	180.77 (18.55)$_c$
CU traits (ICU total)	16.32 (4.16)$_a$	23.22 (5.86)$_b$	37.17 (4.83)$_c$
Aggression (CBCL aggressive behavior)	8.26 (4.22)$_a$	22.19 (6.68)$_b$	30.17 (3.96)$_c$

Data are presented as *M* (*SD*) or percentage. Values with a different subscript letter row-wise denote groups that differ significantly from one another, $p < .05$. CBCL, Child Behavior Checklist; ECBI, Eyberg Child Behavior Inventory; ICU, Inventory of Callous-Unemotional Traits.

suggesting that the task taps into empathic responding (Guo & Wu, 2021).

FaceReader. Children's facial expressions were discretely recorded using a webcam and diffuse frontal lighting while they watched the mood induction films. Video recordings were analyzed using Noldus *FaceReader 6.0* (Loijens & Krips, 2013), an automated facial coding software that classifies facial expressions into six basic emotion categories: happy, sad, angry, surprise, fear, and disgust, using the Facial Action Coding System (Frank & Ekman, 1997) and examines patterns of facial muscle movements to identify expressions of emotions. *FaceReader* identifies locations of 500 key points in the face to form a three-dimensional reconstruction of the face, which it uses to classify facial expressions using an artificial neural network that was trained with a large database of over 10,000 images of individuals of varying ages, ethnicities, and sex (Loijens et al., 2015). The current study used the Children Face Model of *FaceReader* that was trained with images of children between 3- and 10 years old.

In the present study, *FaceReader* was used to analyze each of the four emotion clips per participant at a rate of ~30 frames per second, with emotion classification occurring in each frame. Within each frame, *FaceReader* computes an emotional expression intensity value for each of the six emotions ranging on a scale from 0 (absence of the emotion) to 1 (full intensity of the emotion). This *FaceReader* intensity measure demonstrated 89% accuracy with dynamic facial expressions (den Uyl & van Kuilenburg, 2005) and adequate reliability (Lewinski, Fransen, & Tan, 2014). Several studies have used *FaceReader* to examine facial expressions in young children (e.g. Bugos, DeMarie, Torres, & Fuller, 2022; Dys & Malti, 2016; Fujiwara, Mizuki, Miki, & Chemtob, 2015; Morales-Sánchez, Pérez-López, Reigal, & Hernández-Mendo, 2020). These studies found that *FaceReader* intensity ratings of happy and sad facial expressions were significantly associated with preschoolers' self-reported feelings of happiness and sadness, respectively (Bugos et al., 2022; Fujiwara et al., 2015). Following Fanti, Kyranides, and Panayiotou (2017), *FaceReader* intensity values for each emotion were averaged across all frames within each film condition. Thus, each participant had 24 averaged intensity values, corresponding to the intensity of six facial expressions for each of the four film conditions.

Congruent and incongruent classifications: These 24 averaged intensity values were consolidated into eight values representing the intensity of *congruent* and *incongruent* facial emotion expressions for each of the four film conditions (e.g. intensity of congruent expressions during the angry film clip). An emotional facial expression was categorized as congruent with a film clip when the clip contained one of the five dimensions of antecedent events shown in prior research to elicit that emotional expression (Freed & Mann, 2007; Karasawa, 1995; Matsumoto, Kudoh, Scherer, & Wallbott, 1988; see Table S1). To illustrate, sad expressions were categorized as congruent with film conditions that contained dimensions of loss or death (sadness film condition; Freed & Mann, 2007; Summerfield & Green, 1986); happy expressions were congruent with films containing high pleasantness (happiness film condition; Karasawa, 1995); fearful expressions were congruent with films containing high uncertainty (anger, fear, sadness film conditions; Karasawa, 1995); angry and disgusted expressions were congruent with films that contained unfairness and moral violations (anger and fear film conditions; Matsumoto et al., 1988); and surprised expressions were congruent with films that contained dimensions of novelty (Karasawa, 1995). Since neutral film clips always preceded emotional clips in the present study, all film conditions were considered to contain the dimension of novelty because of their enhanced emotional salience relative to neutral clips. Remaining expressions were classified as incongruent.

Results

All analyses were conducted with IBM SPSS Statistics (Version 27; IMB Corp, Armonk, NY, USA). Data were first screened for outliers and assumptions were tested.

A manipulation check of the mood induction task was performed to determine whether the film stimuli elicited different facial expressions of emotions in the TD subsample. Results of a two-way MANOVA examining differences in intensity of six facial emotional expressions (happy, angry, sad, fearful, surprised, disgusted) between the four film conditions (anger, fear, happiness, sadness) for the TD group indicated a statistically significant interaction effect on the combined dependent variables, $F(18, 15) = 2.556$, $p = .036$, Wilks' $\Lambda = .246$, $\eta_p^2 = .754$, $d = 3.502$. Planned contrasts examining differences in the intensity of happy versus negative (angry, sad, fearful, disgusted) facial emotional expressions for each of the four film conditions (anger, fear, happiness, sadness) were significant for happy ($M_{difference} = 0.145$, 95% CI [0.055, 0.234], $p = .002$, $\eta_p^2 = .252$, $d = 1.161$) and sad films

($M_{difference}$ = 0.042, 95% CI [0.021, 0.063], p < .001, η_p^2 = .338, d = 1.429), but not for anger or fear films. These results indicated that only the pattern of intensity of facial expressions among TD children during the happy and sad film conditions was consistent with an effective mood induction. Thus, subsequent analyses only tested group differences for happy and sad films and the critical α was adjusted to a significance level of p < .00625 since the analysis involved eight planned interactions.

Table 2 reports mean intensity ratings by group for congruent and incongruent emotional facial expressions for the happy and sad film conditions. MANOVA results testing the main study hypothesis indicated that there was a significantly greater mean intensity of congruent versus incongruent expressions in the happy film condition between the TD group and the collapsed groups with clinical CP, $M_{difference}$ = 0.148, 99.375% CI [0.046, 0.249], p < .001, η_p^2 = .146, d = 0.827. This pattern held when separately comparing the TD group with the CP-only group, $M_{difference}$ = 0.135, 99.375% CI [0.028, 0.242], p < .001, η_p^2 = .114, d = 0.717, as well as the CP + CU group, $M_{difference}$ = 0.160, 99.375% CI [0.037, 0.284], p < .001, η_p^2 = .119, d = 0.735. These results indicate that the TD group displayed a greater intensity of congruent than incongruent facial emotional expressions when viewing the happy film clip, relative to the groups with clinical CP. No significant differences were detected between the two groups with clinical CP. When viewing the happy film, the CP + CU group displayed happiness (M = 0.122, SD = 0.178), surprise (M = 0.118, SD = 0.139), and anger (M = 0.105, SD = 0.159) with the greatest intensity, whereas the CP-only and TD groups displayed happiness (M = 0.150, SD = 0.195 and M = 0.208, SD = 0.246, respectively) and surprise (M = 0.121, SD = 0.158 and M = 0.234, SD = 0.270, respectively) with the greatest intensity.

For the sad film condition, MANOVA results indicated that there was a significantly greater mean intensity of congruent versus incongruent expressions between the TD group and the collapsed groups with clinical CP, $M_{difference}$ = 0.086, 99.375% CI [0.004, 0.167], p = .004, η_p^2 = .082, d = 0.598. This pattern was similar but no longer significant after correction when separately comparing the TD group with the CP-only group, $M_{difference}$ = 0.073, 99.375% CI [–0.014, 0.159], p = .021, η_p^2 = .054, d = 0.478, and with the CP + CU group, $M_{difference}$ = 0.099, 99.375% CI [–0.001, 0.198], p = .007, η_p^2 = .074, d = 0.565. These results indicate that the TD group displayed a greater intensity of congruent than incongruent facial emotional expressions when viewing the sad film clip, relative to the collapsed group with clinical CP. No significant differences were detected between the two groups with clinical CP. During the sad film, mean intensity scores for the CP + CU group were highest for anger (M = 0.182, SD = 0.222), and were highest for surprise (M = 0.146, SD = 0.190) and sadness (M = 0.132, SD = 0.198) for the CP-only and for surprise (M = 0.231, SD = 0.269) for the TD group.

MANOVAs were repeated controlling for child sex, age, and ethnicity. Group differences between TD and collapsed clinical groups remained significant for happy and sad films; however, differences between TD and individual clinical groups for the happy and sad film conditions were no longer significant after corrections (see Appendix S2).

Results of a one-way MANOVA to test whether the CP + CU group was generally less emotionally expressive during happy and sad films did not indicate a statistically significant difference between groups across the combination of facial expression intensities, F(48, 148) = 0.978, p = .521, Wilks' Λ = .576; η_p^2 = .241, d = 1.127.

Discussion

The present study sought to test whether well-characterized subgroups of young children with clinically significant CP showed aberrant patterns of facial emotional reactions during a mood induction paradigm. Developmental models of antisocial behavior place emotional mechanisms at the forefront, postulating that emotional processing deficits play a critical role in the onset and maintenance of aggressive antisocial behavior (Blair, 1995; Kochanska, 1991). Although there is substantial empirical support for this view in middle–late childhood, evidence for such mechanisms in early childhood is sparse (cf. Kimonis et al., 2016). Given that children

Table 2 Mean intensity of congruent and incongruent emotional facial expressions for the happy and sad film conditions between typically developing (TD), conduct problems with low callous-unemotional (CU) traits (CP-only), and conduct problems with high CU traits (CP + CU) groups

	TD (n = 28)	CP-only (n = 47)	CP+CU (n = 25)
Film condition/Expressions			
Happiness/Congruent	0.221 (0.139)	0.136 (0.134)	0.120 (0.106)
Happiness/Incongruent	0.026 (0.030)	0.076 (0.069)	0.085 (0.070)
Sadness/Congruent	0.123 (0.081)	0.105 (0.086)	0.094 (0.075)
Sadness/Incongruent	0.039 (0.049)	0.093 (0.093)	0.109 (0.098)

Data are presented as M (SD). Higher values indicate greater intensity of facial emotional expressions.

begin to internalize standards of appropriate behavior in early development (Kochanska et al., 1998), and that behavior is most amenable to change during this period, a comprehensive understanding of early mechanisms of antisocial behavior is critical to developing effective preventive interventions. The current study makes a novel contribution to the literature in finding that children with early starting CP exhibit less congruent and more incongruent facial emotional expressions while viewing happy and sad film clips relative to TD children, with no significant differences detected between CP subtypes.

Contrary to our hypothesis, facial reactions to emotional films did not distinguish children with CP-only and CP co-occurring with elevated CU traits in this preschool sample. That is, CP-only and CP + CU subgroups did not significantly differ in the intensity of their congruent versus incongruent facial emotional expressions when viewing happy or sad film clips. While not directly comparable, this result is inconsistent with prior findings that CP-only children show heightened physiological and neural reactivity to negative stimuli relative to CP + CU children (Dotterer, Hyde, Swartz, Hariri, & Williamson, 2017; Viding et al., 2012). We posit some possible reasons for this divergence from prior studies. First, we used a dynamic induction task specifically designed to measure emotional contagion, relative to tasks using static face stimuli employed in prior studies to measure general emotional reactivity in CP subtypes (Anastassiou-Hadjicharalambous & Warden, 2008; de Wied et al., 2012). Second, differences in emotional processing between CP subgroups may emerge later than preschool age. For example, while school-aged children and adolescents with CP + CU show robust deficits in emotional attention to distress images on a dot probe task, community preschoolers classified into CP subtypes did not significantly differ in their performance (Kimonis et al., 2016). This finding raises an intriguing question around whether emotional or affective empathy deficits in early childhood are also relevant to the developmental psychopathology of the CP-only subtype. A confounding issue was that our CP-only group had significantly higher levels of CU traits than TD children. Together, these findings raise the possibility that emotional deficits exist on a continuum among young children with clinically significant CP, being most profound or pervasive at extreme levels of CU traits. Supporting this assertion, CP + CU boys showed reduced corrugator activity, reduced heart rate, and reduced self-reported emotional contagion during sad films relative to TD boys, whereas CP-only boys differed from TD boys on only one index of emotional contagion (i.e., reduced zygomaticus activity during happy films; de Wied et al., 2012). Indeed, a greater number of emotional deficits to negative stimuli were associated with more severe CU traits (Muñoz, 2009). Future research adopting a multilevel measurement approach to examining emotional deficits in young children with CP is needed to further explore this question.

An interesting finding was that the incongruent emotion that children with CP + CU displayed with the most intensity during happy and sad film clips was anger. The tendency for children with CP + CU to express angry facial expressions at a high intensity during emotional film clips, relative to TD children and children with CP-only who did not, may be explained by the attachment-related themes depicted in these two clips (Dadds et al., 2016). Elevated CU traits were associated with disorganized attachment during the Strange Situation procedure among young children, independent of CP severity (Kohlhoff et al., 2020; see also Bohlin, Eninger, Brocki, & Thorell, 2012). Disorganized attachment involves confused or contradictory expressions and behaviors in the context of attachment relationships, which aptly characterizes the pattern of incongruent emotional expression observed in children with CP + CU in the current study. The highest rates of disorganized attachment were found in children classified as 'secondary CU variants', relative to those classified as 'primary CU variants', who were predominately securely attached (Cecil, McCrory, Barker, Guiney, & Viding, 2018). In addition to attachment differences, greater anger levels also robustly differentiate secondary CU variants from primary CU variants (for a review, see Craig et al., 2020). While our sample size was too small to disaggregate the CP + CU group into primary and secondary CU variants, which is most commonly accomplished according to low versus high internalizing problem scores respectively, our findings encourage further investigation in larger samples to determine whether anger intensity during emotional film clips was driven by secondary CU variants. Typically, a tendency to respond with anger to nonhostile emotions in others (e.g. misattributing expressions of sadness to anger; Schultz, Izard, & Ackerman, 2000) has been attributed to the CP-only group (Dodge et al., 1995; Frick et al., 2003); however, to our knowledge there are no studies comparing CU variant and CP-only subgroups on this hostile attribution bias, constituting a knowledge gap for future research.

Young children with clinical CP in the current study experienced reduced positive emotional reactivity while viewing happy films, relative to TD children. This finding is inconsistent with several studies in middle–late childhood reporting no group differences in positive affectivity (Dadds et al., 2016; Fanti et al., 2017; Kalvin et al., 2016). Owing to a large body of evidence highlighting the importance of negative emotions in the development of conscience and subsequent maintenance of antisocial behavior (e.g. Blair, 1995; Kochanska, 1991), the role of processing positive emotions has received less empirical

attention. However, positive emotional experiences were theorized to foster positive parent–child relationships, which motivate children to cooperate with their parent, comply with rules, and internalize prosocial values (Kochanska, Forman, Aksan, & Dunbar, 2005), supporting their relevance to the developmental psychopathology of CP generally. The sensation-seeking hypothesis of antisocial behavior suggests that a higher-than-typical threshold for reward stimulation motivates risky behaviors intended to alleviate an aversive state of underarousal (Pérez & Torrubia, 1985). Consistent with this view, our finding of reduced positive emotional expressions among children with CP may reflect a higher threshold for reward stimulation, which increases vulnerability to risky antisocial behaviors, such as bullying. Indeed, relative to TD children, those with CP showed atypical activation of reward neurocircuitry (Hawes et al., 2021). The current finding contributes to the literature that preschoolers with both CP subtypes may be characterized by low reward sensitivity, as indicated by reduced positive emotional reactivity.

The nature of the relationship between these aberrant emotional responses and children's development of CU traits and CP warrants consideration. Although this cross-sectional study precludes causal inferences, other prospective longitudinal research offers insights. With respect to the development of CU traits specifically, these traits appear to be uniquely preceded by dispositional differences in processes underlying social affiliation that are evident in the first weeks of life, including lower preference for human faces relative to objects (Bedford et al., 2015) and lower eye gaze toward mothers' faces (Bedford et al., 2017). Findings from the present study also support further investigation into dispositional differences in emotional contagion as predictive of later CU traits and CP more generally. Emotional contagion emerges early in life, beginning with the automatic contagious crying of newborns to other babies' cries (Dondi, Simion, & Caltran, 1999), and becomes more sophisticated over the following 2 years as toddlers begin to display expressions of facial concern to others' emotional states (Hoffman, 2001). This nascent affective empathy is important for motivating prosocial behaviors and inhibiting aggression. Low levels have been identified as a critical causal mechanism explaining the severe, aggressive, and stable CP associated with CP + CU (Ensor, Spencer, & Hughes, 2011; Frick et al., 2014), and the present study supports the relevance of this putative mechanism to early childhood CP more generally.

Strengths & limitations

A major strength of this study was the use of well-characterized clinical samples of preschoolers with subtypes of CP, strengthening the generalizability of our findings to clinical populations. Given the dearth of research investigating emotional processes in subtypes of children with CP during early childhood, current results must be replicated before their application to a clinical context. Limitations of this study should be considered. First, we failed to confirm that the manipulation check for the mood induction paradigm was effective for some of the negative films. Second, the *Lion King* film clips varied in their intensity, which may have influenced associations between facial expressions and group membership, warranting future research using stimuli standardized for intensity. Third, a review of the video recordings showed that some children covered or turned their face away during a frightening scene. Although *FaceReader* can tolerate up to 45° rotation of the face, facial coding degrades with increasing angle and the software is unable to generate an intensity score beyond 45°, meaning that an unrepresentative pattern of facial expressivity was likely analyzed in these cases, especially for negative films. In common with other similar studies, we are unable to rule out whether group differences were due to differential attention to the videos. Fourth, we were unable to covary socioeconomic status (SES) since these data were not collected for most participants. This is an important potential confounder for future research to consider, given reported associations between SES, CP, CU traits, and emotional reactivity (Hackman et al., 2019; Piotrowska, Stride, Croft, & Rowe, 2015). Future research should attempt to replicate the current results using fEMG supplemented with other physiological indicators of emotional reactivity (e.g. heart rate), and employing naturalistic stimuli such as caregivers engaged in standardized emotional displays. Given inherent limitations to each method, a multimethod assessment approach to emotional reactivity will provide the richest understanding of differences in patterns of emotional responsivity in children with heterogeneous CPs.

Severe forms of antisocial behavior begin in childhood and have a profoundly damaging impact on the lives of perpetrators and victims alike. There is growing evidence that early intervention is the most effective approach in preventing and addressing CP concerns (Dodge et al., 2015). Given that CU traits and CP can be reliably detected within the first few years of life, this presents a unique opportunity for early intervention and prevention. The current study provides initial evidence for deficits in facial emotional reactivity to positive and negative stimuli that may influence the development of attachment relationships and antisocial behavior in preschoolers with clinically significant CP with and without CU traits. This study provides preliminary support for further research into these putative emotional

mechanisms as targets of early intervention for antisocial behavior.

Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of the article:

Appendix S1 Methods.
Appendix S2. Results.
Table S1. Categorization of facial expressions as congruent or incongruent for each film condition (rows) according to dimensions of the film's antecedent events (columns).
Figure S1. Examples of mood induction task stimuli.

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Key points

- Subtyping children with early starting conduct problems based on levels of callous-unemotional (CU) traits has proven useful for identifying those with more severe and life course persistent antisocial behavior that is underpinned by distinct mechanisms from children with conduct problems alone.
- This study is the first to examine patterns of facial emotional reactions to mood-inducing stimuli in preschool children with conduct problems and varying levels of CU traits, and typically developing (TD) children.
- Children with clinical conduct problems displayed less congruent and more incongruent facial emotional reactions to happy and sad films relative to TD children. Children with conduct problems and co-occurring CU traits did not differ significantly in their facial emotional reactions to emotional films relative to children with conduct problems alone.
- Children with early emerging conduct problems show atypicalities in their emotional responding, which may contribute to their development of antisocial behavior and empathy deficits.

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