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Attention to Emotion through a Go/no-Go Task in Children with Oppositionality and Callous-Unemotional Traits

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Conflict of interests

The authors declare that they have no conflict of interest.

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Abstract

Background: There is debate about whether the difficulties that children with different degrees of oppositionality (ODD) and callous-unemotional traits (CU) have in processing emotions are related to emotional or attentional deficits and if the problems they have with emotion recognition are global or specific. The aim of this study is to identify difficulties in recognising and attending (reaction time) to emotion (happiness, anger, sadness and fear) through a go/no-go task in children with different levels of ODD and CU traits. Method: A total of 320 8-year-old children were assessed through questionnaires filled out by teachers about oppositional defiant symptoms and CU traits and were then distributed into four groups: LowCU-HighODD, HighCU-LowODD, HighCU-HighODD and a control group (LowCU-LowODD). Results: The analyses of variance comparing the 4 groups showed that the two groups with high ODD were less accurate than the control group in recognising the emotion when the stimuli expressed happiness, fear or neutral emotion. The HighCU-HighODD group differed in the quality of the response (correct/wrong responses) but not in the reaction time in relation to the control group. The LowCU-HighODD group was faster to respond to emotions than the control group. Implications: The results show that the deficit in emotion processing is not restricted to specific distressing emotions such as fear or sadness, but they point to a global impairment in emotion processing in children scoring high in the constructs studied. The results also suggest that the difficulties that children with combined CU traits and oppositional conduct problems have in processing emotions are more of an emotional rather than an attentional nature.

KEYWORDS: Attention; Callous-unemotional traits; Emotion; Oppositional-Defiant.

1. Introduction

Recognising and paying attention to emotional expressions is central to communication between individuals, socialisation and social interaction [1]. Understanding emotional expression facilitates the learning of approach and avoidance behaviours (to what or to whom to approximate or to elude) and allows us to modify behaviour according to the social context and hierarchy [1]. Failure to notice and respond adequately to emotions may harm others and interferes with the acquisition of self-regulatory processes, making social relationships difficult.

Callous-unemotional traits (CU) are characterised by lack of empathy or remorse, reduced affect or shallow emotional responding and not caring about the feelings of others, constituting the affective component of psychopathy [2]. In the literature on adults, CU traits have been strongly linked to deficits in emotion recognition, specifically with deficient fear responding and elevated anger responding in the face of goal frustration. In adults, there is little evidence to suggest impairment in happiness and the results regarding sadness, which has scarcely been studied [3], are inconclusive. Furthermore, CU traits from early childhood on are associated with conduct problem severity [4]. In both clinical and community samples from middle childhood to adolescence, CU traits have shown significant correlation with the number and severity of oppositional defiant disorder (ODD) symptoms [5, 6], which has increased clinical interest in the characteristics associated with these traits.

Two influential meta-analyses on the link between deficits in emotion recognition and CU traits and antisocial behaviours reached different conclusions. While Marsh and Blair [7] in their analyses based on 20 studies reported difficulties mainly in fear and sadness recognition, Dawel et al. [8] in their meta-analysis of 26 studies concluded that emotion recognition deficits in psychopathy are pervasive across emotions and there may be a general deficit extending to other emotions (anger, fear

and sadness), even though the effect size for fear in their analysis was significantly greater.

Studies on children have produced contradictory results as to whether CU traits are associated with a global deficit in identifying emotions or with difficulty in identifying specific emotions. Varying results have been reported in clinical samples of children between the ages of 7 and 18. In children with combined high CU traits and conduct problems fear recognition ability ranges from no deficit [9] through impairment [10, 11, 12] to a better identification of fear [13, 14]. There have also been divergent results regarding sadness, ranging from less accuracy in identifying sad facial expressions [10, 14, 15] to no deficit [9]. CU traits with conduct problems have also been associated with impaired recognition of other emotions, such as surprise [10] and better accuracy in identifying angry faces [9]. The comparison of children with conduct problems and high and low CU traits is also surrounded by controversy. Several studies have found that emotion recognition problems are more marked in low CU trait groups than in the high CU trait groups. Children with low CU traits have been shown to respond more slowly to fearful eyes than to calm eyes [16] and they also display increased amygdala reactivity. Other studies have concluded that they are also less accurate in labelling fear [14] and they need more time to identify sadness, fear and happiness [13]. Conversely, there are also inconsistencies in the results on emotion recognition in children with conduct problems without CU traits. Adolescents with high scores for conduct problems did not recognise anger, fear and sadness as well as others [17]. Early-onset conduct disorder (CD) boys presented impaired recognition of the facial expressions of anger, disgust and happiness, whereas those with adolescent-onset conduct disorder had impaired fear recognition [10]. Girls with CD showed impaired

recognition of anger and disgust [15]. Better fear recognition and impaired anger have also been found [11].

Less research has been carried out on community samples. Results for ages 8 to 17 indicate that CU traits are associated with difficulties in identifying happiness and fear in facial emotions (although not strongly) [18], fear (more conclusive) [19] and complex emotions (hate, shame, guilt, etc.) [20]. The combination of CU traits and conduct problems has been shown to result in impaired identification of fearful faces and postures and more errors for anger [21], while aggressive behaviour without CU traits has been linked to better accuracy for angry postures [21] and poor recognition of neutral faces [19].

Several proposals have tried to explain the deficit in emotion recognition in children with CU traits. On the one hand, Blair et al. [22] put forward a specific deficit for identifying emotions that reflect distress, such as fear and sadness. Typically, developing individuals interpret fear and sadness in others as aversive and when an aggressive act is carried out and an expression of fear or sadness observed, in classical conditioning this act is perceived to be aversive and is inhibited. Failure to identify fear and sadness in others facilitates a lack of inhibition of aggressive behaviours, as these expressions are not identified as aversive. On the other hand, Dadds et al. [23] indicated that a general deficit in attention to relevant emotionally salient stimuli underlies callous-unemotional traits, which results in cascading errors in the development of moral conscience and empathy . Amygdala dysfunction in responding especially to fear but also to a variety of facial expressions has been suggested as the neurological basis of emotion recognition deficit [24, 25]. Other brain regions such as the orbitofrontal cortex and the insula are involved in socioemotional functioning and emotional processing [26, 27]. Fear, sadness and happiness (expressions that serve as positive or negative

reinforcers) preferentially activate the amygdala, whereas anger expressions activate the orbitofrontal cortex regions, which are involved in modulating behavioural responding [1].

A review of the literature demonstrates that it is currently unclear whether deficits in emotion recognition are specific to some emotions or pervasive in children with varying degrees of behaviour problems, or if the underlying deficit is attentional or emotional. The aim of the present study is to use a go/no-go task to identify difficulties in the attention paid to neutral versus emotional stimuli (happiness, anger, sadness and fear) in children with low/high levels of oppositionality with or without callous-unemotional traits, in comparison with children with low levels of both characteristics (control group). According to Dadds et al. [23], the initial hypothesis was that children high in both CU traits and oppositionality would show a general deficit for processing affective stimuli, and would show greater difficulties in the emotion processing of stimuli showing anger, happiness and sadness with special difficulty in paying attention to fear, in comparison with children low in these constructs. Knowing how children affected by oppositional behaviour problems and/or callous-unemotional traits process emotions may help to understand the underlying deficits of both these constructs. This knowledge would be useful for etiological purposes, as well as for detection and prevention, and may be helpful in identifying differential target components for treatment intervention.

2. Method

2.1. Participants

The data are part of a large-scale longitudinal study of behaviour problems in preschool children from age 3 who were screened for behaviour problems and followed

up annually until age 8 (the design procedure is detailed in [28]. The two-phase design involved selecting a random sample of 2,283 children from the census of in-school 3-year-old preschoolers in Barcelona (Catalonia, Spain) during the 2009-10 academic year. A total of 1,341 families (58.7%) agreed to participate in the first phase of the study and there were no sex differences (p = .95) between those who agreed to participate and those who declined. Participation, however, was greater among high socioeconomic (SES) families than low-status families (p < .001). The screening for children in the second phase was carried out using the Strengths and Difficulties Questionnaire (SDQ^{3-4}, [29]) (see ahead). A random sample of 30% of children with a negative screening score and all the children with a positive score were invited to remain part of the longitudinal research process. The final second-phase sample included 622 families (10.6% of those invited declined to participate in the second phase). No differences were found on comparing participants and refusals by sex (p = .82) or by type of school (p = .85).

At age 8, which corresponds to the sixth follow-up, 477 (76.6%) children remained in the study and 403 agreed to participate in the assessment. Seventy cases were used for piloting, calibrating and developing the experimental condition. An additional thirteen cases were excluded because of incomplete registration. The results are based on the remaining 320 children. Participants and drop-outs at age 8 were statistically equal in sex (p = .376), baseline CU-trait mean (p = .543) and ODD symptomatology mean (p = .134). Participants had a higher SES than drop-outs (p < .005). Table 1 shows the demographic characteristics of the total sample.

DSM-5 prevalence in the sample (N = 320), obtained from a semi-structured diagnostic interview with parents, was as follows: 8.7% attention deficit/hyperactivity disorder, 6.8% specific phobia, 6.4% ODD, 1.3% generalized anxiety, 1.3% social

phobia, 1.0% separation anxiety and 0.6% major depression (there were no cases of conduct disorder).

2.2. Instruments

Oppositionality (ODD). The level of ODD symptoms was measured by two items on the conduct scale of the *Strengths and Difficulties Questionnaire* (SDQ; [30]) (temper tantrums, disobedient), plus six additional items required to complete the DSM-5 ODD symptomatology (argumentative, spiteful, annoys, blames, touchy, angry-resentful) , which were added to the list of SDQ questions for the longitudinal study because they were not included in the SDQ$^{5\text{-}17}$ (see Table S1 online). The sum of the eight ODD symptoms coded on a 3-point Likert-type scale (0: *not true*; 1: *somewhat true*; 2: *certainly true*) and completed by teachers was used to obtain the oppositionality symptom score (ODD). The Cronbach's alpha for the sample was .89.

The *Inventory of Callous-Unemotional Traits* (ICU; [31]) includes 24 items coded on a 4-point Likert-type scale (0: *not at all true* to 3: *definitely true*) covering three dimensions: Callous, Uncaring and Unemotional. This instrument was completed by the children's teachers. The total score was used to form the groups in the study (Cronbach's alpha = .92 in our sample).

Attention to emotion task. EventIDE software (Okazolab Ltd, London, UK, and the BGaze system, Braingaze, Spain) were used to present the stimuli. The experimental condition consisted of differentiating emotion (angry, happy, sad and fearful) versus non-emotion (neutral) as expressed by emoticons through a computer-based go/no go task (Figure 1). The children were required to press a key on the keyboard each time an emoticon with an emotion was shown (96 trials; 24 trials per emotion) and to inhibit the response to press the key when a neutral emoticon was presented (24 trials). Emotions

and neutral emoticons were randomly distributed throughout the experimental condition with the same sequence for all the children. Each trial consisted of: 1) 500ms looking at the closed-eyes stimulus; 2) the appearance of eyes for 1000ms; 3) the appearance of the target (emoticon with or without emotion) for 1500ms; 4) closed-eyes stimulus for 500ms. Prior to commencing the experiment, the four emotions plus the neutral emoticons were presented individually to the children in order to ensure they could recognise each emotion. In the case of wrong identification, the experimenter indicated the name of the correct emotion shown to the child. The emotion of the happy emoticon was correctly identified 99.5% of times, fearful 100%, sad 99.2% and angry 91% of times. In the case of error, a retest was carried out after reviewing all of the emotions and ensuring that the child understood the task. All of the children correctly identified the emotions on retest.

Two indexes were calculated. The percentage of correct answers represents the percentage of times the child pressed the key when an emoticon with an emotion was presented and inhibited the response to press when a neutral emoticon was presented. Reaction time (RT) represents the mean time of response to each stimulus. Indexes were calculated for each of the five stimuli separately (neutral, angry, happy, sad and fearful) and averaged for the four emotional stimuli (total emotion). Omission (inhibition to press) was the correct response for neutral emoticons and commission (to press) was the correct response for emoticons showing an emotion. Therefore, reaction times for neutral emoticons are reaction times for errors, while reaction times for emotional emoticons are reactions times for correct responses. In this study, correct/incorrect answers (press/no press) were interpreted to be indicators of emotion recognition (the child recognised the emoticon was showing an emotion). Reaction time was interpreted to be a measure of attention to emotion [32].

2.3. Procedure

The longitudinal project was approved by the ethics review committee of the Universitat Autònoma de Barcelona (Ethics Committee for Human and Animal Experimentation, approval number CEEAH 1385). Informed written consent was obtained from the parents of the children participating in the study, as approved by the ethics committee. The families were recruited at the schools and they provided written consent. Those who agreed to participate and met the screening criteria were contacted by telephone. The teachers were asked to complete the questionnaires by the end of the academic year. Participating teachers had known the 8-year-olds for a mean of 8.1 months (*SD* = 2.7) and the children completed the emotion task in the school.

2.4. Statistical Analysis

The statistical analysis was carried out using SPSS24 for Windows. The 320 children were distributed into four groups based on the combination of the binary classification on the ICU and the SDQ_ODD (ODD). The percentile ≥ 75 in the sample was the cut-off for selecting high-scores (ICU-total ≥ 28; SDQ_ODD ≥ 5). The four groups in the role of independent variables are: the LowCU-LowODD group, who scored below the cut-off in both dimensions (*n* = 207); the LowCU-HighODD group, who scored below the cut-off for CU-traits and above for ODD (*n* = 38); the HighCU-LowODD group, who scored above the cut-off for CU-traits and below for ODD (*n* = 24) and the HighCU-HighODD group, who scored above the cut-off for both dimensions (*n* = 51) (see Table 1).

Taking the percentage of correct responses and reaction time as dependent variables, analyses of variance comparing the four groups were conducted separately for

each emotion and for both the total emotion score and the neutral stimulus. Three a priori contrasts comparing each diagnostic group with the control group were then estimated and Cohen's *d* coefficients calculated. The Cohen's-*d* coefficients measured the effect size for each pairwise comparison (effect size was considered moderate for $|d| > 0.5$ and high for $|d| > 0.8$) [33]. Emotions within each group could not be compared (e.g., correct responses to neutral stimuli in comparison with the four emotions for the LowCU-LowODD group) due to the task characteristics: the correct response to a neutral stimulus is an omission, while the correct response to an emotional stimulus is a commission.

Normality (through inspecting boxplots and normal plot) and homogeneity of variances (Levene's test) were examined and slight heteroscedasticity was found for correct fearful identification ($p = .019$) and for sadness reaction time ($p = .046$). No corrective measures were taken because the variance differences were considered to be too low to influence the conclusions.

The potential confounding effect of sex, socioeconomic status and comorbidities was evaluated. As differences between adjusted and raw effects in no case exceeded 3% and confidence intervals for adjusted effects were wider, raw effects were selected [34].

3. Results

3.1. Comparison of correct answers among the diagnostic groups

Table 2 (upper left part) shows the percentage of correct answers given to the different emotions. There were significant differences between groups in the total emotion percentage of correct answers, as well as in the responses to happy, fearful and neutral ($p \leq .037$), but not to angry or sad (in this case very close to statistical significance): The control group (LowCU-LowODD) obtained the highest percentage of

correct answers and shared the best recognition for fearful with the HighCU-LowODD group. The LowCU-HighODD group obtained the lowest recognition for total emotion and for sad, fearful and neutral, and both the LowCU-HighODD and the HighCU-HighODD groups obtained the lowest recognition for happy. The mean number of correct answers for angry was the same for all groups.

3.2. Comparison of reaction time among the diagnostic groups

The lower left part of Table 2 indicates the mean reaction time for responding to the emoticons. There were significant differences between groups in total emotion reaction time and in all the emotions ($p \leq .047$), except neutral. In all conditions the LowCU-LowODD group obtained the highest mean (they responded slowest) and the LowCU-HighODD group obtained the lowest mean (they responded fastest), except for fearful reaction time where the HighCU-LowODD group was the fastest.

3.3. Comparison of correct answers and reaction time with reference to the LowCU-LowODD control group

As the initial hypothesis was that children high in CU traits and/or ODD would have more difficulty in emotion processing than children under the cut-off in these constructs, a priori contrasts were carried out in relation to the control group (LowCU-LowODD) (Table 2, right part).

In comparison with the LowCU-LowODD group, the diagnostic groups responded correctly less frequently: the LowCU-HighODD group made more errors for total emotion, happy, sad, fearful and neutral (effect sizes in the moderate range, between 0.41 and 0.48); the HighCU-LowODD group made more errors only for neutral (moderate effect size 0.58); and the HighCU-HighODD group made more errors

for total emotion, happy, fearful and neutral (small effect sizes, between 0.33 and 0.39). For an easy interpretation, Figure 2 shows the differences in correct answers for the three comparisons with respect to the control group LowCU-LowODD (in order to avoid erroneous comparisons neutral was not included in the figure because the response registers errors and not correct answers).

Regarding reaction time, in comparison with the LowCU-LowODD group the three diagnostic groups systematically responded faster (17 out of 18 times), the differences being significant for six of the comparisons: the LowCU-HighODD group was faster to respond for total emotion and all four emotions (effect size low-moderate, between 0.36 and 0.50); the HighCU-LowODD group was faster only for fearful (effect size moderate, 0.54) and there were no statistically significant differences in the HighCU-HighODD group. Figure 3 shows the differences in reaction time for the three comparisons with respect to the control group LowCU-LowODD.

4. Discussion

The purpose of the study was to evaluate the specific contributions of CU traits and ODD to emotion processing in a wide sample of 8-year-olds from the community. As expected, the hypothesis of a general deficit for children high in CU traits and oppositionality in the identification of emotions was accomplished. The LowCU-HighODD and HighCU-HighODD groups were less accurate than the control group in processing the information in a go/no-go task, specifically when the stimuli expressed happiness, fear or neutral. These results indicate that a deficit in emotion processing is not restricted to specific emotions reflecting distress, such as fear or sadness, but points to a global impairment in emotion processing (distressing and not distressing) in children high in these constructs, as proposed by Dadds et al. [23]. The LowCU-

HighODD and HighCU-HighODD groups differed more markedly from the control group in the quality of the response (correct/wrong responses) rather than in the reaction time, for which most of the differences were in the HighODD without CU traits group, suggesting that the difficulties children with high CU traits and conduct problems have in processing emotions are more of an emotional rather than an attentional nature. Recently, Hodsoll et al. [35] found differences in attentional capture through emotional faces among children with high and low CU traits: children with low CU traits behaved similarly to control children when shown the targets and distractor faces, while children with high CU traits could ignore the emotional content of the faces and not be distracted by them. The authors suggest a different bottom-up processing of emotional information in children with CU traits and conduct problems that results in not automatically processing the salient aspects of emotional facial stimuli and, as these salient aspects do not capture attention, they do not receive priority processing. Similarly, White et al. [12] also suggested that there is a primary emotional deficit.

The pure oppositional group (LowCU-HighODD) was the most distinctive in relation to the control group. Children with pure ODD not only differed in that they made more errors when identifying emotions (all measures except angry), but they also diverged in RT: The presence of oppositionality without CU traits was associated with higher impulsivity (faster responding) in comparison with the control group. RT in the HighCU groups did not differ from the control group (except for a faster response to fear in the HighCU-LowODD group). These results would indicate that oppositional children are very sensitive to emotions in terms of reaction times, reacting faster to anger, happiness, sadness and fear than the control group children, whereas high CU trait groups displayed reduced reactivity to emotional stimuli, a finding also reported by Willoughby et al. [36]. The effect size for the pure oppositional group was in the

moderate range, especially for anger. Previous studies have highlighted enhanced anger recognition in children with conduct problems [37, 38]. In our study this was observable regarding reaction time but not in the percentage of correct answers (all the groups yielded a similar percentage of correct answers when the stimulus was anger, $p = .641$). Similarly, in terms of correct answers, pure oppositional children were less accurate in responding than control group children when the stimuli represented happiness, sadness and fear. Recently, ODD has begun to be conceptualised as an emotion regulation disorder, where disordered emotion regulation would be a core deficit [39]. Our results for reaction time support this view.

Children high in CU traits but without oppositionality performed similarly to the control group with respect to both accuracy and RT. The only significant differences were in the number of errors for neutral stimuli and RT for fear: Children high in CU traits responded faster to fear than the control group. Using printed pictures and a small clinical sample of 7 to 12-year-old children, Woodworth and Waschbusch [14] also found a tendency in CU children to better identify fear. They argued that individuals with higher CU traits may use fearful cues to identify increased vulnerability in victims, which may facilitate their aggressive behaviour. In our sample, high CU traits without oppositionality identified a group of children with high temperamental callous-unemotional characteristics, but these traits are not always associated with antisocial behaviour, so it cannot be assumed that they always reflect 'psychopathic' behaviour [40].

Most studies have so far focused on emotion recognition in facial expressions using human pictures, body posture [9] and vocal cues [41]. Several experimental tasks have also been used to assess emotional processing, such as computer-presented pictures [35], printed cartoon pictures [14], a morphing task [13] and an emotional dot-

probe [38] to cite some examples. Different reporters have mentioned behaviour problems (including mixing ODD and CD symptoms) and callous-unemotional traits, with a predominance of parents and children as reporters, while only a few studies have included teachers' ratings. This study, however, was based on measures provided by teachers. Teachers' scores have shown higher internal consistency than parents' scores and have proved useful for identifying CU traits [42]. In the present study a go/no-go task and emoticons were used. Emotion recognition programs had been routinely administered in the school from preschool age and emoticons had been included as stimuli, so the children were familiar with the task type. Furthermore, this kind of stimuli were considered to be more appropriate for a go/no-go task. Additionally, emoticons (when they are upright, but not lateral) are processed in occipitotemporal sites similarly to faces, due to their familiar configuration [43]. Though it can be inferred that real faces and emoticons are recognised similarly, the present study did not use real faces, and given the centrality of the amygdala to CU theories future studies should show if emoticons activate this part of the brain to the same degree as faces. Moreover, previous studies used smaller samples of older mean ages, included only one gender (mostly boys) or contained a low percentage of girls and were carried out in Anglo-Saxon countries (see [8] meta-analysis). The present study thus contributes to the literature by including a larger community sample of 8-year-old Spanish children of both sexes with an independent variable comprising the oppositional symptoms and CU traits reported by teachers, who are good observers of social behaviour, and by being the first to use a go/no-go task to study attention to emotion. Some limitations, however, should also be taken into account when interpreting the present results. We studied a young sample of the general population and psychopathology is not very frequent in community samples, so this could have affected the emergence of more associations.

Although the ICU is a well-established measure to assess CU traits, population norms other than our own sample are not available; therefore, percentile 75 was used to separate the 25% of children with the highest scores in these traits. This definition may reflect a high prevalence of CU traits; however, the solution is consistent with the definitions of other studies [44, 45] and the intention of this analysis was to work with children with marked CU traits.

The results of the study have several clinical implications. First, the International Classification of Diseases-11 [46] is considering proposing the subtype 'oppositional defiant disorder without chronic irritability-anger with limited prosocial emotions'. Our results contribute along these lines as they suggest that different patterns of processing emotional information and emotional reactivity may characterise distinct subgroups of young people with oppositional problems. Second, the group with the greatest difficulties in processing the emotional stimuli was the group with only oppositionality, which suggests that emotional recognition training that includes working with several basic emotions and emotional regulation techniques would benefit affected children. These finding are consistent with the current position that highlights the emotional dysregulation deficit in children with ODD [47]. Several cognitive-behavioural therapy techniques that target the deficits in emotion regulation associated with conduct problems, such as anger control training, problem-solving skills training and social skills training, have proven to be efficacious for children with behaviour problems [48]. Third, while children with combined CU traits and oppositionality may benefit from emotion recognition training, according to our results they would not require emotion regulation techniques. Our findings point not to a specific deficit in processing negative emotions such as fear and sadness, but to a global deficit, given that more mistakes were made when the stimuli were happiness and fear and also when it was a neutral stimulus.

The presence of CU traits has been repeatedly associated with poor treatment outcomes for conduct problems [49]. Notwithstanding, some interventions have shown efficacy. In a randomised trial Dadds et al. [44] reported the effectiveness of emotion recognition training for children with CU traits and recommended it as an adjunctive intervention for parent training. Among the novel interventions for treating children with CU traits, Hawes et al. [49] proposed 'emotional engagement' between children and their parents through ameliorating eye contact, which is crucial to understanding the emotional state of others and gaining social competence.

In conclusion, we report that when comparing groups with different levels of CU traits and oppositionality, the groups with LowCU-HighODD and HighCU-HighODD were less accurate than the control group in processing emotional stimuli through a go/no-go task, specifically when the stimuli expressed happiness, fear or neutral emotion. The deficit in emotion processing affected different distressing and non-distressing emotions, suggesting a global impairment in emotion processing. The pure oppositional group made errors in both the quality of the response and RT, whereas the CU traits and ODD group differed from the control group only in the quality of the response and not in RT, suggesting that the difficulties children with CU traits and conduct problems have in processing emotions are more of an emotional rather than an attentional nature. A reactivity deficit was specifically associated with the ODD only group. These findings support the heterogeneity of disruptive behaviour problems and suggest the need for different treatment components for each group.

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Table 1. Descriptives for study sample at age 8.

	Total	LowCU-LowODD	LowCU-HighODD	HighCU-LowODD	HighCU-HighODD			
	N = 320	*n = 207*	*n = 38*	*n = 24*	*n = 51*	χ^2	*df*	*p*
Sex (%)								
Girls	48.4	54.6	31.6	37.5	41.2	9.69	3	.021
Boys	51.6	45.4	68.4	62.5	58.8			
Ethnic group (%)								
Non-Hispanic white	93.4	95.7	86.8	91.7	90.2			
Hispanic-American	3.1	1.4	7.9	4.2	5.9	6.92	6	.329
Other	3.4	2.9	5.3	4.2	3.9			
Socioeconomic status (%)								
High	40.3	41.1	50.0	41.7	29.4			
Mean-high	36.9	41.1	18.4	41.7	31.4			
Mean	11.9	10.1	18.4	4.2	17.6	25.17	12	.014
Mean-low	9.7	7.2	7.9	12.5	19.6			
Low	1.3	0.5	5.3	0.0	2.0			
Comorbidity (%)								
No	83.8	87.4	68.4	83.3	80.4	9.10	3	.029
Yes	16.2	12.6	31.6	16.7	19.6			
						F	*df*	*p*
ICU Total								
Mean (SD)	21.1 (12.1)	14.5 (6.8)	23.6 (6.2)	35.4 (5.5)	39.5 (9.1)	207.4	3;316	<.005
SDQ_ODDs								
Mean (SD)	3.3 (3.7)	1.2 (1.3)	6.8 (1.9)	2.5 (1.3)	9.6 (3.0)	375.4	3;316	<.005

Table 2. Group comparison of emotion recognition and reaction time, with contrasts between diagnostic groups and control group.

	Groups descriptive and ANOVA						*Contrasts between diagnostic groups versus Low CU-Low ODD*								
	LowCU-LowODD	LowCU-HighODD	HighCU-LowODD	HighCU-HighODD	ANOVA (df1=3;df2=316)		LowCU-HighODD vs LowCU-LowODD			HighCU-LowODD vs LowCU-LowODD			HighCU-HighODD vs LowCU-LowODD		
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*	*F*	*p*	MD (CI 95%)	*p*	*d*	MD (CI 95%)	*p*	*d*	MD (CI 95%)	*p*	*d*
Emotion recognition correct answers (%)															
Angry	90.0 (12.6)	89.9 (9.2)	88.4 (12.2)	87.7 (11.8)	0.56	.641	-0.1 (-4.3; 4.2)	.987	0.00	-1.6 (-6.9; 3.7)	.557	0.13	-2.3 (-6.0; 1.5)	.231	0.19
Happy	93.1 (8.5)	89.2 (7.6)	92.5 (7.3)	89.4 (10.9)	3.93	**.009**	-3.9 (-7.0; -0.8)	**.013**	0.48	-0.7 (-4.5; 3.2)	.730	0.09	-3.7 (-6.4; -1.0)	**.007**	0.38
Sad	88.3 (11.2)	83.3 (11.5)	87.1 (8.2)	86.2 (10.4)	2.38	.069	-5.0 (-8.8; -1.1)	**.011**	0.44	-1.1 (-6.0; 3.7)	.646	0.11	-2.1 (-5.5; 1.3)	.231	0.19
Fearful	94.2 (7.9)	89.2 (12.7)	94.4 (7.8)	90.9 (9.0)	4.81	**.003**	-5.0 (-8.1; -2.0)	**.001**	0.48	0.2 (-3.7; 4.1)	.925	0.02	-3.3 (-6.1; -0.6)	**.017**	0.39
Total	91.4 (8.4)	87.9 (8.5)	90.6 (7.2)	88.5 (9.0)	2.86	**.037**	-3.5 (-6.5; -0.5)	**.022**	0.41	-0.8 (-4.5; 2.9)	.672	0.10	-2.9 (-5.5; -0.2)	**.033**	0.33
Neutral*	56.1 (23.2)	42.5 (21.5)	43.7 (19.6)	49.1 (18.3)	6.03	**.001**	-13.6 (-21.4; -5.8)	**.001**	**0.61**	-12.5 (-22.2; -2.7)	**.012**	**0.58**	-7.0 (-13.9; -0.2)	**.044**	0.34
Reaction time (ms)															
Angry	688.3 (128.8)	622.8 (134.6)	645.4 (88.2)	666.6 (117.1)	3.42	**.018**	-65.5 (-109.6; -21.4)	**.004**	**0.50**	-42.8 (-98.2; 12.5)	.129	0.39	-21.7 (-60.5; 17.2)	.273	0.18
Happy	655.3 (129.4)	601.8 (108.9)	611.3 (98.8)	620.7 (102.2)	3.20	**.024**	-53.5 (-96.1; -10.8)	**.014**	0.45	-44.0 (-97.5; 9.5)	.107	0.38	-34.6 (-72.2; 3.0)	.071	0.30
Sad	704.6 (147.0)	638.9 (141.0)	659.5 (105.6)	677.9 (95.4)	3.03	**.029**	-65.7 (-113.9; -17.6)	**.008**	0.46	-45.1 (-105.5; 15.3)	.143	0.35	-26.7 (-69.1; 15.8)	.217	0.22
Fearful	660.1 (121.2)	619.8 (104.2)	604.3 (81.1)	648.1 (91.2)	2.68	**.047**	-40.3 (-79.9; -0.7)	**.046**	0.36	-55.8 (-105.5; -6.2)	**.028**	**0.54**	-12.1 (-47.0; 22.8)	.497	0.11
Total	677.1 (124.5)	620.8 (115.7)	630.1 (83.4)	653.3 (91.6)	3.37	**.019**	-56.2 (-97.1; -15.3)	**.007**	0.47	-46.9 (-98.3; 4.4)	.073	0.44	-23.7 (-59.8; 12.3)	.196	0.22
Neutral**	611.4 (135.0)	575.3 (93.5)	575.1 (94.3)	614.0 (98.7)	1.42	.236	-36.1 (-79.4; 7.2)	.102	0.31	-36.3 (-90.5; 18.0)	.190	0.31	2.6 (-35.6; 40.8)	.893	0.02

Note: In bold, statistically significant effect and moderate or large effect size; * omissions, ** for incorrect answers