**Attentional biases to emotional faces in adolescents with conduct disorder, anxiety disorders, and comorbid conduct and anxiety disorders.**

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# Abstract

Biases in emotion processing have been identified in both conduct disorder (CD) and anxiety disorders (ADs). Given the significant comorbidity between these conditions, it is important to examine whether individuals with comorbid CD+ADs display a combination of the biases observed in the non-comorbid versions of these disorders or their own distinctive pattern. We measured attentional biases and vigilance towards, and disengagement from, angry, fearful and happy faces in adolescents with CD-only (n=31), ADs-only (n=23), comorbid CD+ADs (n=20) and controls (n=30), using standard (500 ms) and masked, brief (17 ms) presentation versions of a visual-probe task. Adolescents with ADs displayed faster reaction times to happy, compared to fearful or angry, faces (irrespective of probe position). In addition to having longer reaction times in general, the CD-only and ADs-only groups showed decreased vigilance towards, and increased disengagement from, emotional faces compared to the comorbid CD+ADs and control groups. These results suggest that CD and ADs interact in terms of their effects on vigilance and disengagement, such that attentional biases are attenuated, rather than exacerbated, in individuals with comorbid CD+ADs.

**Keywords:** Attention bias; threat; emotion processing; visual probe task; conduct disorder; anxiety disorders; comorbidity

# Introduction

Conduct disorder (CD) is a common condition that emerges in childhood or adolescence, and is characterised by rule-breaking, aggression and delinquency (American Psychiatric Association, 2013). CD entails a considerable economic and social burden and is linked to unfavourable adult outcomes such as antisocial personality disorder and persistent criminality (Robins, 1978). In addition, CD frequently co-occurs with other disorders (Nock, Kazdin, Hiripi, & Kessler, 2006), including anxiety disorders (ADs; Greene et al., 2002; Polier, Vloet, Herpertz-Dahlmann, Laurens, & Hodgins, 2012). The reason for this co-occurrence is unknown (e.g., Lahey, Loeber, Burke, Rathouz, & McBurnett, 2002), although some argue that there may be a specific anxiety-mediated developmental pathway to CD (e.g., Frick, Lilienfeld, Ellis, Loney, & Silverthorn, 1999), linked to emotional dysregulation or hyper-reactivity (Frick & Morris, 2004). This may lead to hyper-sensitivity to perceived threat and reactive aggression.

Studies investigating the joint effect of CD and ADs on individuals’ developmental outcomes have yielded mixed findings. Some have reported a more benign outcome for individuals with comorbid CD+ADs than ADs or CD alone (e.g., Walker et al., 1991), while others suggest that anxiety exacerbates the effects of CD (Ialongo, Edelsohn, Werthamer-Larsson, Crockett, & Kellam, 1996; Kendall, Brady, & Verduin, 2001; Sourander et al., 2007). Given that many individuals have both CD and ADs, we need a better understanding of the mechanisms underpinning the comorbidity of ADs and CD. One mechanism that may be important relates to the way in which facial expressions of emotion are processed. For example, attentional biases towards threatening facial expressions (such as fearful or angry faces) have been reported in both adults and children with emotional disorders (Derryberry & Reed, 1994; Lonigan, Vasey, Phillips, & Hazen, 2004). In comparison, adolescents with psychopathy or callous-unemotional (CU) traits have shown reduced attention to distress cues, such as images of people crying (Kimonis, Frick, Cauffman, Goldweber, & Skeem, 2012; Kimonis, Frick, Fazekas, & Loney, 2006; Lykken, 1957; van Honk & Schutter, 2006) and aggression has been associated with increased attention towards angry faces (Smith & Waterman, 2003).

Cognitive theories of ADs hold that biases in processing and allocating attention to threat are critically involved in the aetiology and maintenance of anxiety (Beck & Clark, 1997; Beck, Emery, & Greenberg, 1985; Hofmann, Ellard, & Siegle, 2012; Mathews & Mackintosh, 1998; Mogg & Bradley, 1998). For example, Beck suggests that individuals with ADs have dysfunctional cognitive schemata that disproportionately facilitate the processing of threat-related information (Beck & Clark, 1997; Beck et al., 1985). Evidence to support these theories has largely emerged from studies of selective attention in adults and children with ADs or high levels of trait anxiety, and have largely shown biases towards threat-related stimuli in these groups (e.g., Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007; Garner, 2010; Hadwin & Field, 2010; Lau et al., 2012; Muris & Field, 2008). However, the majority of these studies have used words or affectively-laden images - few studies have examined selective attention to emotional faces in children or adolescents with ADs, and results have been mixed (see Garner, 2010). Some studies have reported attentional biases in AD individuals (Monk et al., 2006; Roy et al., 2008; Waters, Bradley, & Mogg, 2013), whereas others have not (Monk et al., 2008; Waters, Henry, Mogg, Bradley, & Pine, 2010). Furthermore, studies have been inconsistent in terms of the direction of such biases. For example, Monk et al. (2006) found avoidance of angry faces in individuals with ADs, whereas Roy et al. (2008) found that AD individuals were biased towards angry faces, and Waters et al. (2013) reported that individuals with generalised anxiety disorder (GAD) showed attentional biases towards anger, whereas individuals with fear-related disorders were avoidant of anger.

Selective attention to emotional faces has not been assessed in individuals with CD. However, a number of studies have used emotional pictures from the International Affective Pictures System (Lang, Bradley, & Cuthbert, 2008) to examine attentional biases in male adolescent offenders with varying levels of CU traits, aggression and anxiety (Kimonis et al., 2012; Kimonis, Frick, Munoz, & Aucoin, 2007, 2008a). Consistent with the idea that individuals with psychopathy are insensitive to distress cues (Blair, 1995, 2005), the above studies reported reduced vigilance to distressing pictures (e.g., images of people crying) in children and adolescents with CU traits and elevated aggression (Kimonis et al., 2006; Kimonis et al., 2007). Furthermore, Kimonis et al. (2012) found that male offenders with elevated CU traits and high levels of anxiety (i.e., ‘secondary’ psychopathy) displayed increased attentional bias towards images conveying distress, relative to adolescents with CU traits and low levels of anxiety (i.e., ‘primary’ psychopathy). However, as no control groups were included in these studies, it is not known whether antisocial adolescents show attentional biases relative to typically-developing teenagers, irrespective of their level of CU traits. Individuals with CD have been found to show deficits in recognising facial expressions of fear, sadness, anger, disgust, surprise and happiness (e.g., Short, Sonuga-Barke, Adams, & Fairchild, 2016; Sully, Sonuga-Barke, & Fairchild, 2015), which may reflect a general insensitivity to others’ emotions in CD.

A number of methodological issues may have also contributed to the variability in findings to date. For example, the attentional bias typically measured in visual probe tasks is a compound measure of two processes: (i) initial orientation/vigilance towards emotional stimuli; and (ii) disengagement from emotional stimuli (e.g. Koster, Crombez, Verschuere, & De Houwer, 2004). Typical studies of attentional biases compare the reaction times (RTs) for valid trials (probes appearing in the location of the *emotional* stimulus) with RTs for invalid trials (probes in the location of the *neutral* stimulus). Faster RTs on valid, compared to invalid, trials are considered to reflect an attentional bias towards emotional stimuli. However, this RT difference could be driven by *slower* RTs on invalid trials (i.e., reflecting delayed disengagement from the emotional stimulus, which captures attention even though it is irrelevant to task performance), or *faster* RTs on valid trials (i.e., reflecting early attentional capture by the emotional stimulus). Indeed, there is evidence to suggest that the attentional bias towards threat seen in anxious individuals may be due to delayed disengagement from threat or fear-relevant stimuli (e.g., Cisler & Koster, 2010; Eysenck, Derakshan, Santos, & Calvo, 2007; Fox, Russo, & Dutton, 2002; Georgiou et al., 2005), rather than faster orienting towards these stimuli. One method for separating out these two processes in visual probe tasks involves including control trials in which there is no emotional stimulus (i.e., two neutral stimuli are presented). Reaction times for these ‘neutral’ trials can then be compared to the RTs for valid and invalid trials containing emotional stimuli, to assess vigilance and disengagement processes, respectively.

Furthermore, the majority of studies of selective attention in children and adolescents using visual probe tasks have employed relatively long stimulus presentation times (e.g., 500ms). This relatively long stimulus duration allows participants to engage in elaborate, strategic, processing of the threat, in addition to making multiple eye movements, which may interfere with task performance. In contrast, the use of briefly-presented (e.g., 17ms) stimuli, followed by a mask to limit conscious awareness of the stimuli, has been found to enhance the effects of threatening facial expressions on attentional biases in individuals with high levels of trait anxiety (Fox, 2002). In addition, children with CU traits have been found to exhibit pre-attentive fear and disgust recognition deficits using a continuous flash suppression paradigm that suppresses awareness of the face stimuli (Sylvers, Brennan, & Lilienfeld, 2011).

To examine the impact of comorbidity between CD and ADs on threat processing under different levels of awareness (from pre-attentive to conscious), we compared performance on a visual probe task with emotional and neutral faces in adolescents by individuals with CD+ADs, with CD alone, ADs alone, and typically-developing controls. Our study addressed several of the limitations of previous studies. We used pictures of emotional faces, which are preferable to words or pictures of complex scenes. This is because they are processed automatically (e.g. Kanwisher, McDermott, & Chun, 1997; Pessoa, 2005). In addition, their use is not confounded by group differences in literacy or verbal ability, which is important when studying CD populations that frequently have low verbal and reading ability (Burke, Loeber, & Birmaher, 2002; Moffitt, 1993). In addition, we included control trials (neutral-neutral face pairs) and were therefore able to separate out the vigilance and disengagement components of attentional bias and study relationships between each of these measures and psychopathology. Lastly, we included both standard visual probe trials that allowed us to assess attentional biases during the 500ms after face onset (i.e., conscious trials), and trials in which face stimuli were presented briefly (17ms) and followed by a high contrast visual mask to limit conscious processing (e.g., Öhman, 1997). The purpose of this manipulation was to investigate whether CD or ADs (or their combination) are related to biases arising from early (pre-attentive) or late processing stages, or whether threat processing is altered in CD or ADs in both instances.

Previous results from visual-probe tasks involving emotional faces in children and adolescents with anxiety have been mixed, and only a small number of studies have used face stimuli with a design that allows the assessment of both vigilance and disengagement processes. It is difficult, therefore, to make clear directional predictions. However, based on the adult literature, we hypothesised that adolescents with ADs would show attentional biases towards angry and fearful faces, as suggested by studies reporting both enhanced vigilance towards (Bar-Haim et al., 2007; Ehenreich & Gross, 2002; Puliafico & Kendall, 2006), and delayed disengagement from these threatening stimuli (Georgiou et al., 2005). We also hypothesised that individuals with CD-only would show reduced vigilance towards emotional facial expressions, but that this pattern of vigilance might be modulated by CU traits: based on the findings of Kimonis and colleagues (Kimonis et al., 2006; Kimonis et al., 2007), we hypothesised that elevated CU traits would be associated with reduced vigilance towards angry and fearful faces. Conversely, we predicted that individuals with comorbid CD+ADs (putatively similar to ‘secondary psychopathy’) might show increased vigilance towards angry and fearful faces relative to typically-developing controls and the CD-only group (Kimonis et al., 2012). Whilst disengagement has not been measured previously using dot or visual probe tasks in antisocial individuals, there is prior evidence for delayed disengagement from threatening words in healthy adults scoring low on the personality trait of agreeableness (Wilkowski, Robinson, & Meier, 2006). We therefore predicted that CD-only individuals, as well as individuals with comorbid CD+ADs, would show delayed disengagement from angry faces, although we note that this hypothesis was speculative, given the limited evidence in this area.

# Methods

## Participants

Participants were 104 adolescents aged between 12 and 18 years (M = 16.6, SD = 1.5, 37.5% girls), recruited from schools, colleges, Youth Offending Teams and Pupil Referral Units in Southampton and Hampshire. The typically-developing and ADs-only groups were primarily recruited from schools and colleges, whereas the CD and CD+ADs groups were largely recruited from Youth Offending Teams and Pupil Referral Units, although some (approx. 20%) individuals with CD were approached at mainstream schools and colleges. Inclusion criteria were IQ≥75 (measured with the vocabulary and matrix reasoning subtests of the Wechsler Abbreviated Scale of Intelligence; Wechsler, 1999), and being free of pervasive developmental disorders or psychosis. All participants were assessed against DSM-IV criteria for CD, ADHD, generalised anxiety disorder (GAD), major depressive disorder (MDD), social phobia, specific phobia, panic disorder, obsessive-compulsive disorder (OCD), alcohol or substance abuse, posttraumatic stress disorder (PTSD), and oppositional defiant disorder (ODD), using a semi-structured clinical interview: the Kiddie Schedule for Affective Disorders and Schizophrenia–Present and Lifetime version (K-SADS-PL; Kaufman et al., 1997). Of the 104 participants, 51 met criteria for current CD and/or ODD (only 3 met ODD criteria alone). Of this group, 20 additionally met the diagnostic criteria for an AD. 23 participants met criteria for ADs but had no current or lifetime diagnosis of CD/ODD. Comorbidity with other disorders was common (see Table 1). Thirty typically-developing healthy controls screened negative for all disorders.

*[Table 1 about here]*

## Ethical approval

Ethical approval was obtained from the University of Southampton’s Ethics Committee, the Southampton City Council Children’s Services and Learning Directorate, and the Hampshire County Council Research and Evaluation Unit. Participants aged 16 and above gave informed consent for their participation after being given a full description of the study. Assent was obtained from the participant and informed consent obtained from the parent or carer in cases where the participant was less than 16 years of age.

## Procedure

After the clinical interviews had been performed (usually at the participants’ homes), the participants completed a range of laboratory tasks and questionnaires during a 3.5 hour testing session at the University of Southampton. They were subsequently debriefed and paid for their time.

## Measures

Clinical assessment: The K-SADS-PL (Kaufman et al., 1997) was administered by trained interviewers to participants and parents (who were interviewed separately to ensure confidentiality). A symptom was considered present if it was endorsed by either informant. Individuals were allocated to the CD group if they met the criteria for CD (≥3 CD symptoms currently present), or if they met full criteria for ODD and endorsed 1-2 CD symptoms (three participants). K-SADS-PL training was provided by the last author, who received extensive training with the K-SADS-PL from a consultant psychiatrist at the University of Cambridge. The interviews were conducted by PhD students (including the first author, R.S.) with BSc and MSc degrees in psychology**,** and prior experience of working clinically with forensic and neurological populations.

CU traits: The self-report version of the Inventory of Callous-Unemotional Traits (ICU; Frick, 2004) is a 24-item questionnaire focusing on the affective and interpersonal components of psychopathy. Each item is phrased as a statement (e.g., “I do not care who I hurt to get what I want”), and participants are asked to rate how well it describes him/her on a scale of 0 to 3 (from “not at all true” to “definitely true”). Internal consistency in the present sample was good (Cronbach’s alpha = 0.84).

Trait anxiety: The trait subscale of the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), a 20-item self-report questionnaire, was used to assess trait anxiety. Each item is phrased as a statement (e.g., ‘I worry too much over something that really doesn’t matter‘) and rated on a four-point scale (from 1=not at all to 4=very much so). Internal consistency in the present sample was excellent (α = 0.93).

Current depressive symptoms: were assessed using the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983). This is a brief (14-item) scale, which provides measures of clinical anxiety and depression. Items are either negatively- (e.g., “I feel tense or wound up”) or positively-phrased (e.g., “I can sit at ease and feel relaxed”), and are rated on a scale of 1 to 4, indicating the frequency of these feelings in the past week (e.g., “not at all”, “most of the time”, etc.). Internal consistency for the depression subscale was acceptable in the present sample (α = 0.73).

### Assessment of attentional biases to threat

A visual-probe task was used to assess attention to emotional, compared to neutral, facial expressions. Digital photographs of facial expressions were selected from the NimStim MacArthur Network Face Stimuli Set (Research Network on Early Experience and Brain Development, http://www.macbrain.org/resources.htm, Tottenham et al., 2009). Neutral, happy, fearful and angry facial expressions posed by four male actors were employed, giving a total of 16 images. An oval mask was applied to each image to remove non-facial features (e.g., hair, neck, ears), and all images were presented in greyscale, resized to 4.9 x 7.2 cm and matched for mean luminance and contrast (Adams, Gray, Garner, & Graf, 2010; Gray, Adams, Hedger, Newton, & Garner, 2013; Hedger, Adams, & Garner, 2015), thus removing low level image differences that can contribute to image salience and affect processing time (Gray et al., 2013; Hedger, Gray, Garner, & Adams, 2015). Stimuli were presented on a 15-inch CRT monitor (at a viewing distance of approximately 60cm) linked to a Microsoft Windows XP computer, using Inquisit software (Draine, 2004).

Participants completed two versions of the visual probe (VP) task (see Figure 1): a standard version in which face pairs were presented for 500ms, and a masked version in which face pairs were presented for 17ms and replaced by a high contrast masking stimulus lasting 70ms. In both versions, participants were instructed to classify (via a keyboard button press) the direction (up or down) of a target arrow that appeared in the location of one of the preceding face stimuli; this probe classification task, in contrast to a probe position task, requires participants to monitor both stimulus locations (see Mogg & Bradley, 1999). Four types of face pairs were distributed across 104 experimental trials (presented in random order): neutral-angry (n = 32), neutral-fearful (n = 32), neutral-happy (n = 32) and neutral-neutral (n = 18, including two practice trials that were not included in the data analysis). On each trial, the target arrow was either presented in the position of the emotional face (valid) or the neutral face (invalid). The location of the emotional face, and the location, direction and validity of the target arrow were counterbalanced across each emotion. Participants completed the standard task first, followed by a short break during which further instructions were given, and then performed the masked version of the task. The visual probe tasks were followed by an awareness measure in which participants were presented with either a face stimulus (57 trials) or blank screen (57 trials) for 17ms followed by a mask (70ms) and asked to report whether they had seen a face (yes/no). The purpose of this awareness check was to assess the extent to which the 17ms presentation time reduced participant’s conscious processing of the facial stimuli.

*[Figure 1 about here]*

## Data analyses

Group characteristics: The groups were compared in terms of demographic and clinical characteristics using one-way analyses of variance (ANOVAs) and Bonferroni-corrected post-hoc tests. Chi-squared tests were used to compare groups on the categorical variables.

Awareness measure: Participants’ ability to detect masked face stimuli (expressed as d-prime, d’) was calculated from Hits (correct detection of a face) and False Alarms (i.e. reporting the presence of a face on face-absent trials). A mixed-model ANOVA examined the effects of facial emotion (angry, happy, fear, neutral), CD status (+/-) and AD status (+/-) on ability to detect faces (d’).

### Visual Probe Tasks:

Reaction times (RTs) on incorrect trials were removed (4.4% and 3.8% for the standard and masked task, respectively), as well as RTs below 150ms (see Whelan, 2008). The frequency distribution of the raw RTs was positively skewed, therefore any RTs greater than 2000ms, as well as RTs that were greater than or less than three standard deviations (SD) from each participant’s log-transformed mean RT were removed (1.0% and 1.1% of correct responses for the standard and masked task, respectively). These measures were taken to reduce the impact of longer RTs on the mean (e.g., Bradley, Mogg, White, Groom, & De Bono, 1999). RTs were then transformed back into milliseconds for ease of presentation and interpretation.

To investigate the effects of CD and ADs on task RTs, separate 3 (emotion: anger vs. fear vs. happy) x 2 (trial validity: valid, invalid) x 2 (CD status: present, CD+/not present, CD-) x 2 (AD status: present, AD+/not present, AD-) mixed-model ANOVAs were conducted for the standard and masked VP tasks.

Consistent with previous studies, for each emotional expression we calculated reaction time measures of: i) vigilance: RT (neutral-neutral pair) – RT (valid trials); and ii) disengagement: RT (invalid trials) – RT (neutral-neutral pair). Positive scores reflect greater vigilance and delayed disengagement, respectively[[1]](#footnote-1). Vigilance and disengagement scores were entered into separate 3 (emotion: happy vs. fear vs. angry) x 2 (CD status: present, CD+/not present, CD-) x 2 (AD status: present, AD+/not present, AD-) mixed ANOVAs. Effect sizes for the simple effects analyses are reported as Pearson’s *r* (small ≥0.1, medium ≥0.3, large ≥0.5; Cohen, 1992). Finally, within the CD participants only, we examined whether CU traits moderated vigilance and disengagement to emotional faces. CD individuals were classified as high or low in CU traits on the basis of a median split (≥30 on the ICU).

# Results

## Participant characteristics

Group characteristics are presented in Table 2. As expected, the comorbid CD+ADs and ADs-only groups were elevated in trait anxiety relative to the CD-only and control groups (all *p* < 0.05). In addition, there were higher rates of worry-based ADs (i.e., GAD or OCD) within the ADs-only and comorbid CD+ADs groups compared to the control and CD groups (*χ*2 = 89.90, *p* < 0.01), and also higher rates of fear-based ADs (i.e., social phobia, specific phobia and panic disorder) within the ADs-only group compared to the other three groups (*χ*2 = 42.84, *p* < 0.01). As would be expected given the experimental design, the CD-only and comorbid CD+ADs groups had significantly more CD symptoms and higher levels of CU traits than the ADs-only and control groups (all *p* < 0.01), whereas the CD-only and comorbid CD+ADs groups did not differ in CU traits (*p* = 0.53).

The three clinical groups had higher rates of major depressive disorder diagnoses than the control group (*χ*2 = 15.53, *p* < 0.01), and the CD-only and comorbid CD+ADs groups had higher rates of ADHD diagnoses than the ADs-only and control groups (*χ*2 = 15.45, *p* < 0.01). Lastly, the comorbid CD+ADs and CD-only groups reported more depressive symptoms than the controls (both *p* < 0.01). The groups were matched in age, but the proportion of females was higher in the ADs-only group than the other groups (*χ*2 = 23.22, *p* < 0.01). The CD-only group had lower IQs than the control group (*p* < 0.01).

*[Table 2 about here]*

## Exploring the impact of potential confounds

Given that there were group differences in IQ, gender and depressive symptoms, bivariate correlations were conducted between IQ, gender and depressive symptoms, and visual probe (VP) task RTs, vigilance and disengagement scores. Neither IQ nor depressive symptoms correlated significantly with any of the VP task measures, so we did not control for these variables in any of the analyses presented below. Gender, however, was significantly correlated with a number of measures in the masked VP task (RTs in valid and invalid trials containing fearful faces, r = 0.21, p = 0.04, and r = 0.19, p = 0.05, respectively; vigilance to fearful faces, r = -0.30, p = 0.03; and disengagement from fearful faces, r = 0.25, p = 0.01). Therefore, the analyses for the masked VP task below were repeated with gender as an additional factor.

## Awareness check

The participants’ ability to detect masked faces was not affected by Emotion, CD or AD status, and these factors did not significantly interact (all *Fs* < 1.49, *ps* > 0.22). One-sample *t*-tests comparing d’ scores against zero suggested that all four groups performed above chance when discriminating face present from face absent trials, irrespective of facial emotion (*ts* > 4.79, *ps* < 0.01). Our very brief (17ms) masked stimulus presentation undoubtedly reduced our participants’ conscious processing of the face stimuli – participants’ detection of face present trials (‘hit rate’) did not deviate from chance performance (M = 0.52, SD = 0.14 across groups and expressions). However, the low false alarm rate (M = 0.16, SD = 0.21), and resultant d’ scores, suggest that our manipulation did not completely eliminate participants’ awareness of the face stimuli on all trials. We note that our measure of awareness was highly conservative, i.e., determining the presence vs. absence of face stimuli, rather than reporting the valence of the faces. Alternative tasks, such as identifying the emotion of a masked face with the same 17ms duration, have also produced above chance performance in some observers (Pessoa, Japee & Ungerleider, 2005; see Hedger, Gray, Garner, & Adams, in press for a review and meta-analysis of threat-related biases for stimuli presented without awareness).

## Visual Probe Results:

## Raw reaction time (RT) data

Raw RTs for each condition in both tasks are presented in Figure 2.

*[Insert Figure 2 here]*

Masked visual probe: There was a main effect of trial type on RTs (F (1, 100) = 8.33, p < 0.01, r = 0.28). Participants were faster to respond to the valid trials across both tasks, suggesting a general attentional bias towards emotional stimuli. There was also a significant emotion x AD interaction (F (2, 200) = 4.57, p < 0.01): individuals with ADs (i.e., the ADs-only and comorbid CD+ADs groups) had shorter RTs when the display contained happy, compared to angry, faces (F (2, 100) = 3.80, p = 0.05, r = 0.19). In contrast, individuals without ADs had longer RTs when the display contained happy, compared to angry (F (2, 100) = 4.09, p = 0.05, r = 0.20) or fearful (F (2, 100) = 6.19, p = 0.02, r = 0.24) faces.

In terms of overall RTs, there was a significant CD x AD interaction effect (F (1, 100) = 7.87, p < 0.01, r = 0.27). As depicted in Figure 2, the presence of comorbid CD+ADs appeared to result in shorter RTs across all conditions. Individual contrasts showed that CD-only individuals had significantly longer RTs than individuals with comorbid CD+ADs (F (1, 100) = 5.00, p = 0.03, r = 0.22) and controls (F (1, 100) = 11.85, p < 0.01, r = 0.33). Neither gender nor CU traits significantly moderated these effects.

Standard visual probe: There were no main effects of emotion or validity on RTs, and no significant interactions between emotion, validity, and CD and AD group status. In line with findings for the masked condition, there was a significant CD x AD interaction (F (1, 100) = 9.81, p < 0.01, r = 0.35), with the presence of comorbid CD+ADs resulting in shorter RTs (see Figure 2). Individual contrasts showed that CD-only individuals had significantly longer RTs than comorbid CD+ADs individuals (F (1, 100) = 8.87, p < 0.01, r = 0.30), and controls (F (1, 100) = 14.14, p < 0.01, r = 0.35). CU traits did not moderate these effects.

## Vigilance towards Emotional Faces

Masked visual probe: The CD-only and ADs-only groups showed a pattern of performance suggesting avoidance of emotional faces; this reached significance in the ADs-only group (t(22) = -2.20, *p* = 0.04; see Figure 3, left panel), whereas the control and comorbid CD+ADs groups were not avoidant of emotional faces. This interaction between the effects of CD and ADs on vigilance was substantial and significant (*F* (1, 100) = 5.42, *p* = 0.02, *r* = 0.23). Neither gender nor CU traits moderated these effects.

*[Figure 3 about here]*

Standard visual probe task: There were no significant main effects or interactions for vigilance. CU traits did not moderate these effects.

## Disengagement from Emotional Faces:

Masked visual probe: Consistent with the vigilance results, the CD-only and ADs-only groups displayed significantly delayed disengagement from emotional faces (t­CD (30) = 2.21, *p* = 0.04; tADs­ (22) = 3.39, *p* < 0.01; see Figure 3, right panel), whereas the control and comorbid CD+ADs groups did not. This interaction between the effects of CD and ADs on disengagement was substantial and significant (*F* (1, 100) = 6.44, *p* = 0.01, *r* = 0.25). Neither gender nor CU traits moderated these effects.

Standard visual probe: There were no significant main effects or interactions on disengagement scores. CU traits did not moderate these effects.

# Discussion

We investigated attentional bias, vigilance and disengagement during the processing of emotional and neutral faces in adolescents with CD-only, ADs-only and comorbid CD+ADs. Several key findings emerged from the study. First, whilst we did not find a threat-related attentional bias in individuals with ADs-only (for either version of the VP task), the masked presentation of happy faces resulted in shorter RTs (i.e., enhanced performance) for the ADs-only and comorbid CD+ADs groups. In contrast, happy faces resulted in longer RTs, implying that they interfered with task performance, in the CD-only and control groups. However, there were no differential effects of specific emotions on attentional vigilance or disengagement. It is possible that the threat value of the angry and fearful faces was not strong enough to elicit an attentional bias towards these stimuli, within our adolescent sample (i.e., there were no significant differences in RTs between valid and invalid trials across participants). Related to this point, studies have found a non-linear effect of stimulus threat value on attentional bias towards threat: very mild and high threat-value stimuli elicit quicker responses to probes presented in the same position, whereas mild/moderate threat-value stimuli tend not to do so (Mogg & Bradley, 1998; Wilson & MacLeod, 2003). The fact that we found a general attentional bias towards the masked emotional images supports previous studies that have found stronger bias effects for subliminally-presented versus consciously-presented stimuli (e.g., Fox, 2002).

Second, there were significant CD x AD interaction effects on RTs in both versions of the task, and on vigilance and disengagement scores in the masked version of the visual probe task. In each case, individuals with comorbid CD+ADs displayed a normal pattern of performance (i.e., similar to the control group). This was in contrast to the patterns observed in those with pure versions of either disorder: the CD-only and ADs-only groups displayed longer overall RTs, and also showed avoidance of (i.e., vigilance scores that were less than zero) and increased difficulty disengaging from masked emotional stimuli than the comorbid CD+ADs and control groups. This slowing of performance (i.e., interference) in the presence of emotional stimuli is typically shown in studies employing Stroop-like tasks (see Algom, Chajut, & Lev, 2004), and tends to be greater in adults with high levels of anxiety than in those without anxiety (see Williams, Mathews, & MacLeod, 1996). Eysenck et al. (2007) suggest that emotional (and particularly threat-related) stimuli automatically capture attentional resources (disproportionately so, in the case of those with anxiety), at the expense of higher-order processing resources involved in completing the primary (non-threat-related) task. Similar interference effects have been found in individuals with elevated trait anger (van Honk, Tuiten, de Haan, vann de Hout, & Stam, 2001a; van Honk et al., 2001b), and reactive aggression (e.g., Chan, Raine, & Lee, 2010), and may explain the interference effect of emotional stimuli in our CD-only group. However, the fact that there appears to be an attenuating effect (rather than an exacerbating effect) of CD+ADs comorbidity on both vigilance and disengagement suggests that the effects seen in CD-only and ADs-only may not reflect the same types of biases or deficits in selective attention. For example, it is possible that the effects seen in ADs partly reflect a hyper-sensitivity towards emotional stimuli, whereas those seen in CD may be partly due to a general lack of motivation to complete the task as quickly as possible. Future research should aim to use a variety of tasks to measure selective attention in these groups and include measures of motivation or even manipulate motivation levels by providing rewards for accurate or fast performance.

Third, within the CD-only and comorbid CD+ADs groups, there were no significant effects or interactions involving CU traits. This was unexpected given the results of Kimonis et al. (2012), who found that individuals with high CU traits and low anxiety (putatively similar to ‘primary psychopathy’) showed avoidance of distressing images, whereas individuals with high CU traits and high anxiety (putatively similar to ‘secondary psychopathy’) showed vigilance towards distressing images in a visual probe task. Furthermore, previous research has found that individuals with psychopathy show reduced Stroop interference compared to non-psychopaths (Hiatt, Schmitt, & Newman, 2004; Newman, Schmitt, & Voss, 1997; Vitale, Brinkley, Hiatt, & Newman, 2007). Indeed, Newman and colleagues suggest that psychopaths are less likely to be distracted by task-irrelevant information (Lorenz & Newman, 2002; MacCoon, Wallace, & Newman, 2004; Newman & Lorenz, 2003) – this forms a key element of the response modulation hypothesis of psychopathy, which is essentially an attention-based model. It is possible that the range of CU traits in our sample was not sufficiently large to modulate the effects of CD and ADs on attentional biases. However, the levels of CU traits in our high and low CU-traits CD groups were comparable to those reported in Kimonis et al. (2012), and many other studies using the self-report version of the Inventory of Callous-Unemotional traits have observed lower levels of CU traits in their samples of young people who have committed criminal offenses (Feilhauer, Cima, & Arntz, 2012; Kimonis et al., 2008b).

## Strengths and limitations

To our knowledge, this is the first study to examine attentional biases in adolescents with conduct disorder and those with comorbid CD and ADs using emotional and neutral faces, which are arguably more ecologically-valid than other affective pictures or emotional words (the word ‘blood’ presented on-screen). We also presented the target stimuli under both standard and masked conditions (500 versus 17ms followed by a masking stimulus), to examine attentional allocation across different time courses and at different levels of awareness. In addition, the inclusion of neutral-neutral face trials allowed us to compute separate measures of vigilance and disengagement, rather than using a compound attentional bias measure. As well as these methodological advances, we used a standardised interview-based measure, the K-SADS-PL, to assess for CD, ADs and other common psychiatric disorders such as depression, and in the majority of cases obtained diagnostic information from multiple informants (i.e., parents as well as the young people). We also assessed callous-unemotional traits using a standardised questionnaire and investigated whether CU traits modulated the findings obtained in the CD groups. However, the present results also need to be interpreted in the light of several limitations. First, the groups differed on both IQ and gender. Whilst we did not find that IQ or gender affected our main findings, it is difficult to match experimental groups on these variables, consistent with findings from the epidemiological literature. The groups included in the current paper are largely representative of the broader CD and AD populations; individuals with CD have frequently been found to have lower IQs than controls (Farrington, 1995; Frick et al., 1991; Lynam, Moffitt, & Stouthamer-Loeber, 1993; Moffitt, Gabrieli, Mednick, & Schulsinger, 1981; Moffitt & Silva, 1988), and ADs tend to be more common among females than males (e.g. Kessler, Chiu, Demler, & Walters, 2005; McLean & Anderson, 2009). Second, our sample size was modest, which may explain why some of the group comparisons or interactions did not reach conventional levels of statistical significance. This is, nevertheless, the largest study of its kind and provides a foundation for future research exploring attentional biases in those with comorbid CD and anxiety disorders. Subsequent research might further explore the effects and interactions associated with additional comorbidity that is common in these groups. For example, three individuals in our CD groups had Oppositional Defiant Disorder (ODD) plus sub-threshold CD (although we note that the exclusion of ODD-only individuals did not affect the key results). The considerable comorbidity (as well as DSM-IV symptom overlap) between these disorders (see Maughan, Rowe, Messer, Goodman, & Meltzer, 2004), presents a challenge in identifying ‘pure’ cases of CD. In addition, depression was common among our clinical groups. It is possible that depression and anxiety differentially impact upon attentional biases (Mogg & Bradley, 2005), although neither the level of depressive symptoms nor the rate of depression diagnoses differed among our clinical groups and depressive symptoms were not significantly correlated with attentional biases.

## Conclusions

This is the first study to investigate attentional biases in individuals with CD and comorbid CD+ADs using a visual probe task employing emotional and neutral facial expressions as target stimuli and different presentation durations designed to assess threat processing at different time courses and levels of awareness (i.e., conscious versus pre-attentive). The avoidance of emotional faces in the CD-only group, and increased disengagement from emotional faces observed in the ADs-only group appeared to normalise in the comorbid CD+ADs group, who performed similarly to typically-developing controls. We hypothesise that there is a different developmental pathway, which is unrelated to impairments in emotion processing, for individuals with co-occurring externalising and internalising disorders such as CD and ADs. This pathway may be more closely related to problems with emotion regulation (i.e., impairments in the ability to reappraise events and downregulate strong negative emotions or amplify and sustain positive emotions), than difficulties in recognising and allocating attention to emotional stimuli such as angry or fearful faces.

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Tables

Table : DSM-IV diagnoses by group

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CD | | ADs | | Comorbid | |
| Diagnoses | N | Diagnoses | N | Diagnoses | N |
| CD | 16 | CD & GAD | 6 | GAD | 6 |
| CD & MDD | 6 | CD, GAD & MDD | 5 | GAD, MDD | 3 |
| CD & ADHD | 3 | CD, GAD & ADHD | 4 | GAD & Panic | 2 |
| ODD | 2 | CD, GAD, ADHD & MDD | 1 | GAD, MDD & Panic | 2 |
| ODD & ADHD | 1 | CD, GAD, ADHD & OCD | 1 | GAD, Panic & OCD | 2 |
| CD, ODD & ADHD | 1 | CD, GAD, MDD & OCD | 1 | Phobias | 2 |
| CD, ADHD & MDD | 1 | CD, GAD, MDD & Panic | 1 | OCD | 1 |
| CD & Substance Misuse | 1 | CD, GAD, MDD, OCD & Substance Misuse | 1 | Social Phobia | 1 |
|  |  |  |  | GAD & Phobias | 1 |
|  |  |  |  | GAD, Panic & Phobias | 1 |
|  |  |  |  | GAD, MDD, OCD & Substance Misuse | 1 |
|  |  |  |  | Phobias & MDD | 1 |
| *Note:* ADHD = attention-deficit/hyperactivity disorder, ADs = anxiety disorders, CD = conduct disorder, GAD = generalised anxiety disorder, MDD = major depressive disorder, OCD = obsessive-compulsive disorder. | | | | | |

Table : Participant characteristics

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Control  N = 30,  24 males | CD  N = 31,  24 males | ADs  N = 23,  5 males | Comorbid  N = 20,  12 males | *F* |
|  | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) |  |
| Age (years) | 16.26 (1.48)a | 16.76 (1.40)a | 16.42 (1.93)a | 16.84 (1.08)a | 0.87 |
| Intelligence Quotient | 109.03 (12.25)a | 94.52 (9.67)b | 102.78 (11.44)a,b | 103.15 (13.16)a,b | 8.15\*\* |
| CD Symptoms† | 0.10 (0.40)a | 7.77 (3.07)b | 0.35 (0.65)a | 6.45 (3.52)b | 82.22\*\* |
| CU traits | 20.53 (7.05)a | 30.57 (9.75)b | 19.02 (6.98)a | 27.23 (9.72)b | 11.15\*\* |
| STAI Trait Anxiety | 36.27 (9.74)a | 44.18 (10.88)b | 51.93 (10.46)c | 57.35 (9.66)c | 20.44\*\* |
| HADS Depression | 3.40 (2.81)a | 7.00 (3.61)b | 5.17 (3.55)a,b | 7.30 (4.16)b | 7.24\*\* |
| *Psychotropic medication* | | | | | |
| Antidepressants | 0 | 1 (3.23%) | 5 (21.74%) | 3 (15.00%) |  |
| Stimulants (for ADHD) | 0 | 3 (9.68%) | 0 | 0 |  |
| \*\*p<0.01, †Total number of K-SADS-PL lifetime CD symptoms endorsed (out of 15). ADHD = attention-deficit/hyperactivity disorder, ADs = anxiety disorders, CD = conduct disorder, CU = callous-unemotional, HADS = hospital anxiety and depression scales, K-SADS-PL = Kiddie-Schedule for Affective Disorders and Schizophrenia-Present and Lifetime version, STAI = State-Trait Anxiety Inventory. *Note:* Values with different subscripts differ significantly at *p* < 0.05. | | | | | |

Figures

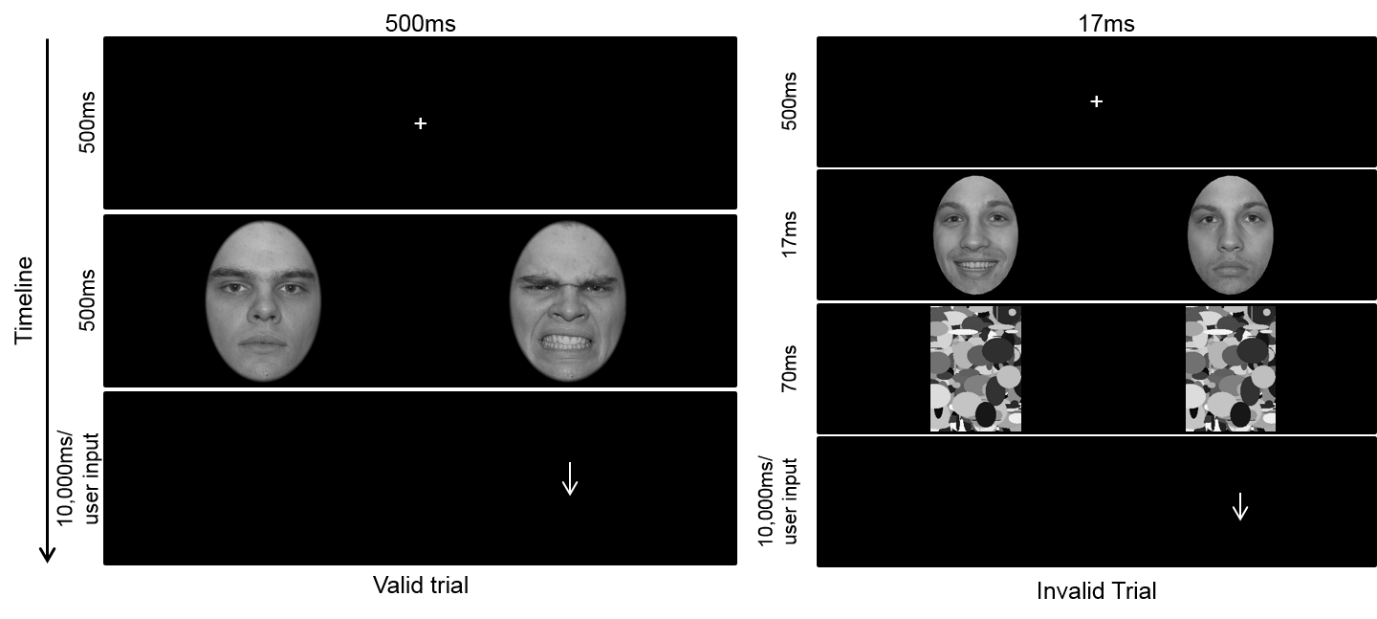


Figure : Schematic representation of a valid (left) and invalid (right) trial in the standard and masked visual probe tasks, respectively. In the masked version of the task (right), a high contrast masking stimulus was presented for 70ms following the facial expressions (17ms). Participants had to press up or down to indicate the direction of the visual probe (i.e., upward or downward arrow).

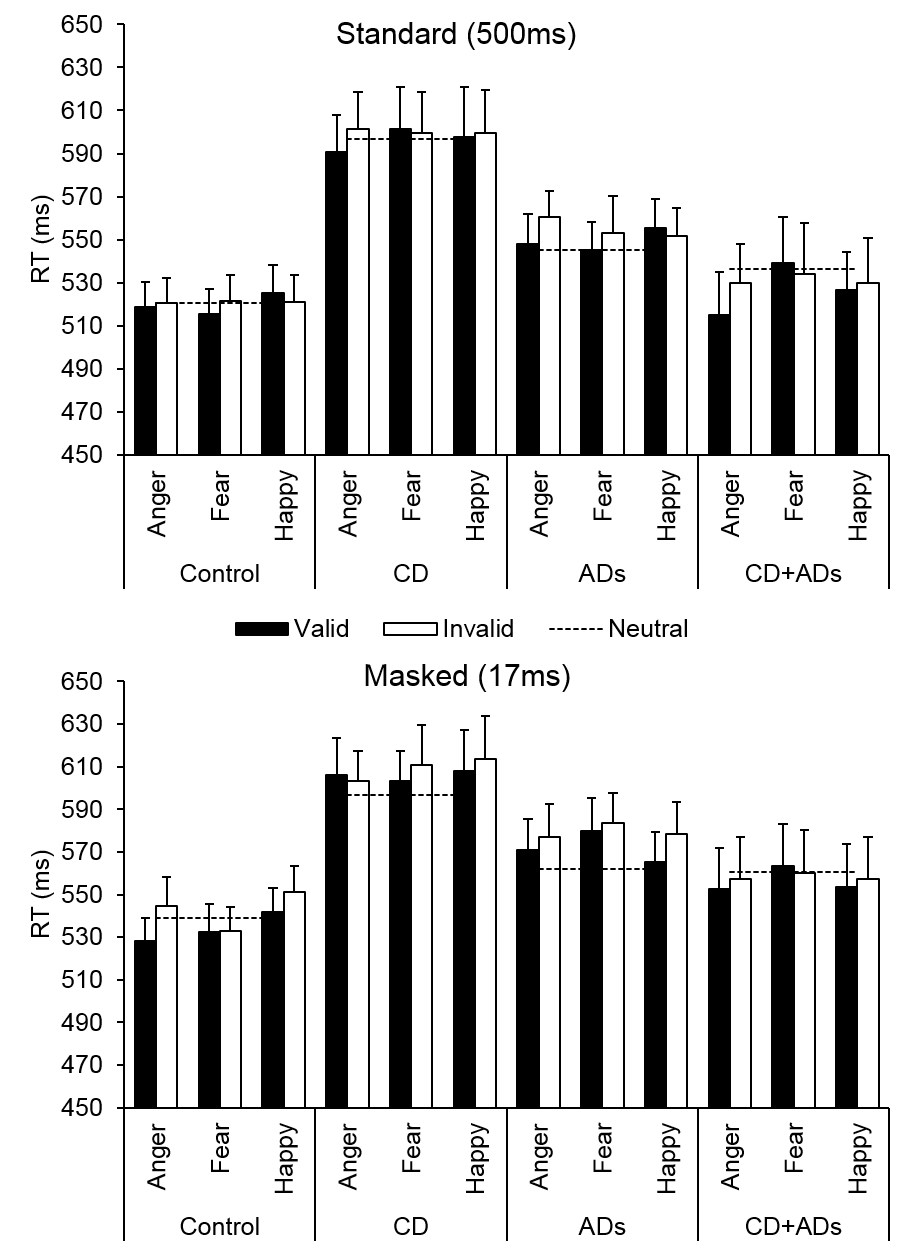


Figure : Mean reaction times (RTs) for the valid and invalid trials compared to the neutral-neutral trials (dashed horizontal lines) for each version of the visual probe task. The face stimuli were presented for 17ms and then masked for 70ms in the unaware version of the task (bottom panel). Key: ADs, anxiety disorders; CD, conduct disorder. Error bars represent +1 standard error of the mean.

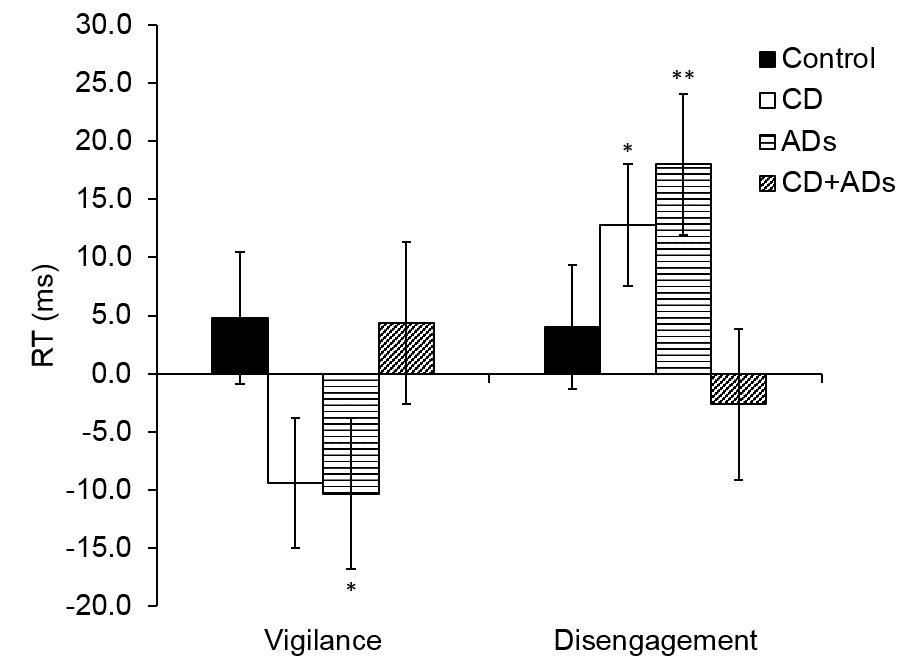


Figure 3: Conduct Disorder (CD) x anxiety disorder (AD) interaction effects on vigilance (left) and disengagement (right) scores, averaged across emotions, for the masked version of the visual probe task. Error bars represent ±1 standard error of the mean. RT, reaction time (expressed in milliseconds). Asterisks indicate significant differences from 0 (as assessed using one-sample t-tests); \**p* < 0.05, \*\**p* < 0.01.

1. Throughout the Results section, increased/decreased vigilance and disengagement refer to relative increases or decreases in vigilance and disengagement scores (i.e., not necessarily indicating the presence of scores that are significantly different from zero). [↑](#footnote-ref-1)