Callous–unemotional traits affect adolescents' perception of collaboration

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Background: How is the perception of collaboration influenced by individual characteristics, in particular high levels of callous–unemotional (CU) traits? CU traits are associated with low empathy and endorsement of negative social goals such as dominance and forced respect. Thus, it is possible that they could relate to difficulties in interpreting that others are collaborating based on a shared goal. **Methods:** In the current study, a community sample of 15- to 16-year olds participated in an eye tracking task measuring whether they expect that others engaged in an action sequence are collaborating, depending on the emotion they display toward each other. Positive emotion would indicate that they share a goal, while negative emotion would indicate that they hold individual goals. **Results:** When the actors showed positive emotion toward each other, expectations of collaboration varied with CU traits. The higher adolescents were on CU traits, the less likely they were to expect collaboration. When the actors showed negative emotion toward each other, CU traits did not influence expectations of collaboration. **Conclusions:** The findings suggest that CU traits are associated with difficulty in perceiving positive social interactions, which could further contribute to the behavioral and emotional problems common to those with high CU traits. **Keywords:** Callous–unemotional traits; social cognition; eye movement; adolescence.

Introduction

Collaboration is crucial for successful participation in one's social environment. Even from an observer perspective, knowing when others are collaborating can provide information about social networks as well as a general sense of the world as socially supportive. Thus, difficulties in perceiving collaboration could have cascading effects on social development.

What might lead to impaired collaboration perception? One possibility is having elevated levels of callous–unemotional (CU) traits. Children and adolescents with high CU traits are characterized by low empathy, fearfulness, anxiety, and sensitivity to punishment, as well as greater aggressive behavior and risk for serious and persistent criminal behavior (see Frick, Ray, Thornton, & Kahn, 2014 for a review). They tend to endorse social goals related to dominance, revenge, and forced respect over those related to conflict avoidance and relationship building; show reduced concern for victims (Pardini, 2011); believe that aggression is a good way to achieve outcomes (Pardini, Lochman, & Frick, 2003); and are more likely to make selfish rather than altruistic decisions (Sakai, Dalwani, Gelhorn, Mikulich-Gilbertson, & Crowley, 2012).

While the main focus of research on CU traits has been on negative interactions, research examining positive social interactions suggests that CU traits are particularly related to these interactions as well. Most notably, 4- to 8-year olds with high CU traits are more likely to actively reject their mother's eye contact and physical affection, even though mothers themselves do not differ in the affectionate behavior they direct toward them (Dadds et al., 2014). There is also evidence that despite the relatively strong genetic component of CU traits (Frick et al., 2014), experience with positive parenting interactions (Kochanska, Kim, Boldt, & Yoon, 2013; Pardini, Lochman, & Powell, 2007) can lead to decreases in CU traits over time. Finally, CU traits are related to decreased emotional responses to others' happiness when viewing video clips (de Wied, van Boxtel, Matthys, & Meeus, 2012; Fanti, Panayiotou, Lombardo, & Kyranides, 2016). Yet it is not known whether CU traits might negatively affect adolescents' perception and interpretation of positive social interaction in others.

The current study examined whether CU traits in 15- to 16-year olds are related to difficulties in using social cues between others to infer collaboration. We used an adapted version of an eye tracking paradigm that has previously shown that 18-month olds use positive social cues to bind together ambiguous action sequences performed by two people into a collaboration (Fawcett & Gredebäck, 2013, 2014). In those studies, infants saw an action sequence in which an object was moved to one location by a first actor and then the same object was moved to a second location by a second actor. The actions were intentionally ambiguous as to whether the actors were collaborating to move the object to the second location, or whether they each had individual goals about where the object should be. This ambiguity allowed for close control of the perceptual features of

the situation, as well as examination of the subtle social features that might bias the participants' interpretations. In a later test phase, infants showed that they were more likely to expect the actors to have the same, shared goal of placing the object in the final location when the actors were previously socially engaged with each other, compared to when they were not engaged with each other, suggesting that these social cues lead to an interpretation of collaboration. In the current study, we compared positive and negative social engagement between the actors, allowing us to examine whether emotional valence within social interactions affects action binding differently based on observers' CU traits. In the positive situation, we expect CU traits to interfere with perception of the actions as based on a shared goal, making it less likely for those higher on these traits to bind the actions into a collaborative sequence. In the negative situation, we expect all adolescents, regardless of their level of CU traits, to view the actions as individually motivated and refrain from binding the actions into a collaborative sequence. We also controlled for other potentially confounding behavioral traits.

Method
Participants

Ninety-nine adolescents (42 females; age: M = 15 years, 9 months, SD = 6 months) participated in the study. Participants were recruited from a larger longitudinal study. In this longitudinal sample, children were initially recruited either from randomly selected child health clinics (sample A, n = 650) or daycare centers (sample B, n = 217) in Sweden at ages 4–6 (time point 1; Wåhlstedt & Bohlin, 2010; Wåhlstedt, 2009). From these samples, children high on attention deficit hyperactivity disorder (ADHD) symptoms were oversampled. Specifically, 40% of contacted parents

had children who scored in the top 30% for ADHD symptoms and 60% had children who scored in the lower 70%. Given that the population the participants were recruited from was relatively high on parental education and income level, this oversampling helped to increase dimensional variability in other behavioral traits to typical levels for separate follow-up assessments approximately 3, or 2 years respectively after initial assessments (time point 2; sample A, n = 233; sample B, n = 111). Five years later, these participants (n = 344) were contacted to take part in another follow-up, which resulted in a sample of 317 children of ages 12–14 (time point 3). To recruit the current sample, parents of children meeting one of the following four criteria based on aggregated parent and teacher ratings from time point 3 were contacted (n = 159): (a) lowest 40% on both CU traits and oppositional defiant disorder (ODD) symptoms, (b) highest 30% on ODD symptoms and lowest 50% on CU traits, (c) highest 30% on CU traits and lowest 50% on ODD symptoms, or (d) highest 30% on both CU traits and ODD symptoms. Of the 159 parents contacted under these criteria, 70% (n = 112) gave permission for their child to participate and complete data were collected for 99 children [participation rate per criterion: (a) 53 contacted, 38 (72%) gave permission, 32 included; (b) 26 contacted, 19 (73%) gave permission, 17 included; (c) 26 contacted, 19 (73%) gave permission, 18 included; (d) 54 contacted, 36 (67%) gave permission, 32 included]. Reasons for attrition were that the child did not wish to participate (n = 4), the child did not show up for assessment (n = 2), there were technical problems (n = 1), or we were unable to schedule a time with the child's school before summer break (n = 6).

At the current time point, adolescents' levels of callous–unemotional traits and ADHD symptoms were typical for the wider population, as suggested by normative studies. Specifically, ICU scores for 15- to 16-year olds in a normative sample were M = 26.54, SD = 7.4 (Essau, Sasagawa, & Frick, 2006) and in our sample were M = 28.24, SD = 7.98; ADHD symptoms in a normative sample were M = 8.37, SD = 8.35 (DuPaul et al., 1998) and in our sample were M = 7.65, SD = 8.12 (see Table 1 for additional descriptive data). This indicates that the oversampling technique used was successful in recruiting a representative community sample, although the local population from which it was drawn tends to be particularly high on parental education and income level.

Table 1 Behavioral ratings

					Descriptive statistics		Effect of ICU on collaborative prediction score (Positive condition) with rating included	
	M	SD	Range	Cronbach's alpha	r and 95% CI for correlation with ICU (combined)	r and 95% CI for correlation with collaborative prediction score	b and 95% CI	F
ICU (parent)	19.84	9.00	3–44	.86	–	−.26 [−.39, −.12]	–	–
ICU (child)	20.98	6.91	4–41	.76	–	−.08 [−.22, .06]	–	–
ICU (combined)	28.24	7.98	12–48	–	–	−.18 [−.31, −.04]	–	–
ADHD symptoms	7.65	8.12	0–40	.93	.52 [.35, .65]	−.08 [−.21, .06]	−0.03 [−0.07, 0.00]	4.13*
ODD symptoms	3.56	3.60	0–15	.88	.44 [.27, .59]	.00 [−.14, .14]	−0.04 [−0.08, −0.01]	7.77**
BYI anxiety	12.11	7.74	0–37	.89	−.04 [−.24, .16]	.19 [.05, .32]	−0.04 [−0.07, −0.01]	8.10**
BYI depression	12.39	8.84	0–33	.92	.24 [.03, .42]	.17 [.02 .30]	−0.05 [−0.08, −0.02]	8.17**
BYI anger	8.60	7.03	0–34	.89	.25 [.05, .43]	.20 [.06, .33]	−0.05 [−0.08, −0.02]	8.16**
BYI disruptive behavior	4.25	3.82	0–17	.81	.55 [.40, .68]	.01 [−.13, .15]	−0.06 [−0.09, −0.02]	8.02**
BYI self-concept	39.58	10.55	14–58	.94	−.28 [−.45, −.08]	−.01 [−.15, .13]	−0.04 [−0.07, −0.01]	7.82**

ADHD and ODD symptoms were rated by parents. BYI was rated by children. ADHD, attention deficit hyperactivity disorder; BYI, Beck Youth Inventory; CI, confidence interval; ICU, Inventory of Callous and Unemotional Traits; ODD, oppositional defiant disorder.
*p < .05; **p < .01.

Parents received detailed written information about the study and returned a signed consent form if they wanted their child to participate. Participants themselves were asked for their assent on the day of testing and were reminded that participation was voluntary and they were free to ask any questions or stop participating at any time without giving a reason. Participants and their parents each received two movie vouchers (worth approximately 20 euros) for participation in the current study.

Materials

Behavioral rating questionnaires. A series of questionnaires were completed online by parents of the participants at the current time point as part of the original longitudinal study. All questionnaires were presented in Swedish. These included the Inventory of Callous and Unemotional Traits (ICU; Essau et al., 2006); and measures of ADHD and ODD based on the diagnostic criteria from the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM IV; American Psychiatric Association, 1994). Participants themselves completed the Beck Youth Inventories of Emotional and Social Impairment (BYI; Beck, 2001; subscales: anxiety, depression, anger, disruptive behavior, and self-concept) and the ICU. The questionnaires are described in greater detail below and descriptive statistics and internal reliabilities (Cronbach's alpha) for all scales are presented in Table 1.

Attention deficit hyperactivity disorder and ODD symptoms were assessed using a rating scale containing the items for ADHD and ODD as presented in the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM IV; American Psychiatric Association, 1994). This measure has been well validated and is frequently used in ADHD research (e.g. DuPaul, Power, Anastopoulos, and Reid, 1998). Eighteen items assessed ADHD (nine for symptoms of inattention and nine for symptoms of hyperactivity/impulsivity), and eight items assessed ODD symptoms. Each item was rated on a 4-point scale ranging from 0 ('never or rarely') to 3 ('very often').

Callous–unemotional traits were assessed with the ICU (Essau et al., 2006): a parent-, teacher-, and self-report scale that includes 12 positively and 12 negatively worded items that are rated on a 4-point Likert scale ranging from 0 ('not at all') to 3 ('definitely true'). Previous research has verified the validity of the ICU in community and clinical samples of youth (Frick et al., 2014). In the current sample, parents' and children's ICU ratings were correlated ($r = .294$, $p = .004$, 95% confidence interval (CI) [0.094, 0.472]) and we created a combined ICU measure by taking the higher score on each item given by either the parent or child to account for possible underreporting of behaviors and symptoms (Piacentini, Cohen, & Cohen, 1992).

The BYI measures emotional and social difficulties in children and adolescents (Beck, 2001). This self-report questionnaire includes five scales for assessment of the individual's experience of anxiety, depression, anger, disruptive behavior, and self-concept. Each scale contains 20 statements that are rated on a 4-point scale ranging from 0 ('never') to 3 ('always'). Satisfactory internal and discriminant validity has been shown (Bose-Deakins & Floyd, 2004).

Action binding stimuli. For each condition, participants viewed a sequence of video scenes that lasted approximately 3 min altogether. All speech was in Swedish, though English translations are presented here.

The context (14 s) began with two adult female actors sitting next to each other at a table. In front of them were three novel location-objects of different colors. The actors then turned toward each other and either smiled (Positive condition) or made an angry expression with a frown and furrowed brows (Negative condition) and each said a short statement (i.e. 'I'm going to play with blocks today' and 'I like to play with blocks')

with their tone of voice matching the emotions they portrayed, before turning to face forward again with a neutral expression (see Figure 1A).

Participants viewed four repetitions of the Familiarization (28 s each; Figure 1B). To begin, the two actors briefly turned toward each other and smiled (Positive condition) or frowned (Negative condition). Then, the actor on the right (Actor 1) took a large yellow block from below the table and held it in her hands, equidistant from the Right and Center location-objects. She counted to three aloud and then placed it on the Center location-object. At the base of the Center location-object, a visual cue (spinning light) as well as an audible cue (chime) occurred exactly 3 s after she finished counting. Next, the actor on the left (Actor 2), placed her hand on the same yellow block, counted to three aloud and then moved it to the Left location-object. Again, a chime was heard and a spinning light was seen on the base of the object holding the block 3 s after Actor 2 finished counting. Thus, the actions themselves were ambiguous as to whether Actor 1 was collaborating with Actor 2 to move the block to the Left location-object, or whether Actor 1 had an individual goal to place the block on the Center location-object.

The Exit (12 s) showed Actor 2 standing up and leaving the scene, followed by Actor 1 taking her place between the Left and Center Location-objects.

Participants viewed two repetitions of the Test (19 s each; Figure 1C). Actor 1 took a block out from beneath the table and held it equidistant from the Center and Left location-objects and said, 'I found another block; I wonder where I should put it'. An opaque screen then appeared covering her head, arms, and the tops of all three location-objects so that it would not be possible to see where she placed the block. She counted to three aloud and then the chime was heard 3 s later, as in the Familiarization, serving as a cue that the block had been placed. Notably, no light was seen so that it was not apparent where the block had been placed. Gaze to the Center location-object indicates anticipation of an individual goal, as that is where Actor 1 previously placed blocks, while gaze to the Left location-object indicates anticipation of a collaborative goal as Actors 1 and 2 worked together to get the block to that location in the Familiarization.

Procedure

The Action Binding tasks were presented as one part of a larger battery of 11 tasks measuring various cognitive and social skills. Participants were tested individually in a quiet room at their school and completed questionnaires throughout the procedure to decrease boredom by changing task types frequently. However, the ICU was always completed after the Action Binding task (or a week before in two cases) to ensure that there were no priming effects. The two within-subject conditions (Positive and Negative) were presented as the first and ninth tasks, order counterbalanced across participants. The entire procedure took approximately 1 hr and 20 min and was approved by the local ethical board.

For the Action Binding task, participants sat approximately 50 cm away from a Tobii T120 eye tracker. A 9-point calibration was completed before participants viewed the video sequence for each condition. Participants were instructed that they needed only to watch the video and see what happens.

Data reduction and statistical analyses

Eye tracking data were processed in the open source program TimeStudio version 3.03 (timestudioproject.com; Nyström, Falck-Ytter, & Gredebäck, 2016; the analysis tools and settings used in this study, including source code, can be downloaded through uwid: ts-491-644 inside the TimeStudio environment). Areas of interest were created around the Left and Center location-objects (see Figure 1C) and the duration of gaze to these areas was summed for 3 s between when the
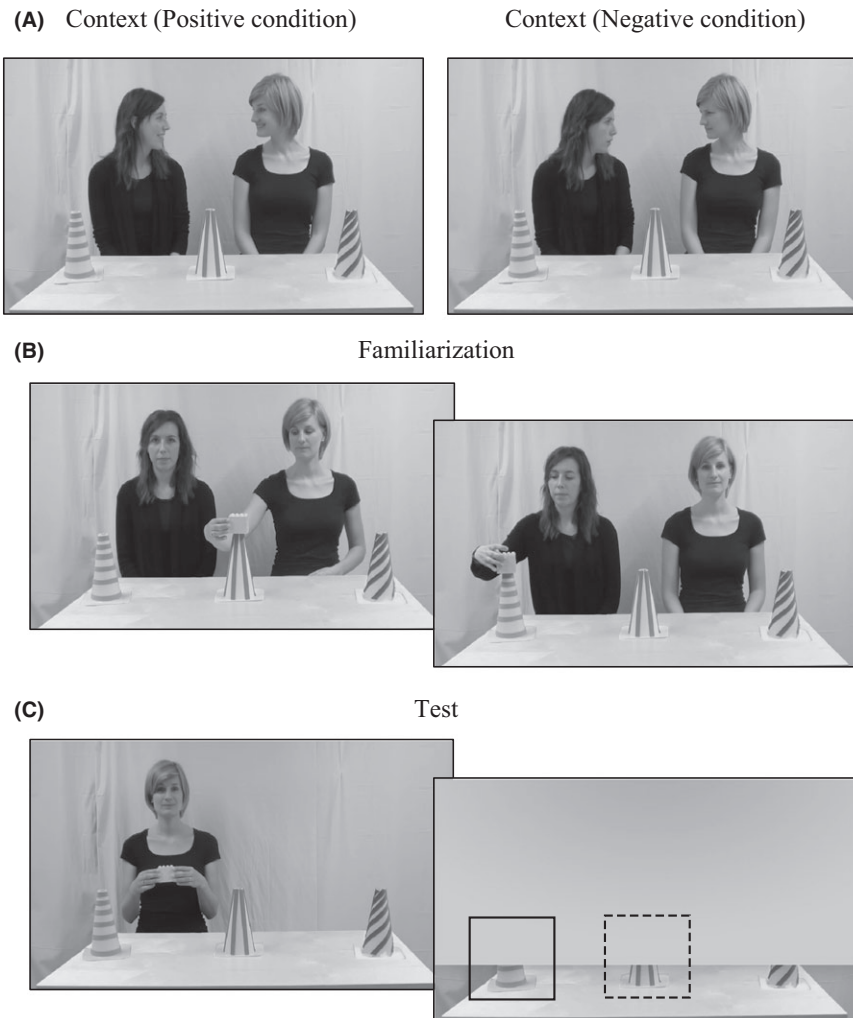
Figure 1 (A) Context: actors first turned toward each other and expressed positive (left) or negative (right) emotion. (B) Familiarization: then they moved the block to the Center, and then Left location-objects. (C) Test: finally, Actor 1 was in the other seat and held the final block, but an opaque screen appeared so that participants could not see where it was placed. Areas of interest for the Left (collaborative goal, solid line) and Center (individual goal, dashed line) are indicated

actor finished counting and when the chime was heard. A difference score was then calculated by subtracting gaze to the Center location-object from gaze to the Left location-object. Higher difference scores thus indicate greater expectation of the block being placed in the location associated with the collaborative goal (Left) rather than the individual goal (Center). These collaborative prediction scores were analyzed using linear mixed-effects models in R (version 3.1.1, R Development Core Team, 2014) with the package lme4 (version 1.1-7, Bates, Maechler, Bolker, & Walker, 2014). We examined the relation between collaborative prediction scores and CU traits across the Positive and Negative social contexts using the fixed effect factors of Condition (Positive or Negative), ICU score, and the interaction between them, as well as random effects for participant and trial number (first or second test trial). Random effects are beneficial for taking into account the individual variability of participants or across trials to strengthen analyses (Baayen, Davidson, & Bates, 2008). Following the main analyses, additional regression analyses controlled the effects of other adolescent traits on the relation between ICU and collaboration prediction scores.

Results

Preliminary analyses on the order of presentation of the two conditions and sex of participant revealed no effects on collaborative prediction scores or interactions between scores and condition, so these variables were not included in further analyses. In addition, total durations of looking at the Context, Familiarization, and Test were not related to ICU score or the interaction between ICU score and condition. Finally, proportion of gaze to the actor versus the rest of the scene in the Test was not related to ICU score. Thus, overall attention to the task was comparable.

Correlations between collaborative prediction scores and the behavioral traits are displayed in Table 1. At the group level, collaborative prediction scores (the difference in gaze between the Left and Center location-objects; $M = -.410$, $SD = 1.110$) revealed an overall expectation that the block would be placed in the center, as indicated by a preliminary regression model with no fixed effect predictors, which had an intercept significantly below zero ($b = -0.46$, $SE = 0.11$, 95% CI [-0.81, -0.12], $F(1, 388) = 16.17$, $p = .019$). The main analyses address how those expectations varied based on condition and CU traits.
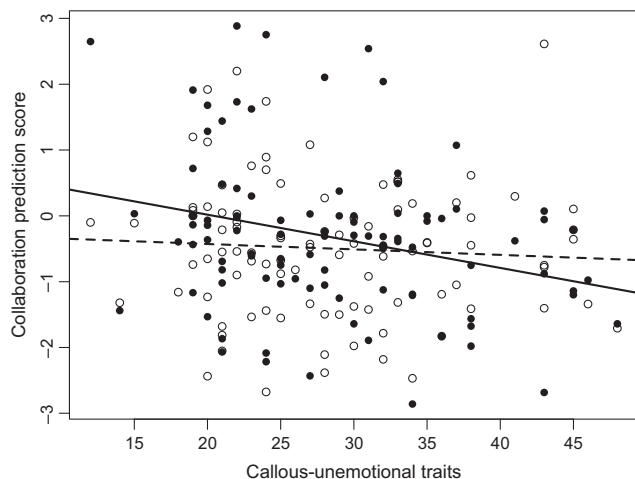
Figure 2 Relations between callous–unemotional traits and collaboration prediction scores for the Positive (filled circles, solid line) and Negative (open circles, dashed line) conditions. Only in the Positive condition was the relation significant

The initial regression model examining collaborative prediction scores revealed a significant effect of condition with overall higher scores in the Positive condition ($b = 1.12$, $SE = 0.46$, 95% CI [0.21, 2.03], $F(1, 388) = 5.84$, $p = .016$) and an interaction between condition and ICU score ($b = -0.03$, $SE = 0.02$, 95% CI [-0.06, 0.00], $F(1, 388) = 4.39$, $p = .040$). Data were then split to analyze the effect of ICU score in each condition. In the Positive condition, there was an effect of ICU score on collaborative prediction score ($b = -0.04$, $SE = 0.01$, 95% CI [-0.07, -0.01], $F(1, 189) = 7.75$, $p = .006$), revealing that adolescents with higher levels of CU traits were less likely to make collaborative goal predictions than those lower on CU traits when actors displayed positive emotions to each other. In the Negative condition, there was no effect of ICU score on collaborative prediction score ($b = 0.01$, $SE = 0.01$, 95% CI [-0.02, 0.03], $F(1, 196) = 0.38$, $p = .536$), suggesting that predictions of collaborative goals did not differ based on CU traits when actors were negative toward each other (see Figure 2).

Further analyses examined whether the CU effect in the Positive condition could be explained by other possibly related, confounding behavioral ratings. To do so, we used mixed-effect regression models with fixed effects for ICU and the tested behavioral rating, as well as random effects for participant and trial. In every case, ICU retained predictive value for the gaze difference scores over and above any other effects (see Table 1).

Discussion

Adolescents with elevated CU traits demonstrated a decreased tendency to bind individual actions into a collaborative sequence. This effect was apparent while observing a social interaction in which the actors were happily engaged with each other and carrying out an action sequence that was ambiguous as to whether the actions were collaborative or not.

Being less likely to perceive collaboration as such and being biased toward interpreting social interactions as individually motivated actions could potentially underlie many of the core expressions of high CU traits, such as hostility and low empathy. In contrast, adolescents high on CU traits did not differ from their peers when interpreting a negatively toned situation in which collaboration would not be expected. Here, interpreting the actions as individually motivated was equally likely for those higher and lower on CU traits.

The current findings could not be explained by other potentially related behavioral traits, such as ADHD or ODD. This shows that it is specifically CU traits that impair interpretations of others as interacting in a positive, collaborative way and further suggests that individuals with high CU traits may have difficulty perceiving and engaging in positive social interactions more generally.

This study is the first to examine how CU traits relate to perceptions of positive social interactions from an observer perspective and has the potential to inform the cognitive processes underlying the behavioral problems associated with high CU traits. Previous work showed that increased likelihood of perceiving hostile intent in others does not seem to underlie the increased aggression in those with CU traits (Stickle, Kirkpatrick, & Brush, 2009); however, our results suggest that it is possible that an inability to perceive *positive* intent in others could contribute to the social problems associated with CU traits.

A strength of our study is that it was based on a community sample. Previous studies examining CU traits have mainly been based on individuals who had already been identified as having problematic behavior or were adjudicated (e.g. Pardini, Lochman, & Frick, 2003; Stickle et al., 2009). Community samples are particularly important to show that the effects of CU traits can be seen even in diverse populations. That is, even in samples with high levels of parental education and typical school environments, these traits influence social skills.

A possible limitation is that the action binding paradigm was originally designed for young children and may have appeared odd to adolescents. However, we did make efforts to alter the paradigm, for example by decreasing the number of Familiarization and Test trials. More importantly, the fact that effects were found demonstrates that the paradigm was successful and that even in a somewhat unnatural situation, an implicit sense that people are acting together or not is enough to bias expectations about goals. Relatedly, we did not examine adolescents' explicit judgments of the actors' collaboration, but rather relied on their implicit reactions as revealed by gaze patterns as they potentially reflect true judgments without biases based on self-presentation or experimenter effects and are likely more relevant for assessing how individuals deal with ongoing real-world interactions. Moreover, the practice of examining cognitive

processes in both infant and adult age groups using the same implicit measures is common in developmental psychology for both low-level action prediction (e.g. Gredebäck & Falck-Ytter, 2015) and higher level social cognition (e.g. Senju, Southgate, White, & Frith, 2009).

A second possible limitation is that we cannot be certain that participants judged Actor 1's goal as cooperation with Actor 2, even if they did expect her to place the block on the left. That is, it is possible that the actors had the same goal, without that goal being shared. Still, showing CU traits modulate the ability to interpret actors' positive interactions as an indicator of similarity in goals is evidence that social understanding is affected by CU traits, particularly when positive emotions are displayed.

The current study is the first to show an impairment in the perception of positive social interactions related to CU traits. The decreased tendency to bind action sequences together into collaborations suggests that those high on CU traits perceive their social environment as less of a network, and potentially reinforces their perception that people must look out for themselves, rather than building relationships and being open to support from their family or peers.

Acknowledgements

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Key points

- CU traits are associated with low empathy, greater risk for serious criminal behavior, and endorsement of negative social goals such as dominance and aggression. However, little is known about how CU traits relate to perception of others' positive interactions.
- The current study used eye tracking to examine adolescents' perception of others' goals in an ambiguous action sequence based on the actors' positive or negative emotions.
- Higher levels of CU traits were related to decreased likelihood of interpreting that others were collaborating when they showed positive emotion. No differences were found when the actors displayed negative emotion.
- Being less likely to perceive others as collaborating could further contribute to the behavioral problems associated with CU traits.

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