Callous-unemotional traits and pubertal development: Sex-specific effects on disruptive behavior in children at ages 11 and 12

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ABSTRACT

Purpose: This study aims to explore the effects of callous-unemotional (CU) traits on disruptive behavior during the ages of 11 and 12 while considering main and moderating influences associated with pubertal development (PD), distinguishing outcomes by sex.
Methods: This longitudinal study of a Spanish community sample explores children at ages 11 (n = 447, M = 11.6, SD = 0.3) and 12 (n = 360, M = 12.8, SD = 0.3). Separate linear regression models were estimated according to age and sex and for each analyzed outcome of disruptive behavior.
Results: Significant interactions between CU traits and PD in boys at age 11, and in girls at age 12, on disruptive behavior were found. Specifically, the odds of disruptive behavior increased with higher CU scores only in boys with medium or high PD and in girls with low or medium PD. CU traits were directly associated with higher externalizing problem scores reported by teachers, regardless of PD level for both boys and girls.
Conclusions: There are sex-specific patterns in the relationship between CU traits, PD, and disruptive behavior in children aged 11 and 12. CU traits and PD should be considered when assessing and treating disruptive behavior in clinical practice.

1. Introduction

Callous-Unemotional (CU) traits are marked by social and emotional difficulties that consist of the absence of guilt or remorse, absence of empathy, lack of interest in academic or professional performance, and superficial or inadequate emotions (Frick, Ray, Thornton, & Kahn, 2014a). In children and adolescents, CU traits are frequently regarded as the affective aspect of adult psychopathy (Salekin, 2016). These traits share key characteristics such as low emotional sensitivity, poor recognition of emotions, deficits in positive social behavior, and boldness with psychopathic traits (Waller & Hyde, 2018).

Most studies on child and adolescent CU trait prevalence have not treated CU traits as a stand-alone concept but in combination with conduct disorder (CD) (Colins, Andershed, Salekin, & Fanti, 2018). Herpers, Rommelse, Bons, Buitelaar, and Scheepers (2012) reviewed epidemiologic studies on CU traits and only found five studies based on community samples that analyzed CU traits separately from CD. Among

these studies, the prevalence of only CU traits accounted for 3–11% among children and adolescents (ages 5–18). Colins et al. (2018) found that the prevalence of only CU traits in a community sample of children (ages 7–12) was around 10%. In a clinical sample (ages 5–18), up to 50% of children with CD also met the CU trait criteria, while children with only CU traits made up to 30% (Kahn, Frick, Youngstrom, Findling, & Youngstrom, 2012).

Consistent research findings indicate that children and adolescents exhibiting CU traits are more prone to involvement in delinquent and aggressive behaviors, indicating the presence of more severe behavioral issues and an increased likelihood of participating in criminal activities (Frick et al., 2014a). Moreover, poor treatment outcomes are also linked to CU traits and more stable paths of antisocial conduct (Frick & Wall Myers, 2018). As a result, the Diagnostic and Statistical Manual of Mental Disorders, (DSM-5) (American Psychiatric Association, 2013) has included CU traits as a "Limited Prosocial Emotions" specifier for conduct disorder (CD), and the International Classification of Diseases,

11th revision (ICD-11) (World Health Organization, 2018), has embraced this specifier for the analysis of conduct-dissocial disorder and oppositional defiant disorder (ODD).

But, at which point in childhood do CU traits develop? Different longitudinal studies have followed children and adolescents between 8 and 15 years and have found that there seem to exist four distinct developmental trajectories of CU traits from childhood to adolescence: an early childhood onset CU traits group, which shows high stable CU traits along early childhood and adolescence; an adolescent onset CU traits group, which shows increasing CU traits along adolescence; a decreasing CU traits group in which young children scored high on CU traits, but these decreased over adolescence; and a low, stable CU trait group (Fanti, Andershed, Colins, & Sikki, 2017; Fontaine, Rijsdijk, McCrory, & Viding, 2010; Klingzell et al., 2016). Although previous studies have found that the early childhood onset group is more severely affected in comparison to the other three groups (Fanti, Andershed, Colins, & Sikki, 2017). Docherty, Beardslee, Byrd, Yand and Pardini (2019) found that the adolescent-onset increasing group demonstrates similar outcomes to the early onset high stable group in terms of psychopathic traits and antisocial behavior in adulthood. Nevertheless, the authors suggest that exhibiting CU traits at any time during childhood and adolescence may lead to problematic outcomes, although the underlying mechanisms may differ for each trajectory.

These cited studies on CU traits apply the concept of adolescence according to age, using the range age of 9–18 as adolescence. Nevertheless, the phase of adolescence has transformed over the course of the last century, with puberty starting earlier nowadays than in comparison to 50 years ago. Plus, our conceptualization of life-long learning and growing has led to lifting the endpoint of adolescence around the mid-20s. Therefore, a more comprehensive approach to adolescence would consider that it reaches from 10 to 24 years of age (Sawyer, Azzopardi, Wickremarathne, & Patton, 2018).

In this context, adolescence-onset CU traits are of particular interest due to the sensitivity of this developmental phase. Adolescence is a period marked by significant hormonal changes that lead to not only physical but also emotional transformations (Mendle, 2014). It is during this time that the highest scores on CU traits are often observed (Kemp et al., 2021; Ueno, Ackermann, Freitag, & Schwenck, 2021). For example, normative data show that for the teacher-report Inventory of Callous Unemotional Traits version (ICU), adolescents between 11 and 14 years score higher in the ICU than children aged 6 to 10 years (Ueno et al., 2021). These results may suggest that when children reach puberty, CU scores might be higher due to compatibility with certain adolescent behaviors (such as rule-breaking, risk-taking, defiant behavior, shallow emotional display, etc.).

Puberty is characterized by the observation of secondary sexual characteristics changes in boys and girls. The Tanner Staging system, introduced by Tanner in 1986, is employed to document the timing and sequence of these changes. The staging criteria include breast development in females, genital changes in males, and pubic hair development in both sexes. Tanner Stage 1 defines prepubertal status, while Stage 2 marks the onset of puberty with the initial production of gonadal hormones. Progressing through Stages 3 and 4 signifies further development of secondary sex characteristics, and Stage 5 indicates the completion of the pubertal maturation process. Experiencing early puberty has been linked to rule-breaking behavior, more aggressive and delinquent behavior (Najman et al., 2009), and general externalizing behavior (Dimler & Natsuaki, 2015). The effect of puberty on externalizing behavior may vary by sex. For example, a study suggests that early pubertal timing predicts earlier age of sexual intercourse in both sexes, increased substance use in girls, and increased conduct disorder symptoms in boys (Beltz, Corley, Wadsworth, DiLalla, & Berenbaum, 2020). Moreover, these authors suggest that early puberty is more strongly associated with externalizing problems in girls than in boys. However, early puberty in boys can be considered a significant risk factor for experiencing externalizing symptoms such as attention deficit

disorder, conduct issues, aggression, delinquency, and risk-taking behavior (Ge & Natsuaki, 2009; Lynne, Graber, Nichols, Brooks-Gunn, & Botvin, 2007).

Concerning girls, previous research has dealt with the relationship between early PD and its impact on antisocial behavior in girls. Girls with early PD report higher criminality rates, substance use problems, social isolation, early sexual behavior, or psychiatric problems in comparison to girls with on-time PD (Copeland et al., 2010). Girls with early PD are more prone to report engaging in risky behaviors such as smoking cigarettes, consuming alcohol, using marijuana, displaying disorderly conduct, selling drugs, being involved in gang membership, participating in group fights, and having engaged in violent actions such as shooting or stabbing someone. This contrasts with girls reporting average pubertal development who are less likely to engage in such behaviors (Haynie, 2003). Moreover, early age at menarche is not only significantly associated with antisocial behaviors during adolescence, but also during young adulthood (Mendle, Ryan, & McKone, 2018).

In their meta-analysis, Javdani, Sadeh, & Verona (2011) suggest a conceptual framework to better understand how early PD in girls acts as a risk factor for antisocial behavior. According to these authors, biological (genes, hormones) and environmental factors (negative life events, poverty, and economic problems) contribute to early puberty. These risky genes and family environments are also risk factors for antisocial behavior. Girls with early puberty may find themselves in disadvantaged environments in which they might also have to face gendered experiences, such as a higher expectation of their responsibility and autonomy, or more pressure to act more mature than they are prepared for. In this context, girls might get involved with delinquency or engage in risky behaviors. For the authors, gender becomes salient during puberty, because in this phase gendered roles and norms become evident. Therefore, they consider that early puberty, together with environmental risk factors, can lead to encountering environments that emphasize gender-related factors, thereby fostering tendencies toward antisocial behavior.

Curiously, there is a dearth of scholarly investigations regarding CU traits during adolescence that explore the relationship between the biological concept of pubertal development or pubertal timing and CU traits (Centifanti et al., 2018). Understanding how pubertal development might shape behavior, especially when combined with CU traits, provides insights into the complexities of adolescent psychosocial development. Thus, the socioemotional difficulties that emerge during adolescence might have long-term impacts on internalizing and externalizing behaviors (Mendle et al., 2018). Therefore, investigating the interplay between pubertal development and CU traits helps to identify potential risk factors. One of the few specific studies on CU traits and puberty analyzed a female sample of adolescents and concluded that CU traits were not associated with early but with later pubertal timing (Centifanti et al., 2018). These authors suggest that late-maturing female adolescents may experience feelings of social incompetence, isolation, and low self-esteem, which can contribute to the development of CU traits as a means of coping with negative emotions and seeking social status. They also consider that late-maturing adolescent girls may also be more vulnerable to peer pressure and involvement in deviant behaviors, which could further exacerbate CU traits.

Overall, the theoretical perspectives on the link between pubertal timing and mental health suggest that pubertal maturation and timing may have significant implications for socio-emotional development and behavioral outcomes in adolescence. Even though there is evidence for an adolescence-onset CU trait trajectory (Docherty et al., 2019), it is unclear how CU traits interact with pubertal development (PD) to affect disruptive behavior, especially because there is only one previous study that explored CU and pubertal development (Centifanti et al., 2018). Interestingly, in this study, girls with delayed menarche compared to girls with early or normotypical menarche timing showed higher CU traits but the association vanished when other signs of pubertal development were included. Similarly, a study that controlled for pubertal

status among male and female adolescents at age 14 showed that there were no differences in pubertal status between youth with CD and high CU traits, in comparison to youth with CD and low CU traits or typically developing adolescents (Pauli et al., 2021).

Therefore, the present study aimed to expand the literature on CU traits and puberty by investigating, separately by sex and at ages 11 and 12, if the effect of CU traits on disruptive behavior is moderated by the level of PD, or contrarily, it is a direct effect. Understanding the relationship between CU traits, PD and externalizing behavior may be important for identifying individuals at risk for negative outcomes and developing effective interventions to address these risks.

This study focused on girls and boys at ages 11 and 12, as it is the average onset age at which first signs of puberty emerge (Rosenfield, Lipton, & Drum, 2009). According to these authors, in boys, testicular enlargement occurs around 11.5 years, followed by sperm production at approximately 13.5 years. In females, breastbudding occurs at a mean age of 10.2 years. Menarche, the onset of menstruation, follows with an average onset age of 12.4 years (Lacroix, Gondal, Shumway, & Langaker, 2023). To detect possible changes in these initial stages of puberty, ages 11 and 12 were analyzed separately.

Following Centifanti, et al.'s results (Centifanti et al., 2018) that girls with high CU traits showed later pubertal timing, we hypothesized that CU traits and low pubertal development at age 12 in girls would be associated with disruptive behavior. Following more general research on pubertal timing and externalizing behavior (Dimler & Natsuaki, 2015), we hypothesized CU traits and high pubertal development in boys at age 11 would be associated with disruptive behavior.

2. Method

2.1. Participants

The sample comes from a longitudinal study of behavioral problems starting at the age of 3. As Fig. 1 shows, a double-phase sampling design was employed. The first phase started with a random sample of 2283 children selected from the census of early childhood schools in Barcelona. From these, 1341 families (58.7%) agreed to participate (50.9% boys; 33.6% high socioeconomic status (SES), 43.1% middle-high/middle SES, and 23.3% middle-low/low SES). In the second phase of the sampling, a parent-rating questionnaire of Oppositional Defiant Disorder (ODD) symptoms (8 items) based on the four items of the conduct problems (temper tantrums, disobedient, spiteful, and argumentative) scale of the Strengths and Difficulties Questionnaire (SDQ) plus four additional ODD items (annoys, blames, touchy and angry) to complete the Diagnostic and Statistical Manual of Mental Disorders (4th Edition; DSM-IV) description, was used to screen children with possible psychological problems. Two groups were considered: screen positive, comprising all children with SDQ $\geq$ 4 on the conduct problems scale (cut-off corresponding to Percentile 90 in community samples, considered the "abnormal band" scores) or with a response option of two ("certainly true") in any of the eight DSM-IV parent's self-reported oppositional defiant symptoms (n = 417; 49.0% boys); and screen negative, comprising a randomly selected 28% who did not fulfill the previous conditions (n = 205; 51.2% boys). Exclusion criteria were showing autism spectrum disorder or intellectual disability, planning to live abroad the next year, and limited understanding of the Spanish language. The number of children in the screening-positive group was higher than those from the screening-negative group to increase the number of participants with potential psychological problems, as it is known that the occurrence of psychological problems in a community sample is low.

The follow-up study, consisting of a yearly evaluation from the age of 3 to 14 years old (12 assessment points), started with a sample of 622 children (91.1% Caucasian). The data used in this study were collected when children were 11 (n = 447) and 12 years old (n = 360). There were no differences in sex (p = .630) due to attrition, although the available
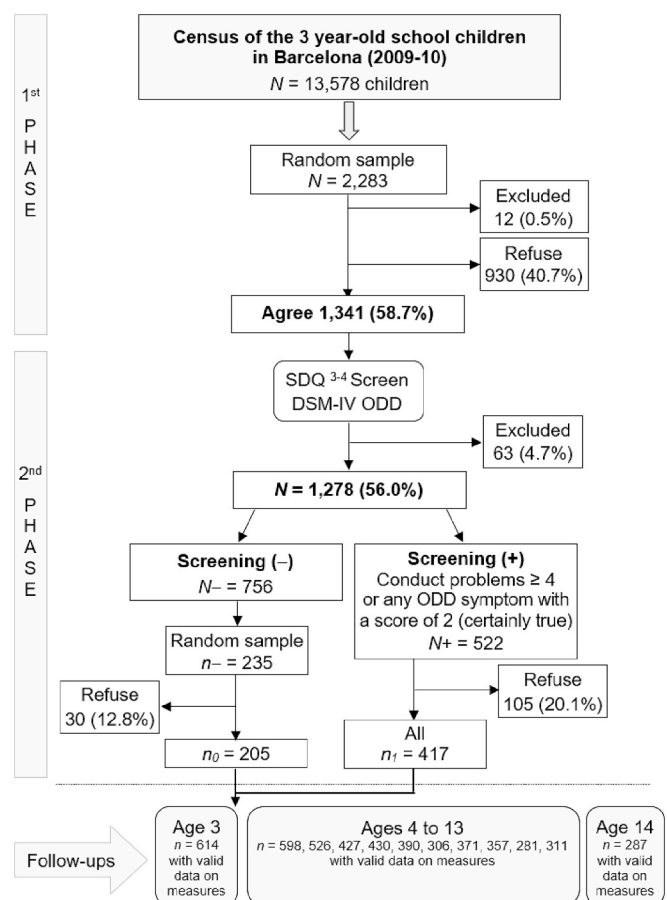

Fig. 1. Two-Phase Sampling Design and Study Follow-ups.
SDQ: Strengths and Difficulties Questionnaire; ODD: Oppositional Defiant Disorder from Diagnostic Interview for Children and Adolescents.

sample at the analyzed ages had a higher SES (p < .001) than the initial sample at age 3. Table 1 shows the descriptive of the sample at ages 11 and 12 separately by sex. There were significant differences between sexes at both ages with boys showing higher scores on callous-unemotional and externalizing problems reported by teachers, and lower scores on pubertal development.

2.2. Measures

The *Inventory of Callous-Unemotional Traits* (ICU; Frick, 2004) includes 24 items with a 4-point Likert-type scale from 0 (*not at all true)* to 3 (*definitely true*). This study incorporated responses from individuals aged 11 and 12. The items are distributed in 3 scales (callousness, uncaring, and unemotional) and the sum of all the items forms the total score. Higher scores indicate greater CU traits. Only the total score was used and demonstrated good internal consistency (Cronbach's α in the present sample ranged from 0.88 to 0.93 over time). Because callousness is mostly observed in social interactions, teachers, who have frequent opportunities to observe them, were the informants of these traits annually.

The *Strengths and Difficulties Questionnaire* (SDQ) (Goodman, 1997) is a brief screening questionnaire for the mental health of children based on five scales (emotional symptoms, conduct problems, hyperactivity/inattention, peer relationships problems, prosocial behavior) of five items each (0: *not true* to 2: *certainly true*). Parents and teachers completed the questionnaire annually, but for this study, only the data of 11- and 12-year-olds was used. Peer problems original scale and externalizing problems (conduct plus hyperactivity problems scales; Goodman, 1997) were analyzed. Ordinal alpha for peer problems was

Table 1
Sample description by sex and age

	Age 11				Age 12			
	All (*N* = 447)	Girls (*N* = 229)	Boys (*N* = 218)	Girls vs Boys	All (*N* = 360)	Girls (*N* = 187)	Boys (*N* = 173)	Girls vs Boys
	N (%)	*N (%)*	*N (%)*	*p*	*N (%)*	*N (%)*	*N (%)*	*p*
SES								
High	152 (34.0)	77 (33.6)	75 (34.4)	0.898	124 (34.4)	66 (35.3)	58 (33.5)	0.110
Medium + Medium/High	223 (49.9)	117 (51.1)	106 (48.6)		189 (52.5)	91 (48.7)	98 (56.6)	
Low + Medium/Low	72 (16.1)	35 (15.3)	37 (17.0)		47 (13.1)	30 (16.0)	17 (9.9)	
School type								
Public	296 (66.2)	154 (67.4)	142 (64.9)	0.637	228 (63.3)	125 (67.2)	103 (59.5)	0.121
Private + Semiprivate	151 (33.8)	75 (32.6)	76 (35.1)		132 (36.6)	62 (32.8)	70 (40.5)	
ODD DSM-5 diagnosis								0.254
Present	36 (8.1)	16 (7.0)	20 (9.1)	0.385	30 (8.3)	19 (10.2)	11 (6.4)	
	M (SD)	*M (SD)*	*M (SD)*	*p*	*M (SD)*	*M (SD)*	*M (SD)*	*p*
Age	11.6 (0.3)	11.6 (0.3)	11.6 (0.3)	0.682	12.8 (0.3)	12.8 (0.3)	12.8 (0.3)	0.798
ICU (0–72)	**19.5 (10.7)**	**17.3 (9.8)**	**21.8 (11.2)**	**<0.001**	**20.7 (10.6)**	**18.6 (10.0)**	**22.9 (10.9)**	**<0.001**
Pubertal Development (1–4)	**1.8 (0.4)**	**2.0 (0.4)**	**1.6 (0.3)**	**<0.001**	**2.2 (0.6)**	**2.5 (0.6)**	**1.8 (0.4)**	**<0.001**
SDQ Peer Teacher (0–10)	1.1 (1.6)	1.1 (1.7)	1.2 (1.6)	0.623	1.3 (1.7)	1.2 (1.6)	1.3 (1.8)	0.629
SDQ Ext. Teacher (0–20)	**3.6 (3.9)**	**2.8 (3.4)**	**4.5 (4.2)**	**<0.001**	**3.6 (3.8)**	**2.7 (3.2)**	**4.5 (4.1)**	**<0.001**
SDQ Peer Parents (0–10)	0.7 (1.3)	0.8 (1.3)	0.7 (1.4)	0.681	0.8 (1.3)	0.9 (1.4)	0.7 (1.3)	0.174
SDQ Ext.Parents (0–20)	3.5 (2.9)	3.1 (2.8)	3.9 (3.0)	0.003	3.2 (2.9)	2.9 (2.8)	3.4 (3.0)	0.197

Bold: significant differences between sex; SES: Socioeconomic Status; ODD: Oppositional Defiant Disorder from Diagnostic Interview for Children and Adolescents; ICU: Inventory of Callous unemotional; SDQ: Strengths and Difficulties Questionnaire; SDQ Ext.: SDQ Externalizing.

0.82 and 0.83 at ages 11 and 12, respectively, and for externalizing problems, it was 0.88 and 0.94.

The *Diagnostic Interview for Children and Adolescents for Parents of Preschool and Young Children* (DICA-PPYC) is a semi-structured diagnostic interview for assessing DSM-5 psychological disorders. It was answered by the parents when the children were 11 and 12 years old. The diagnosis of ODD was used for this study.

The *Self-Rating Scale for Pubertal Development* (Petersen, Crockett, Richards, & Boxer, 1988) is a self-report measure of pubertal status. It comprises five items describing the degree of each pubertal change: Items 1 to 3 are common to both sexes (growth in height, pubic hair, and skin changes) whereas items 4 and 5 are differentiated for boys and girls (hair growth and voice change in boys; breast development and menarche in girls). Each item is rated on a 4-point Likert scale from 1 to 4 (not yet started (1 point)); barely started (2 points); definitely started (3 points); seems complete (4 points); I don't know (missing), except for the menarche item in the girl's version (scored 1 or 4: yes (4 points)) and no (1 point)). A global score from 1 to 4 is calculated separately for boys and girls as the mean of the five items.

2.3. Procedure

This project was approved by the Ethics Committee on Animal and Human Experimentation of the author's institution and follows the ethical standards of the 1964 Declaration of Helsinki and its later amendments. Families were recruited from schools and those who met screening criteria and gave their consent to participate in the study were assessed by teachers annually.

2.4. Data analysis

The statistical analysis was conducted with Stata 17. As the sampling design was two-stage, to restore the population characteristics all the analyses were weighted by the inverse probability of selection in the second phase of sampling.

Bivariate comparison for categorical measures was done with Pearson chi-square or Fisher's exact test when some expected frequency was <5 and with *t*-test or analysis of variance (ANOVA) for continuous measures. In case of a significant result in the ANOVA, post-hoc comparisons were done using Sidak's approach.

To achieve the main objective, separate linear regression models were estimated for boys and girls at ages 11 and 12, and each analyzed outcome (ODD DSM-5 diagnosis, SDQ Peer, and SDQ Externalizing informed by teachers and parents). To determine if the effect of CU was moderated by PD its interaction was included in regression models. When CU × PD interaction was not statistically significant the interaction term was removed but PD was kept as an adjustment term, and the main effect of CU on the disruptive behavior was calculated. In the presence of a significant CU × PD interaction, the effect of CU on the disruptive behavior was estimated for percentiles 5 (low value), 50 (medium value), and 95 (high value) of PD. Regression models were adjusted by socioeconomic status, ethnicity, and pubertal development (the last when analyzing main effects).

3. Results

Table 2 shows the comparison of the primary variables of interest between groups of SES. As a different pubertal development between sexes was expected, for this measure the comparison was done for all the sample and separately by sex. Statistically significant higher scores for higher SES were obtained in ICU, pubertal development in boys, and SDQ-Externalizing problems reported by teachers at age 11. Table 3 shows the same comparison of primary variables of interest between school types. Only a higher score for private/semiprivate schools on SDQ-Peer problems reported by teachers at age 11 was established. Given the overlap of information between SES and school type, only the former was included as an adjustment term in posterior regression models. Including school type in models that already contain SES causes minor changes in the estimated regression coefficients.

The zero-order correlation between primary measures of interest is shown in Table 4. Values below/above the main diagonal belong to ages 11 and 12 respectively. Results for both ages were similar. The highest association was found between ICU and SDQ problems, both externalizing and peer, reported by teachers. High correlation values were also obtained between parents and teachers when reporting the same type of problems. Table 5 shows the main and moderated PD effects of CU on disruptive behavior at age 11 separately by sex. At age 11 significant interactions between CU and PD were found only in boys and for ODD diagnosis (*p* = .016), SDQ externalizing reported by teachers (*p* < .001), and SDQ peer reported by parents (*p* = .031). For a boy with low or medium PD, the odds of an ODD diagnosis did not statistically change when CU increased (*OR* = 0.98, *p* = .982 for low PD; *OR* = 1.04, *p* = .100 for medium PD). Inversely, a one-point increase in CU score in boys with high PD significantly increased the odds of an ODD diagnosis by *OR* =

Table 2

Comparison of primary measures between SES groups separately by age

		High (1)	Medium + Medium/High (2)	Low + Medium/Low (3)	Anova	Significant Contrasts
		M (SD)	M (SD)	M (SD)	p	
Age 11	ICU	**17.6 (9.7)**	**20.5 (11.5)**	**20.5 (9.8)**	**0.022**	**1 < 2**
	Pubertal Development					
	All	1.8 (0.4)	1.8 (0.4)	1.8 (0.4)	0.723	
	Girls	2.0 (0.5)	2.0 (0.4)	1.9 (0.4)	0.455	
	Boys	**1.6 (0.3)**	**1.6 (0.3)**	**1.8 (0.3)**	**0.044**	**2 < 3**
	SDQ Peer Teacher	1.0 (1.5)	1.2 (1.7)	1.3 (1.7)	0.560	
	SDQ Ext. Teacher	**2.8 (3.4)**	**3.9 (3.9)**	**4.6 (4.8)**	**0.003**	**1 < (2 = 3)**
	SDQ Peer Parents	0.7 (1.3)	0.7 (1.2)	0.9 (1.5)	0.572	
	SDQ Ext.Parents	3.1 (2.8)	3.7 (3.0)	3.6 (2.7)	0.181	
Age 12	ICU	19.4 (10.7)	20.7 (10.8)	23.8 (9.0)	0.060	
	Pubertal Development					
	All	2.1 (0.6)	2.2 (0.6)	2.3 (0.6)	0.055	
	Girls	2.4 (0.6)	2.6 (0.6)	2.6 (0.5)	0.126	
	Boys	1.7 (0.3)	1.8 (0.4)	1.8 (0.5)	0.178	
	SDQ Peer Teacher	1.0 (1.5)	1.3 (1.7)	1.7 (2.0)	0.059	
	SDQ Ext. Teacher	3.1 (3.6)	3.6 (3.8)	4.7 (3.7)	0.055	
	SDQ Peer Parents	0.8 (1.5)	0.7 (1.2)	1.0 (1.5)	0.523	
	SDQ Ext.Parents	2.9 (3.0)	3.2 (2.7)	4.1 (3.3)	0.143	

Bold: significant differences between SES; SES: Socioeconomic Status; ICU: Inventory of Callous unemotional; SDQ: Strengths and Difficulties Questionnaire; SDQ Ext.: SDQ Externalizing.

Table 3

Comparison of primary measures between school type separately by age

		Public	Private + Semiprivate	Mean comparison
		M (SD)	M (SD)	p
Age 11	ICU	19.1 (10.6)	20.2 (10.9)	0.330
	Pubertal Development			
	All	1.8 (0.4)	1.8 (0.4)	0.056
	Girls	2.0 (0.5)	1.9 (0.4)	0.258
	Boys	1.7 (0.3)	1.6 (0.4)	0.111
	SDQ Peer Teacher	**1.0 (1.5)**	**1.4 (1.8)**	**0.016**
	SDQ Ext. Teacher	3.7 (4.0)	3.5 (3.8)	0.706
	SDQ Peer Parents	0.8 (1.3)	0.7 (1.3)	0.544
	SDQ Ext.Parents	3.6 (3.0)	3.2 (2.7)	0.184
Age 12	ICU	20.3 (9.8)	21.3 (12.0)	0.365
	Pubertal Development			
	All	2.2 (0.6)	2.1 (0.7)	0.168
	Girls	2.5 (0.5)	2.5 (0.6)	0.463
	Boys	1.8 (0.4)	1.8 (0.5)	0.971
	SDQ Peer Teacher	1.2 (1.6)	1.4 (2.0)	0.384
	SDQ Ext. Teacher	3.8 (3.4)	3.1 (3.7)	0.100
	SDQ Peer Parents	0.7 (1.2)	0.9 (1.5)	0.376
	SDQ Ext.Parents	3.3 (2.9)	2.9 (2.9)	0.342

Bold: significant differences between school type; ICU: Inventory of Callous unemotional; SDQ: Strengths and Difficulties Questionnaire; SDQ Ext.: SDQ Externalizing.

Table 4

Pearson correlations between primary measures separately by age

	1	2	3	4	5	6
1.ICU		−0.120	**0.317**	**0.523**	0.068	**0.233**
2.Pubertal Development	−0.080		0.049	−0.169	**0.137**	0.047
3.SDQ Peer Teacher	**0.357**	0.070		**0.256**	**0.455**	**0.228**
4.SDQ Ext. Teacher	**0.627**	−0.090	**0.330**		**0.135**	**0.474**
5.SDQ Peer Parents	0.046	0.082	**0.393**	0.055		**0.322**
6.SDQ Ext.Parents	**0.208**	−0.026	**0.192**	**0.445**	**0.272**	

Below the main diagonal are shown correlations at age 11; Above the main diagonal are shown correlations at age 12.

Bold: significant correlations; ICU: Inventory of Callous unemotional; SDQ: Strengths and Difficulties Questionnaire; SDQ Ext.: SDQ Externalizing.

increasing odds of an ODD diagnosis ($OR = 1.22$, $p < .001$ for low PD; $OR = 1.08$, $p = .007$ for medium PD), with increasing scores of SDQ externalizing scores reported by teachers ($B = 0.19$, $p < .001$ for low PD; $B = 0.11$, $p < .001$ for medium PD) and with increasing scores of SDQ peer problems reported by parents ($B = 0.07$, $p = .003$ for low PD). The effect of CU was not statistically significant for girls with high PD.

To exemplify the effects of CU on disruptive behavior moderated by PD, as well as the differential results in girls and boys, Fig. 2 graphs the regression lines of SDQ-externalizing problems reported by teachers on CU, separately for low, medium, and high PD scores. While for boys at age 11, the slope is higher for the lowest PD, for girls at age 12 the opposite happens.

Estimated CU main effects (not moderated by PD) were mostly positive and significant. They were found at age 11 for girls in ODD diagnosis ($OR = 1.05$, $p = .029$), in SDQ peer problems scores reported by teachers ($B = 0.06$, $p < .001$) and in SDQ externalizing problems scores reported by teachers ($B = 0.22$, $p < .001$), and also at age 11 for boys in SDQ peer problems scores reported by teachers ($B = 0.06$, $p < .001$) and in SDQ externalizing problems scores reported by parents ($B = 0.09$, $p < .001$). At age 12, positive and significant main effects of CU were found for girls in SDQ peer problems scores reported by teachers ($B = 0.05$, $p < .001$), and for boys in ODD diagnosis ($OR = 1.06$, $p = .029$), in SDQ peer problems scores reported by teachers ($B = 0.05$, $p < .001$), in SDQ externalizing problems scores reported by teachers ($B = 0.22$, $p < .001$) and reported by parents ($B = 0.07$, $p = .005$).

1.13 ($p = .003$). For behavior reported by teachers, an increment of CU increased SDQ externalizing problems score both for boys with low, medium, and high PD ($p < .001$), although the magnitude was higher for high ($B = 0.29$) than for low ($B = 0.18$) PD. Finally, increasing CU scores were associated with large SDQ peer problem scores reported by parents only when PD was medium ($B = 0.02$, $p = .019$) or high ($B = 0.05$, $p = .004$).

The main and moderated PD effects of CU on disruptive behavior at age 12 and separately by sex are shown in Table 6. At age 12 significant CU × PD interactions were found in the same three disruptive measures that at age 11, ODD diagnosis ($p = .023$), SDQ externalizing problems score reported by teachers ($p = .040$), and SDQ peer problems score reported by parents ($p = .008$), but in girls instead of boys. Concretely, for girls with low or medium PD larger CU scores were associated with

Table 5
Effect of CU by pubertal development on disruptive behavior at age 11 by sex

Age 11	Girls			Boys		
	OR	CI95% *OR*	*p*	*OR*	CI95% *OR*	*p*
ODD DSM-5 diagnosis						
ICU x PD	0.89	0.77 to 1.02	0.101	**1.15**	**1.03 to 1.29**	**0.016**
ICU main effect	*1.05*	*1.01 to 1.10*	*0.029*	NA	NA	NA
ICU effect for PD Low	NA	NA	NA	0.98	0.92 to 1.05	0.982
ICU effect for PD Medium	NA	NA	NA	1.04	0.99 to 1.09	0.100
ICU effect for PD High	NA	NA	NA	*1.13*	*1.04 to 1.22*	*0.003*
	B	CI95% *B*	*p*	*B*	CI95% *B*	*p*
SDQ Peer Teacher						
ICU x PD	−0.01	−0.06 to 0.05	0.832	0.01	−0.03 to 0.05	0.610
ICU main effect	*0.06*	*0.04 to 0.08*	*<0.001*	*0.06*	*0.04 to 0.07*	*<0.001*
SDQ Externalizing Teacher						
ICU x PD	0.00	−0.09 to 0.09	0.979	**0.06**	**0.04 to 0.07**	**<0.001**
ICU main effect	*0.22*	*0.18 to 0.25*	*<0.001*	NA	NA	NA
ICU effect for PD Low	NA	NA	NA	*0.18*	*0.12 to 0.24*	*<0.001*
ICU effect for PD Medium	NA	NA	NA	*0.22*	*0.18 to 0.26*	*<0.001*
ICU effect for PD High	NA	NA	NA	*0.29*	*0.22 to 0.36*	*<0.001*
SDQ Peer Parents						
ICU x PD	0.00	−0.05 to 0.05	0.892	**0.05**	**0.01 to 0.10**	**0.031**
ICU main effect	−0.01	−0.02 to 0.01	0.599	NA	NA	NA
ICU effect for PD Low	NA	NA	NA	0.00	−0.02 to 0.02	0.941
ICU effect for PD Medium	NA	NA	NA	*0.02*	*0.00 to 0.04*	*0.019*
ICU effect for PD High	NA	NA	NA	*0.05*	*0.02 to 0.09*	*0.004*
SDQ Externalizing Parents						
ICU x PD	0.00	−0.12 to 0.12	0.985	0.01	−0.10 to 0.11	0.883
ICU main effect	0.02	−0.02 to 0.06	0.280	*0.09*	*0.05 to 0.13*	*<0.001*

Adjusted by socioeconomic status, ethnicity, and pubertal development.
Bold: Significant ICU × PD interaction; Italic: Significant ICU effect (main or for PD low, medium or high); ODD: Oppositional Defiant Disorder from Diagnostic Interview for Children and Adolescents; ICU: Inventory of Callous unemotional; PD: Pubertal Development; SDQ: Strengths and Difficulties Questionnaire.
PD Low was a score of 1.4 for girls and a score of 1.2 for boys (percentile 5).
PD Medium was a score of 2.0 for girls and a score of 1.6 for boys (percentile 50).
PD High was a score of 3.0 for girls and a score of 2.2 for boys (percentile 95).

Table 6
Effect of CU by pubertal development on disruptive behavior at age 12 by sex

Age 12	Girls			Boys		
	OR	CI95% *OR*	*p*	*OR*	CI95% *OR*	*p*
ODD DSM-5 diagnosis						
ICU x PD	**0.88**	**0.79 to 0.98**	**0.023**	1.06	0.92 to 1.22	0.455
ICU main effect	NA	NA	NA	*1.06*	*1.01 to 1.12*	*0.029*
ICU effect for PD Low	*1.22*	*1.09 to 1.38*	*<0.001*	NA	NA	NA
ICU effect for PD Medium	*1.08*	*1.02 to 1.14*	*0.007*	NA	NA	NA
ICU effect for PD High	1.00	0.92 to 1.09	0.943	NA	NA	NA
	B	CI95% *B*	*p*	*B*	CI95% *B*	*p*
SDQ Peer Teacher						
ICU x PD	−0.01	−0.05 to 0.03	0.668	0.03	−0.04 to 0.09	0.433
ICU main effect	*0.05*	*0.03 to 0.07*	*<0.001*	*0.05*	*0.02 to 0.07*	*<0.001*
SDQ Externalizing Teacher						
ICU x PD	**−0.08**	**−0.16 to − 0.01**	**0.040**	0.05	−0.08 to 0.17	0.468
ICU main effect	NA	NA	NA	*0.22*	*0.17 to 0.27*	*<0.001*
ICU effect for PD Low	*0.19*	*0.10 to 0.28*	*<0.001*	NA	NA	NA
ICU effect for PD Medium	*0.11*	*0.06 to 0.15*	*<0.001*	NA	NA	NA
ICU effect for PD High	0.06	−0.01 to 0.12	0.096	NA	NA	NA
SDQ Peer Parents						
ICU x PD	**−0.05**	**−0.09 to − 0.01**	**0.008**	0.02	−0.03 to 0.08	0.454
ICU main effect	NA	NA	NA	0.00	−0.02 to 0.02	0.744
ICU effect for PD Low	*0.07*	*0.02 to 0.11*	*0.003*	NA	NA	NA
ICU effect for PD Medium	0.01	−0.01 to 0.04	0.215	NA	NA	NA
ICU effect for PD High	−0.02	−0.05 to 0.01	0.264	NA	NA	NA
SDQ Externalizing Parents						
ICU x PD	−0.05	−0.13 to 0.03	0.205	−0.04	−0.17 to 0.09	0.564
ICU main effect	0.04	−0.01 to 0.09	0.072	*0.07*	*0.02 to 0.12*	*0.005*

Adjusted by socioeconomic status, ethnicity, and pubertal development.
Bold: Significant CU × PD interaction; Italic: Significant CU effect (main or for PD low, medium or high); ODD: Oppositional Defiant Disorder from Diagnostic Interview for Children and Adolescents; ICU: Inventory of Callous unemotional; PD: Pubertal Development; SDQ: Strengths and Difficulties Questionnaire.
PD Low was a score of 1.60 for girls and a score of 1.20 for boys (percentile 5).
PD Medium was a score of 2.60 for girls and a score of 1.80 for boys (percentile 50).
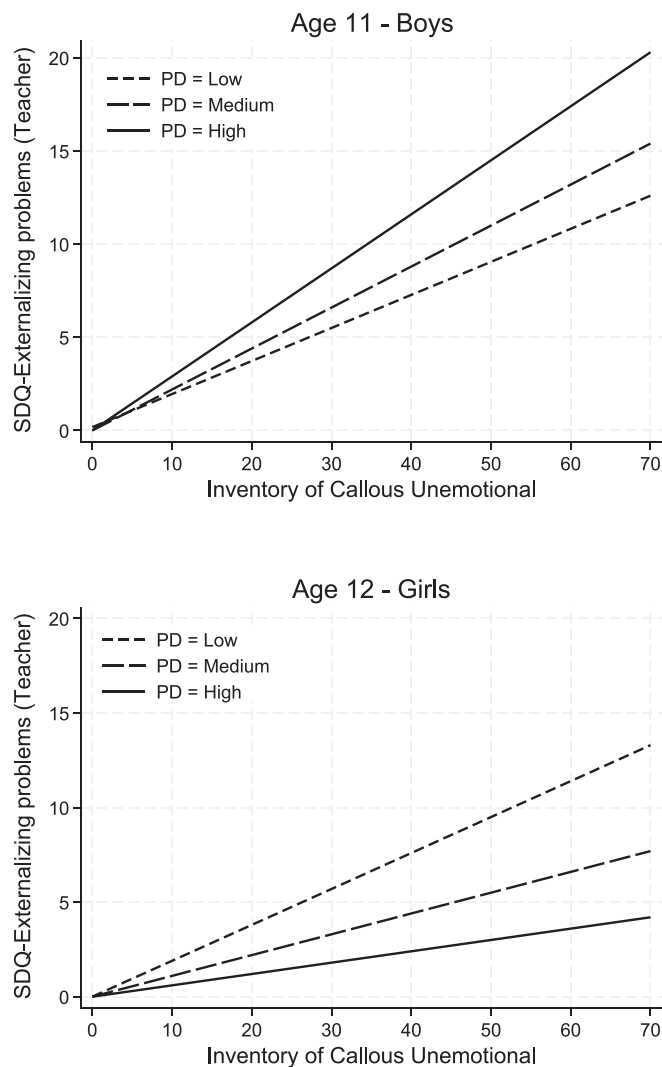PD High was a score of 3.20 for girls and a score of 2.60 for boys (percentile 95).

Age 11 - Boys

Age 12 - Girls

Fig. 2. Moderation of pubertal development in the effect of callous unemotional on SDQ-Externalizing problems reported by teachers at age 11 in boys and at age 12 in girls.

PD = Pubertal development.

4. Discussion

The current study examined the relationship between CU traits and disruptive behavior, as well as the potential moderating role of PD and sex, in a community sample of children aged 11 and 12. Our hypothesis that CU traits and low pubertal development at age 12 in girls would be associated with disruptive behavior, whereas CU traits and high pubertal development at age 11 in boys would be associated with disruptive behavior was supported in this study.

The results revealed significant interactions between CU traits and PD in boys at age 11, and in girls at age 12, on three measures of disruptive behavior: ODD diagnosis, SDQ externalizing problems scores reported by teachers, and SDQ peer problems scores reported by parents. Specifically, the odds of an ODD diagnosis increased with higher CU scores only in boys with high PD and in girls with low PD, as hypothesized. Moreover, CU traits were directly associated with higher SDQ externalizing problems scores reported by teachers, regardless of PD level for both boys and girls. Therefore, we could conclude that the effect of CU traits on disruptive behavior is moderated by the level of PD, though differently for boys than for girls. Previous research on PD and psychopathology has identified early pubertal timing as a trans-diagnostic risk factor for psychopathology (ODD and aggression) in both

sexes (Hamlat, Snyder, Young, & Hankin, 2019). Different frameworks explain the effects of early pubertal timing on psychopathology, and specifically externalizing behavior including hormonal exposures, gene-by-enviroment interactions, maturation disparity (differences between physical, social, and psychological maturation), contextual amplification (early puberty is a risk factor for social disadvantage), accentuation (pubertal transition occurs together with preadolescent vulnerabilities) or developmental readiness (asynchrony between physical, cognitive and socioemotional maturity (Ge & Natsuaki, 2009).

According to Negriff and Susman (2011), such existing theoretical perspectives on pubertal development effects are deemed insufficient in explaining the diverse findings related to moderating factors, such as parent-child relationships, the role of deviant peers or socioeconomic status, and the role of gender. In this sense, Javdani, Sadeh, and Verona (2011) propose a comprehensive model for the development of antisocial behavior in girls in which they integrate individual-level characteristics and family-related risk factors with female-specific risk factors (pubertal timing, sexual abuse, gendered contexts). In addition, they also consider that gender identity becomes more salient after puberty so that risk factors become more female-specific during adolescence and early adulthood.

Applied to our study, we could argue that low pubertal development in girls with CU traits at age 12 and externalizing behavior might be understood within the context of the complex interplay between biological, psychological /individual-level characteristics, and social factors. While previous research has indeed indicated that early puberty is a risk factor for externalizing behavior (Dimler & Natsuaki, 2015), it's important to recognize that the relationship between pubertal development and behavioral outcomes is multifaceted. CU traits may introduce a unique dimension to this relationship. Girls exhibiting these traits may have a distinct psychological profile that interacts with the timing of pubertal development (Centifanti et al., 2018). For example, those girls with CU traits might experience challenges in emotional regulation and social interactions, and these difficulties could manifest differently depending on their pubertal stage. Low pubertal development may contribute to feelings of social inadequacy or perceived differences, potentially exacerbating existing CU traits and leading to externalizing behaviors as a coping mechanism or means of asserting control (Hamlat et al., 2019). This contrasts with the more established understanding that early puberty is often associated with externalizing behaviors, as it may introduce premature exposure to adult-like roles and expectations, as Javdani, Sadeh and Verona (2011) suggest.

But in line with the findings of Centifanti et al. (2018), in which girls with delayed pubertal timing suffered from higher CU traits, our study suggests that for girls with CU traits, low PD at age 12 should be considered a risk factor, as low PD was associated with externalizing behavior and peer problems. Whereas the current stream of research indicates that early pubertal timing is a risk factor for antisocial behavior (Javdani, Sadeh, & Verona, 2011), it might be that a lower pubertal development in girls who already show CU traits might lead to more externalizing behavior because of the role of social perceptions in adolescent development (Hoyt, Niu, Pachucki, & Chaku, 2020). Visible signs of physical development during adolescence may lead adults, peers, and the individuals themselves to associate these changes with social or cognitive maturity. This, in turn, can result in varied behavioral expectations and assumptions (Carter, Mustaffa, & Leath, 2017; Mora, 2012). Consequently, girls who appear younger than their peers may experience differential treatment from their parents, friends, or teachers. For example, girls with CU traits and low pubertal development at age 12 might engage in more childish behavior, or take less responsibility for their rule-breaking actions (Centifanti et al., 2018). In addition, moral understanding and greater impulse control develop during adolescence (Hazen, Schlozman, & Beresin, 2008), and it might be that girls with high CU traits and low pubertal development at age 12 might show less moral development or impulse control than their high developing peers, leading to increased peer problems and

externalizing behavior.As the average age of the start of puberty is around age 10.4 in girls (Lacroix et al., 2023), a low pubertal development at age 11 could be considered as normotypical, and no social perceptions or expectations would interplay between PD, CU traits and externalizing behaviors.

While Centifanti et al. (2018) only focused on girls, our study also included adolescent boys. In our study, high CU traits and early pubertal development at age 11 emerged as risk factors for externalizing behavior and peer problems in boys. Boys with high pubertal development at age 11 (when the average starting age of puberty is 11.5 years) may find themselves interacting with peers who exhibit more advanced social behaviors. To fit in, these boys may adopt more callous unemotional attitudes and behaviors to align with the perceived expectations of their social group. In this sense, male adolescents with CU traits often bond with deviant peers, and engage in aggressive behavior and delinquency (Ray et al., 2017). The different impacts of low and high pubertal development in both sexes that we found in our study may also be explained by biological factors. Puberty is a period of hormonal changes in which testosterone in boys and estrogen in girls are increasingly produced. Existing literature has consistently highlighted a significant (but weak) association between elevated levels of testosterone and the manifestation of aggressive behaviors specifically in boys, but this relationship has not been observed to the same extent in girls (Geniole et al., 2020). However, in the case of pubertal girls, there is evidence supporting a positive correlation between higher levels of estrogen and the expression of anger (Ramirez, 2003). Testosterone has been associated with aggression and antisocial behavior, which are features associated with CU traits (Frick et al., 2014a). In a study on prenatal testosterone and estrogen exposure, children with CU traits exposed to higher levels of prenatal testosterone showed more externalizing behavior; while children with CU traits exposed to lower levels of prenatal testosterone showed less externalizing behaviors (Blanchard & Centifanti, 2017). Boys with CU traits who experience high pubertal development may be exposed to higher levels of testosterone during a crucial period of social and emotional development, potentially influencing externalizing behaviors (Ramirez, 2003). In girls, showing low pubertal development may result in lower levels of estrogen, which could impact the development of empathy and prosocial behaviors, potentially contributing to the emergence of CU traits (Waller et al., 2020). Other biological factors such as brain structure and functioning, neurotransmitter systems, and the stress response may be implicated in both pubertal timing and the development of CU traits, although the specific mechanisms should be explored in future studies.

In addition, there are also environmental factors that impact PD, for example, socioeconomic status. Previous research has shown that adolescents from low SES families experience earlier PD, especially girls with low SES, who can enter puberty almost one year earlier than girls with high SES (Deardorff, Abrams, Ekwaru, & Rehkopf, 2014; Stumper, Mac Giollabhui, Abramson, & Alloy, 2020) For boys, findings are mixed, suggesting that low SES and age of pubertal onset are not as robustly associated in males than in females (Oelkers et al., 2021). In our study, no differences between high, medium, or low SES were found among girls when it comes to pubertal development. This would be in line with a recent meta-analysis that also found no association between low SES and pubertal development in girls, suggesting that other related factors such as family dysfunction or sexual abuse are stronger risk factors for early puberty (Zhang, Zhang, & Sun, 2019).

In our study, and among boys, low SES in comparison to medium SES was associated with slightly higher pubertal development at age 11, but not at age 12. These results may be because the underlying mechanisms between SES and pubertal development are multifaceted and go beyond only low SES. For example, low SES is associated with more exposure to negative life events and more social disadvantage, which, in turn, are associated with a disruption of the hypothalamic-pituitary-adrenal (HPA) axis, which can lead to an earlier start of puberty (James-Todd, Tehranifar, Rich-Edwards, Titievsky, & Terry, 2010). Other moderating

factors such as healthy status or body mass index should be considered in future research to determine the interplay between SES and pubertal development in girls and boys (Oelkers et al., 2021).

It is important to note that the explanations are theoretical, as only a limited number of studies have explored the relationship between puberty and CU traits. Puberty is a complex process influenced by various biological, genetic, and environmental factors, and its relationship with CU traits likely involves multiple interacting mechanisms (Frick et al., 2014a). Further research is needed to better understand the underlying mechanisms and the role of pubertal status in the development of CU traits in different sexes. In this study, disruptive behavior and CU traits were evaluated using multiple informants, specifically parents and teachers. The informants of our study provided different perspectives on the child's behavior: interaction effects were found for SDQ teacher externalizing problems and SDQ parents peer problems, but not for SDQ teacher peer problems or SDQ parents externalizing problems. The variations in reporting can be attributed to differences in the informants' knowledge, perception, and interpretation of the child's behavior (De Los Reyes et al., 2015). As De Los Reyes et al. (2015) suggest, when pairs of observers, such as parents or teachers, watched children in the same setting, their reports tended to be more consistent compared to pairs of observers who watched the children in different settings (e.g., one parent and one teacher). They also highlight that there is generally more agreement between observers when they are reporting on the behavior of younger children compared to when they are reporting on the behavior of older children or adolescents. Therefore, it may be plausible that parents and teachers observe and report differently. Moreover, parents, due to their stronger emotional bond and attachment to the child, might be inclined to downplay or minimize externalizing and CU traits in their reports (Kemp, 2020). On the other hand, teachers, focusing primarily on observable behaviors and interactions within the classroom context, may be more likely to identify socially deviant behaviors associated with externalizing behavior (Ueno et al., 2021). Children with CU traits seem to be more rejected by their peers, as they are perceived as less trustworthy, they suffer from more peer victimization and show poorer prosocial behavior than adolescents without CU traits (Matlasz, Frick, & Clark, 2022; Wagner, Bowker, & Rubin, 2020). Teachers should be able to perceive these peer problems as salient in the classroom setting, but as adolescence is also a period in which teenagers can act differently, teachers might normalize certain peer problems during adolescence (being solitary, not being liked by others, getting along better with adults…), while they do not normalize externalizing behavior such as having tantrums, being disobedient, fighting with others, cheating, or stealing. Parents, on the contrary, might face different peer-related conflicts at home, so they may be more sensitive in interpreting that their children are rather solitary or unpopular, or are being victimized.

The inclusion of boys and girls, being a community sample, and obtaining information from multiple informants are strengths of the current study. Most research on CU traits is focused only on boys, and the phenomenology of callousness in girls is understudied (Pihet, Etter, Schmid, & Kimonis, 2015). In this study, we contribute reporting separately by sex if the effect of CU traits on externalizing and peer problems depends on PD, and this permits us to know gender-specific risks. Along the same lines, most research on CU traits includes samples of criminal justice offenders, but elevated CU traits are also frequent in community samples (range 10 to 32%) (Frick, Ray, Thornton, & Kahn, 2014b), and these numbers require study. Also, as recommended in clinical practice, we tried to obtain information on the children's behavior in the different contexts in which they were developing and reports from multiple informants (parents, teachers, children) (De Los Reyes et al., 2015).

However, some limitations should also be considered. First, working with a community sample implies a lower presence of mental health problems in comparison to clinical samples. Second, we used a self-report scale to assess pubertal development, which may introduce

subjectivity and reporting bias through social desirability, socially accepted norms, and limited insight into responses. Additionally, these measures may not capture the full complexity of pubertal changes, therefore, future research should consider incorporating more objective measures, such as hormonal assessments, to provide a more accurate representation of pubertal development. Also, we used the quantitative concept of pubertal development based on maturity signs, which provides information about the presence or absence of certain chances but may not capture the timing and sequence of these changes accurately. In addition, pubertal development does not only imply physical, but also nonphysical changes in cognitive development, emotional regulation, socioemotional relationships, sexual and gender identity, and general psychological well-being, including self-esteem and body image (Hazen et al., 2008). Future research could also address these aspects that might work as mediators of pubertal development and might help to identify different pathways to psychosocial difficulties.

Finally, because teachers have multiple opportunities to observe social interaction, in our study teachers were the reporters of the CU traits. We did not obtain information from the children about callousness. However, the validity of the different versions of the ICU (parents, teachers, and self-) varies across grades (Matlasz et al., 2022). Specifically, these authors found that whereas the validity of teacher reports declines as a child leaves elementary school (by age 13), the validity of self-report increases with the child's increasing age, and at age 13 obtained the best validity indicators. In their study, by sixth grade (11 years old) teacher reports added important information to self-report. As such, the information we obtained from the teacher seems appropriate.

The findings of this study have important implications for clinical practice and educational settings. The results suggest that there are sex-specific patterns in the relationship between CU traits, PD, and disruptive behavior in children aged 11 and 12. In light of the link between CU, early puberty, and externalizing behavior, it is recommended that clinicians inquire about individuals' experiences during puberty and adolescence. By understanding their unique journey through this phase, clinicians can provide personalized support, potentially reshaping their overall health trajectory. This approach aims to mitigate the risk of future antisocial behavior or adult psychopathology (Klump, 2022). Educational settings should also consider the impact of PD on externalizing behaviors. Creating a supportive environment based on positive feedback that promotes social and emotional support might help mitigate the development of CU traits as coping mechanisms (Hawes, Price, & Dadds, 2014). Sensitivity to individual differences in pubertal development and collaboration with mental health professionals might enhance support for students within educational settings.

5. Conclusions

The current study provides evidence for sex-specific patterns in the relationship between CU traits, PD, and disruptive behavior in children aged 11 and 12. Our findings support the hypothesis that CU traits and low pubertal development in girls are associated with disruptive behavior, while CU traits and high pubertal development in boys are also linked to disruptive behavior. These results underscore the importance of considering both CU traits and PD when assessing and treating disruptive behavior in clinical practice. However, further research is needed to explore the underlying mechanisms and validate these findings in larger and more diverse samples.

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CRediT authorship contribution statement

Natalia Pueyo: Conceptualization, Writing – original draft. **José-Blas Navarro:** Data curation, Formal analysis, Methodology, Writing – review & editing. **Núria de la Osa:** Investigation, Writing – review & editing. **Pedro Pechorro:** Writing – review & editing. **Lourdes Ezpeleta:** Conceptualization, Funding acquisition, Investigation, Writing – review & editing.

Declaration of competing interest

The authors do not have any conflict of interest to disclose.

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