Evaluating the Sensitivity to Threat and Affiliative Reward (STAR) Model in in Relation to the Development of Conduct Problems and Callous-Unemotional Traits Across Early Adolescence.

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Abstract

Background: The Sensitivity to Threat and Affiliative Reward (STAR) model proposes low threat sensitivity and low affiliation as risk factors for callous-unemotional (CU) traits. Preliminary evidence for the STAR model comes from work in early childhood. However, studies are needed that explore the STAR dimensions in late-childhood and adolescence when severe conduct problems (CP) emerge. Moreover, it is unclear how variability across the full spectrum of threat sensitivity and affiliation gives rise to different forms of psychopathology beyond CU traits. **Methods:** The current study addressed these gaps using parent- and child-reported data from three waves and a sub-study of the Adolescent Brain Cognitive Development Study® of 11,878 youth (48% female; ages 9-12). **Results:** Consistent with the STAR model, low threat sensitivity and low affiliation were independently related to CU traits across informants and time. Moreover, there was significant interaction between the STAR dimensions, such that children with lower sensitivity to threat and lower affiliation had higher parent-reported CU traits. Unlike CU traits, children with *higher* threat sensitivity had higher parent-reported CP and anxiety. Finally, children with lower affiliation had higher parent-reported CP, anxiety, and depression. Results largely replicated across informants and time, and sensitivity analysis revealed similar findings in children with and without DSM-5 defined CP. **Conclusions**: Results support the STAR model hypotheses as they pertain to CU traits and delineate threat sensitivity and affiliation as independent transdiagnostic risk factors for different types of psychopathology. Future research is needed to develop fuller and more reliable and valid measures of affiliation and threat sensitivity across multiple assessment modalities.

Keywords: affiliation; callous-unemotional; conduct problems; parenting; psychopathology; threat sensitivity.

Conduct problems (CP) refer to violations of rules and norms, including aggression, theft, and defiance (American Psychiatric Association, 2013). Disorders characterized by CP, including oppositional defiant disorder (ODD) and conduct disorder (CD), are among the most prevalent childhood conditions (Merikangas et al., 2022). CP predict high lifetime risk for antisocial behavior, depression, and substance abuse, and confer vast economic costs through healthcare, justice, and school expenditures (Rivenbark et al., 2018). However, the etiology, prognosis, and treatment needs of children with CP are heterogeneous, especially for those with co-occurring callous-unemotional (CU) traits, defined by a callousness, uncaring, and remorselessness (Frick et al., 2014; Waller, Wagner, et al., 2020). CU traits represent a developmental extension of the affective facet of psychopathy in adults and predict future antisocial outcomes, even accounting for CP severity (Hawes et al., 2017; McMahon et al., 2010; Neo & Kimonis, 2021). Importantly, while evidence-based treatments (e.g., parenting programs) are effective for reducing CP, children with CU traits start and end treatment with greater symptom severity than those without CU traits (Perlstein et al., 2023). Given the devastating consequences of CP, we need more effective treatments targeting the specific interpersonal difficulties associated with CU traits.

In this context, the Sensitivity to Threat and Affiliative Reward (STAR) model proposed that low threat sensitivity and low affiliation represent temperament dimensions underpinning the development of CU traits (Waller & Wagner, 2019). Drawing on findings from the adult psychopathy literature (Cleckley, 1951; Karpman, 1941; Lykken, 2013) and developmental models of conscience and moral learning (Blair, 2017; Kochanska et al., 1994), low threat sensitivity (i.e., fearlessness) refers to reduced recognition and responsiveness to social and non-social threat. Fearlessness increases risk for CU traits by disrupting children's ability to learn about or respond to aversive environmental cues that otherwise signals need for behavior change (e.g., others' distress, punishment) (Blair, 2017; Waller & Wagner, 2019). Affiliation is characterized as the motivation for and maintenance of social relationships, stemming from

reward gained through closeness with others. This definition draws on studies investigating the biological basis of social bonding (Depue & Morrone-Strupinsky, 2005; Feldman, 2012), interpersonal behavior and personality (Hill, 1987; Wiggins, 1996), and the neurobehavioral dimensions underlying psychopathy (Patrick & Drislane, 2015; Viding & McCrory, 2019). Low affiliation is thought to increase risk for CU traits by disrupting children's initiation and enjoyment of positive physical and emotional connections with others, which would otherwise promote adaptive social bonding (Viding & McCrory, 2019; Waller & Wagner, 2019).

Preliminary support for the STAR model comes from studies that have documented links between CU traits and low threat sensitivity when operationalized as difficulties recognizing fearful, angry, or sad facial expressions (Blair et al., 2014; Kimonis et al., 2016; White et al., 2016) or body postures (Muñoz, 2009; Powell et al., 2023). In laboratory assessments, observed fearlessness in toddlerhood was prospectively related to CU traits in early (Barker et al., 2011; Waller et al., 2017, 2021) and middle (Goffin et al., 2018) childhood. CU traits were also linked to questionnaire measures of low threat sensitivity, assessed via parent (Perlstein, Wagner, et al., 2023) and teacher (Domínguez-Álvarez et al., 2021) report. For affiliation, laboratory studies show that CU traits in early childhood are preceded by lower attention to faces and reduced eye contact in infancy (Bedford et al., 2015; Peltola et al., 2018), lower social engagement and imitation in toddlerhood (Perlstein et al., 2021; Wagner et al., 2020; Waller et al., 2016) and difficulties responding to positive emotions during adolescence (Fanti et al., 2016; Hodsoll et al., 2014; O'Nions et al., 2017). In addition, lower affiliation was linked to CU traits in late-childhood and adolescence based on child reports of the affective quality of the teacher-child relationship (Hwang et al., 2021), child-reported friendship quality (Miron et al., 2020), and child-reported relationship satisfaction (Facci et al., 2023). Studies have also established the independent contributions of low threat sensitivity and low affiliation to CU traits (i.e., considered simultaneously as predictors) (Perlstein, Wagner, et al., 2023; Waller et al., 2021), with some evidence that their interaction explains additional variance (Domínguez-Álvarez et al., 2021).

However, a number of gaps exist in our knowledge about the STAR model for characterizing risk for CU traits and psychopathology more broadly. First, we need studies during late-childhood, when knowledge about the STAR dimensions could help to target and adapt interventions to divert children from severe trajectories of CP that begin in adolescence (Fonagy, 2021; Hinshaw et al., 1993). Second, prior studies have relied on parent report due to the younger age of samples (Wagner et al., 2019; Waller et al., 2021) or leveraged indirect indices of affiliation during adolescence, such as child-reported friendship quality or peer acceptance (Hwang et al., 2021; Miron et al., 2020). To better characterize the STAR dimensions and links with CU traits, we need direct, multi-informant assessments of threat sensitivity and affiliation (De Los Reyes et al., 2015). Third, studies need to explore interactions between threat sensitivity and affiliation in relation to CU traits. This question could establish whether targeting either threat sensitivity or affiliative processes alone might precipitate reductions in CU traits, or point to the need for interventions that target both processes to increase efficacy. Finally, no prior studies have established whether prediction of CU traits by the STAR dimensions holds for all children. Thus, studies need to include sensitivity analyses that explore whether hypothesized prediction of CU traits by low threat sensitivity and low affiliation persist across a full dimensional spectrum of CP severity or are driven by a subgroup with clinically-significant CP symptoms (i.e., ODD/CD diagnosis).

In addition to these knowledge gaps, we need studies that explore whether the STAR dimensions add to our understanding of risk pathways for other forms of psychopathology, as outlined in the theoretical model (Waller & Wagner, 2019). For example, while low threat sensitivity is implicated in CU traits and psychopathy, *heightened* threat sensitivity (e.g., exaggerated threat responding) is common to psychopathology characterized by emotion dysregulation, including anxiety disorders (Kramer et al., 2020; Lobue & Pérez-Edgar, 2014; Mobbs, 2018) or CP among children without (or controlling for) co-occurring CU traits (Dotterer et al., 2020; Mills-Koonce et al., 2015; Viding et al., 2012). Low affiliation is also implicated in

psychopathology characterized by interpersonal difficulties, including mood (Kupferberg et al., 2016) and anxiety (Gilboa-Schechtman, 2020; Weisman et al., 2011) disorders. However, the directionality of findings linking threat sensitivity and affiliation to other types of psychopathology is inconsistent. For example, some studies link *lower* threat sensitivity to depression (Shankman et al., 2013; Yancey et al., 2015) or the combination of *higher* threat sensitivity and *higher* affiliation to social anxiety or anxious attachment (Kirkwood, 2017; Schwartz et al., 2007). To date, however, no studies have systematically or simultaneously examined (potentially divergent) main and interactive effects of the STAR dimensions in relation to outcomes across the externalizing and internalizing spectra. Such an approach is consistent with broader efforts to dimensionally model the empirical structure of psychopathology while accounting for comorbidity or transdiagnostic features of different disorders (Kotov et al., 2017).

The aim of the current study was to evaluate the utility of the STAR model in relation to psychopathology in late childhood, modeling how individual differences in threat sensitivity and affiliation related to CU traits, CP, depression, and anxiety. Under our first study aim, we tested main and interactive effects of threat sensitivity and affiliation on CU traits and CP (i.e., CU traits controlling for CP and vice versa). We hypothesized that low threat sensitivity, low affiliation, and their interaction would be related to CU traits and that findings would replicate for parent and child report (i.e., across informants) and in groups with or without DBD (i.e., sensitivity analysis). In contrast, we hypothesized that *high* threat sensitivity would specifically be associated with CP (e.g., Dotterer et al., 2020; Viding et al., 2012). Under our second aim, we tested main and interactive effects of threat sensitivity and affiliation in relation to anxiety and depression, hypothesizing that high threat sensitivity would be associated with more anxiety symptoms and low affiliation to more depression symptoms.

Methods

Participants and Procedures

Participants were from the Adolescent Brain Cognitive Development (ABCD) Study®, a

large longitudinal study of youth in the US. Participants were recruited at ages 9–10 from 21 sites across the US using approaches intended to yield a demographically representative final sample (Garavan et al., 2018). The baseline sample was 48% female (64% White, 16% Black, 2% Asian, 5% other race, 13% Multiracial; Volkow et al., 2018). We used survey data from three time points. The baseline visit (T1) included 11,878 youth (M_{age}=9.92 years, *SD*=.63), with 11,225 completing the 1-year follow-up visit (T2; M_{age}=10.92, *SD*=.64; 94.5% retention), and 10,414 completing the 2-year follow-up (T3; M_{age}=12.00, *SD*=.66; 87.7% retention). We also used data from the separate ABCD Social Development sub-study (ABCD-SD; *N*=2,300; 22.1% of T3 sample), conducted at 5 of the 21 sites (Hoffman et al., 2019). ABCD-SD data were collected in parallel to the 2-year follow-up of the main study (i.e., T3; M_{age}=11.66 years, *SD*=.95). From T1 to T2 and T3, participants lost to follow-up were more likely to identify as Black, had higher CP and CU traits, and were from lower income households (**Table S1**). ABCD-SD participants differed by site, were younger and more likely to identify as Black, had higher CP, and were from lower income households than the baseline T1 sample (**Table S1**).

Ethical Considerations

Study procedures were approved by institutional review boards at each site. Legal guardians provided written informed consent and participants provided assent prior to participating.

Measures

Table S2 provides an overview of questionnaires, informants, time-points, and sample sizes.

Threat sensitivity (T1, T3). At T1, we assessed child-reported threat sensitivity using a mean score for 4 items from the Behavioral Inhibition System (BIS) questionnaire (Carver & White, 1994). Items were theoretically consistent with conceptualizations of threat sensitivity (Perlstein, Wagner, et al., 2023) or overlapped with other fearfulness measures (Capaldi & Rothbart, 1992) (see **Figure S1**). Items were rated on a 4-point scale (0=not true, 3=very true;

ωt =.59; Mean Inter-item Correlation, MIC=.23). At T3, we assessed parent-reported threat sensitivity using a summed score of the 6-item fear scale (e.g., “worries about getting into trouble”) from the Early Adolescent Temperament Questionnaire (EATQ-R; Ellis & Rothbart, 1999), with items rated on a 5-point scale (1=almost always untrue, 5=almost always true; ωt =.62).

Affiliation (T2, T3). At T2, we assessed parent-reported affiliation using a mean score for 4 items from the Social Responsiveness Scale–Short Form (SRS-SF) (Sturm et al., 2017). Items were theoretically consistent with conceptualizations of affiliation in the Research Domain Criteria (RDoC) framework, existing measures (Perlstein, Wagner, et al., 2023), or the affiliation factor from the full 60-item SRS (Uljarević et al., 2020) (see **Figure S1**). Items were rated on a 4-point scale (1=not true, 4=almost always; ωt =.56; MIC=.28). At T3, we assessed parent-reported affiliation using a summed score of the 6-item affiliation scale (e.g., “wants to have close relationships with others”) from the EATQ-R (Ellis & Rothbart, 1999), with items rated on a 5-point scale (1=almost always untrue, 5=almost always true; ωt =.75).

Callous-unemotional (CU) traits (T2, T3). At T2 and T3, we assessed parent-reported CU traits using summed scores for a 4-item measure validated in prior ABCD studies (e.g., “doesn't feel guilty after misbehaving”) (Hawes et al., 2020; Waller, Hawes, et al., 2020). Internal consistency was acceptable (T2, ω_t=.78, MIC=.42; T3, ω_t=.79, MIC=.45). At T3, we assessed child-reported CU traits using mean scores for 18 of the 24 original items from the Inventory of Callous-Unemotional Traits (ICU) (Frick, 2004) available within ABCD-SD (**Table S2**). Items were rated on a 4-point scale (0=not at all true, 3=definitely true; ω_t=.70).

Conduct problems (CP; T2, T3). At T2 and T3, we assessed parent-reported CP using a summed score of 16 items from the DSM-oriented CP scale from the Child Behavior Checklist (CBCL; Achenbach, 2013) (e.g., “breaks rules at home, school or elsewhere”). Items were rated on a 3-point scale (0=not true, 2=very true; T2, ω_t=.81; T3, ω_t=.82). To avoid content overlap with CU traits, a single item (“lack of guilt”) from the original 17-item scale was omitted.

Aggression (T3). At T3 in ABCD-SD, we assessed child-reported aggression using a mean score for the 23-item Reactive Proactive Questionnaire (PRQ) (Raine et al., 2006) (e.g., “react angrily when provoked by others”). Items were rated on a 3-point scale (0=never, 2=often; ω_t=.85).

Anxiety symptoms (T2, T3). We assessed parent-reported anxiety using summed scores for the 9-item DSM-oriented Anxiety Problems scale from the CBCL (Achenbach, 2013) (e.g., “nervous, high-strung, or tense”). Items were rated on a 3-point scale (0=not true, 2=very true; T2, ω_t=.79; T3, ω_t=.79).

Depressive symptoms (T2, T3). We assessed parent-reported depression using a summed score of the 13-item DSM-oriented Depressive Problems scale of the CBCL (Achenbach, 2013) (e.g., “feels worthless or inferior”). Items were rated on a 3-point scale (0=not true, 2=very true; T2, ω_t=.75; T3, ω_t=.76).

CD or ODD diagnosis (T1). We indexed current/lifetime CD or ODD diagnosis using parent report on a computerized version of the Kiddie Schedule for Affective Disorders and Schizophrenia for School-Aged Children–Lifetime Version (K-SADS-PL DSM-5) (Barch et al., 2018; Kaufman et al., 2021; Kobak et al., 2013). At T1, 1,799 children (15.1%) met criteria for ODD (*n*=1,424, 12.8%), CD (*n*=132, 0.9%) or both (*n*=243, 2.1%).

Covariates. We included parent-reported measures of child sex, age in months, and income from the baseline survey. Parents also reported at baseline whether their child had previously received an autism spectrum disorder (ASD) diagnosis (*n*=201, 1.7%).

Analytic Strategy

Analyses were conducted in Mplus version 7 (Muthén & Muthén, 2012). Complex sampling and recruitment procedures implemented in the ABCD study (e.g., siblings, site) were accounted for using the cluster and stratification options and Type=Complex command. To establish the fit of the purported two-factor model representing separable sensitivity to threat and affiliation dimensions, we applied confirmatory factor analysis (CFA) to compare the fit of

one- and two-factor solutions using Mean and Variance Adjusted Weighted Least Squares (WLSMV) estimation. Model fit was evaluated using standard cut-offs for the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA) (Hu & Bentler, 1999). Models were compared using DIFFTEST. Next, measurement invariance was tested across boys and girls using the grouping and model options in Mplus (i.e., configural, metric, scalar). Based on our CFA results, we created observed measures of affiliation and threat sensitivity by computing the mean of the standardized items, with results similar using factor scores. To establish construct validity, we regressed the threat sensitivity and affiliation at T3 onto measures of threat sensitivity at T1 and affiliation at T2, controlling for sex, age, and income.

Under our first aim, we used regression to evaluate whether child-reported threat sensitivity at T1 and parent-reported affiliation at T2 were associated with parent-reported CU traits at T2 or longitudinally associated with parent- and child-reported CU traits at T3. We first entered sex, age, income, and CP into the model, then main effects of threat sensitivity and affiliation, and finally their interaction. We examined similar models with parent-reported CP (T2 and T3) as the dependent variable, with CU traits entered as a covariate to assess specificity. To establish whether findings replicated across informants, we ran models using data from the ABCD-SD sub-study with child-reported CU traits or aggression at T3 as the dependent variable. As a further sensitivity analysis, models were re-run for parent and child reports of CU traits among children who did (*n*=1,799) and did not meet (*n*=9,926) criteria for past/current CD and/or ODD diagnosis. Finally, we examined models using alternative (EAT-Q) parent-reported measures of threat sensitivity and affiliation at T3 in relation to parent- and child-reported CU traits at T3 (i.e., replicability across measures, time, and informants). Under our second aim, we adopted a similar approach, but included parent-reported anxiety or depression (models for each covaried for the other) at T2 or T3. Significant interactions were probed using an online tool (www.quantpsy.org) and plots were created in R (R Core Teams, 2020).

Results

Psychometric Support for Distinct Threat Sensitivity and Affiliation Factors

A two-factor model showed excellent fit to the data ($\chi^2(19)=144.43$, $p<.001$, CFI=.99, TLI=.99, RMSEA=.02), which was superior to a one-factor model ($\Delta\chi^2(1)=2576.03$, $p<.001$; see **Figure S1** and **Table S3** for item-factor loadings). The configural model showed excellent fit ($\chi^2(38)=133.56$, $p<.001$, CFI=.99, TLI=.99, RMSEA=.02, SRMR=.02), indicating a similar factor structure for boys and girls. No difference was found between the configural and metric models ($p=.61$), indicating similar item-factor loadings by sex. Subsequent analyses were conducted using mean observed scores for standardized threat sensitivity and affiliation item ratings, with models controlling for child sex, age, and family income. In support of construct validity, our *post hoc* measure of affiliation at T2 was related to a fuller, established measure of affiliation at T3 ($\beta=.24$, $p<.001$, 95% CI=.21, .26), with an effect size that was significantly larger in magnitude (i.e., non-overlapping confidence intervals) than that for threat sensitivity at T1 and affiliation at T3 ($\beta=.05$, $p<.001$, 95% CI=.02, .06; i.e., discriminant validity). Higher threat sensitivity at T1 ($\beta=.12$, $p<.001$, 95% CI=.09, .13) and lower affiliation at T2 ($\beta=-.12$, $p<.001$, 95% CI=-.15, -.10) both converged with the alternative, established measure of threat sensitivity at T3 (**Table S4**).

Aim 1. Associations between STAR Model Dimensions, CU Traits, and CP

Tables S1 and **S2** present descriptive statistics and **Table S5** summarizes bivariate correlations between study variables. Lower child-reported threat sensitivity at T1 ($\beta=-.03$, $p=.001$) and lower parent-reported affiliation at T2 ($\beta=-.22$, $p<.001$) were independently related to higher parent-reported CU traits at T2, controlling for CP, child sex, age, and family income (**Table 1**). There was a significant interaction between affiliation and threat ($\beta=.03$, $p=.02$), such that lower threat sensitivity was associated with higher CU traits at T2, specifically among children with low ($B=-.14$ $SE=.04$, $p<.001$) or mean ($B=-.06$. $SE=.02$, $p=.002$) affiliation, but not children with high affiliation ($B=.02$, $SE=.04$, $p=.62$) (**Figure 1a**).

Next, we ran a series of robustness tests comparing findings across time, measures,

informants, and diagnosis subgroups. First, results replicated across time for *parent-reported* CU traits assessed at T3 (**Table S6, Figure 1b**) and the main effects replicated across informants for *child-reported* CU traits at T3 (**Table 2**). Second, results replicated using the *alternative parent-reported measures* for the main effects of threat sensitivity and affiliation at T3 in relation to parent-reported CU traits at T3 (**Table S7)**. For child-reported CU traits at T3, only the main effect of low affiliation replicated using the alternative parent-reported measure at T3 (**Table S7**). Third, results were unchanged either after controlling for ASD diagnostic status or excluding children with ASD (**Table S8**). Finally, in separate models for children with versus without current/lifetime diagnoses of parent-reported CD/ODD, we replicated the main effects of lower threat sensitivity and lower affiliation for *parent-reported CU traits* in the DBD subsample (*n*=1,799; **Table S9**). There was also a significant interaction between low threat sensitivity and affiliation within the DBD subsample for *child-reported* CU traits at T3 (*n*=372; **Figure 1c, Table S9**). In the non-DBD subsample (*n*=9,926), there were significant main effects for low threat sensitivity and affiliation in relation to both parent- and child-reported (*n*=1,895) CU traits but no interaction (**Table S10**).

To evaluate specificity of findings to CU traits, we tested models substituting parent-reported CP at T2 as the dependent variable and controlling for CU traits (**Table 1**). Unlike the CU traits model, *higher* child-reported threat sensitivity at T1 was related to *higher* CP at T2 *(β*=.02, *p*=.02). Similar to the CU traits model, lower parent-reported affiliation at T2 was associated with higher CP (*β*=-.18, *p*<.001). No interaction emerged between threat sensitivity and affiliation. Results were similar when we examined parent-reported CP at T3 (**Table S6**). Across informants, we replicated the finding linking *higher* child-reported threat sensitivity at T1 to higher *child-reported aggression at T3* (*β*=.10, *p*<.001). Parent-reported affiliation at T2 was unrelated to child-reported aggression at T3 and there was no interaction between threat sensitivity and affiliation (**Table 2**).

Aim 2. Associations between STAR Model Dimensions and Anxiety and Depression

Symptoms

Higher child-reported threat sensitivity at T1 (*β*=.06, *p*<.001) was related to higher parent-reported anxiety at T2, controlling for child sex and age, family income, and depression (T2). In addition, lower parent-reported affiliation at T2 was related to higher parent-reported anxiety at T2 (*β*=-.12, *p*<.001). There was no interaction of threat sensitivity and affiliation in relation to parent-reported anxiety at T2 (**Table 3**). No association was found between child-reported threat sensitivity at T1 and parent-reported depression at T2. However, lower parent-reported affiliation at T2 (*β*=-.26, *p*<.001) was related to higher parent-reported depression at T2. There was no interaction of threat sensitivity and affiliation in relation to parent-reported depression at T2 (**Table 3**). Results were unchanged when CU traits and CP were included as covariates in the model (**Table S11**) and within longitudinal models with anxiety and depression assessed at T3 (**Table S12**). Result were largely replicated when we examined all outcomes simultaneously (i.e., CU traits, CP, anxiety, and depression) within a single correlated dependent variables model (**Tables S13** and **S14**).

Discussion

We examined how threat sensitivity and affiliation related to CU traits, CP, depression, and anxiety during preadolescence. In line with hypotheses, lower threat sensitivity and lower affiliation were independently related to higher CU traits, with results largely replicating across informants, time, different measures, and diagnostic groups. Findings contribute to a growing literature supporting the unique contribution of both dimensions to risk for CU traits (Barker et al., 2011; Domínguez-Álvarez et al., 2021; Perlstein, Wagner, et al., 2023; Waller et al., 2016). In addition, models provided some evidence for a significant interaction between threat sensitivity and affiliation, such that the highest CU traits were observed among children with the lowest levels of *both* threat sensitivity and affiliation.

Findings are consistent with the positioning of CU traits within the STAR model (Waller & Wagner, 2019), as well as work specifying the broader adult psychopathic personality to emerge

in the context of meanness (i.e., low affiliation) and boldness (i.e., fearlessness), alongside low inhibitory control (Patrick et al., 2009). However, more research is warranted to understand developmental pathways from threat sensitivity and affiliation in children to meanness and boldness in adults (Dotterer et al., 2017; Waller & Wagner, 2019). Moreover, an evaluation of simple slopes revealed a somewhat different pattern contingent on informant: low parent-reported affiliation was associated with child-reported CU traits regardless of the level of threat sensitivity, with the interaction driven by the combination of high threat sensitivity and high affiliation related to the lowest levels of CU traits. In contrast, low parent-reported affiliation was related to parent-reported CU traits across different levels of child-reported threat sensitivity, with the highest CU traits evident in the context of both low affiliation and low threat sensitivity.

Lower affiliation was most consistently related to higher CU traits across measures, times, and informants. Thus, results reinforce the importance of affiliative processes within etiological and treatment models for CU traits. The majority of treatments for CP/CU traits already target affiliation, including social skills training (Kjøbli & Ogden, 2014) and recent CU-based adaptations to Parent-Child Interaction Therapy (PCIT-CU), which coach parents to use warm/affectionate parenting behaviors (Donohue et al., 2021; Fleming et al., 2022; Kimonis et al., 2019). Importantly, the interaction between affiliation and threat sensitivity in relation to CU traits highlights the need for treatment modules designed to help children pay attention to, learn, and adapt behavior in response to threat cues (Hubble et al., 2015; Kyranides et al., 2020). Indeed, PCIT-CU also teaches parents to prioritize reward over discipline, given the potential insensitivity of high-CU children to threat or punishment cues (Fleming et al., 2022).

Threat sensitivity also signaled risk for other psychopathology, further establishing its known transdimensional relevance, with findings summarized in **Figure 2**. Consistent with prior literature, higher threat sensitivity was implicated in greater anxiety symptomatology (Kramer et al., 2020; Lobue & Pérez-Edgar, 2014; Mobbs, 2018). CP were also linked to higher threat sensitivity, dovetailing with evidence of equifinality in risk pathways to CP, including a subgroup

of children with CP and *low* CU traits who exhibit heightened neural reactivity to cues of social threat or distress (Dotterer et al., 2020; Mills-Koonce et al., 2015; Viding et al., 2012) and more emotion dysregulation (Marsee & Frick, 2007; Raine et al., 2006). Thus, threat sensitivity may differentiate CP subgroups with or without CU traits (Colins et al., 2021), consistent with adult studies showing that boldness distinguishes psychopathy from antisocial personality disorder in adults (Venables et al., 2014). Assessing threat sensitivity may help to differentiate between children with CU traits who have low ("primary") versus high ("secondary") co-occurring internalizing psychopathology (Craig et al., 2021; Kimonis et al., 2012). The current study adopted a dimensional approach, but future person-centered analytic approaches are warranted in this and other samples to evaluate how threat sensitivity and/or low affiliation distinguish CP/CU subtypes.

Low affiliation signaled transdiagnostic risk in similar directions for CU traits, CP, anxiety, and depression (**Figure 2**), including when outcomes were considered as correlated dependent variables in the same model. This finding is consistent with impaired functioning in the social domain representing a core criterion distinguishing normal individual differences from disorder-specific features (Koudys et al., 2019). However, the affiliative difficulties underpinning CU traits, CP, anxiety, and depression likely differ in important ways that may not have been captured in our brief report measures. For example, children with CU traits may have low motivation to affiliate with others because they do not find social relationships rewarding (Viding & McCrory, 2019). However, affiliative difficulties among children with internalizing problems and/or high fearfulness may reflect intact affiliative reward motivation but either difficulties in the *enactment* of those motivations (Coplan et al., 2004) or withdrawal to avoid the possibility of exclusion/rejection (Gilboa-Schechtman, 2020). To fully characterize its relevance to different forms of psychopathology, future research needs to leverage more nuanced and multi-informant conceptualizations of affiliation. Of note, affiliation difficulties are also typical of youth with ASD (O'Nions et al., 2015). Our results were unchanged after controlling for ASD diagnostic status

and after removing children with ASD (*n*=201) from analyses. However, future studies beginning earlier in life that include dimensional assessments of ASD symptomatology are needed to establish the affiliative difficulties that may be shared versus unique among children with CU traits and/or ASD.

Findings should be considered in the context of several limitations. First, testing the predictions of a theoretical model using existing data is challenging. In this case, we largely relied on *post hoc* measures that were not purpose-developed to assess our core constructs. To mitigate concerns around the validity of measures, we replicated findings across informants, within cross-sectional and longitudinal analyses, and using alternative (previously validated) parent-reported measures of threat and affiliation at T3. Use of *post hoc* measures is not uncommon to maximize the utility of existing datasets (Brislin et al., 2018; Willoughby et al., 2011), such as the ABCD study, which harnesses the power of very large sample sizes to undertake research beyond the original scope (Patrick et al., 2019). However, items within our measures were certainly not exhaustive in covering all aspects of the theoretical constructs within the STAR model and there was low-to-moderate convergence between T1 and T3 measures of the same construct (though relatively higher than for other measures in the ABCD study; Owens et al., 2021). Undoubtedly, future studies are needed that incorporate, develop, or establish fuller measures of threat sensitivity and affiliation (e.g., Perlstein et al., 2022) or combine report measures with those derived from computer tasks and/or attentional, physiological, or neural assessments. Second, the threat sensitivity and affiliation measures for the main analyses were derived from different informants at different time points, which may have artificially inflated the magnitude of associations between parent-reported affiliation and parent-reported psychopathology symptoms. Future studies should carefully consider the role of cross-informant effects in modeling risk for CU traits. Third, the majority of effects were very small in the context of established heuristics (Cohen, 2013). In an evaluation of effect-size distributions in the ABCD study, *r*=.03 represented the median effect size, while *r*=.07 fell in the

third quartile and values remained in this range even when a higher significance threshold and stricter corrections were applied (Owens et al., 2021). Thus, while small by traditional metrics, our reported effect sizes are consistent with those expected within this sample. Moreover, small effect sizes accumulate across individuals and over time, such that even small effects become meaningful (Funder & Ozer, 2019). Finally, the STAR model simplifies the complexity of the constructs being studied, including affiliation and CU traits, contrasting with calls to *increase* the complexity of measurement and causal models and move away from "essentialist" accounts that rely on single measures of narrow constructs (Fried, 2015). In the context of the small number of items and low internal consistency for some of our measures, future research is needed to establish richer and more reliable assessments of threat sensitivity and affiliation, which can better elucidate how their disruption manifests in complex phenotypes, such as CU traits. High-resolution, multi-method approaches can also improve characterization of the person-by-context interactions that contribute to the emergence of CU traits (Kimonis, 2023) and can disentangle underlying risk mechanisms for CU traits from the observable phenotype that is most commonly indexed through use of parent, teacher, or child reports of *behavior* (Viding and McCrory, 2020).

In sum, we find empirical support for the utility of the STAR model for characterizing risk for CU traits in preadolescence, as well as showing model-consistent and transdiagnostic relationships between the STAR dimensions and other forms of psychopathology. To inform more effective interventions, we need reliable screening tools to identify young children at risk for CU traits and CP and adapted interventions or personalized adjunctive treatments when children have high CU traits (Perlstein et al., 2023). The measurement and study of threat sensitivity and affiliation across different methods, assessment levels, and developmental stages can contribute to advancements in the scientific understanding of the origins of CU traits and improve preventive interventions and treatments for childhood CP and CU traits.

Key points (119 words)

- The Sensitivity to Threat and Affiliative Reward (STAR) model proposes low threat sensitivity and low affiliation as risk factors for callous-unemotional (CU) traits.
- Prior studies have focused on early childhood, rarely exploring joint effects of threat sensitivity and affiliation or different forms of psychopathology as outcomes.
- We examined whether threat sensitivity and affiliation independently, and in concert, explained variance in different forms of psychopathology, including CU traits, in a large sample of preadolescents.
- Low threat sensitivity and low affiliation related to higher CU traits, while higher threat sensitivity related to more conduct problems and anxiety.
- Improved knowledge of the mechanisms underlying CU traits, as guided by the STAR model, can inform future preventive interventions and treatment.

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Table 1. Regression analyses examining child-reported threat sensitivity at T1 and parent-reported affiliation at T2 in relation to parent-reported CU traits and CP at T2 in the full ABCD study sample (*N*=11,878)

	Parent-reported CU traits (T2)									*Parent-reported CP (T2)*								
	Model 1			**Model 2**			**Model 3**			**Model 1**			**Model 2**			**Model 3**		
Independent variables	*B (SE)*	*β*	*p*	*B (SE)*	*β*	*p*	*B (SE)*	*β*	*p*	*B (SE)*	*β*	*p*	*B (SE)*	*β*	*p*	*B (SE)*	*β*	*p*
Sex (T1)	-.25 (.03)	-.09	<.001	-.22 (.02)	-.08	<.001	-.22 (.02)	-.08	<.001	-.25 (.04)	-.06	<.001	-.24 (.04)	-.06	<.001	-.24 (.04)	-.06	<.001
Age (T1)	.00 (.00)	.00	.29	.00 (.00)	.00	.78	.00 (.00)	.00	.77	.00 (.00)	.00	.70	.00 (.00)	-.01	.360	.00 (.00)	-.01	.36
Income (T1)	.02 (.01)	.04	.001	.03 (.01)	.04	<.001	.03 (.01)	.05	<.001	-.15 (.01)	-.18	<.001	-.14 (.01)	-.17	<.001	-.14 (.01)	-.17	<.001
Parent-reported CP (T2)	.30 (.01)	.42	<.001	.25 (.01)	.36	<.001	.25 (.01)	.36	<.001									
Parent-reported CU traits (T2)										.58 (.02)	.41	<.001	.50 (.02)	.35	<.001	.50 (.02)	.35	<.001
Child-reported threat sensitivity (T1)				-.06 (.02)	-.03	.002	-.06 (.02)	-.03	.001				.07 (.03)	.02	.018	.07 (.03)	.02	.02
Parent-reported affiliation (T2)				-.45 (.02)	-.22	<.001	-.46 (.02)	-.22	<.001				-.53 (.04)	-.18	<.001	-.52 (.04)	-.18	<.001
Threat x affiliation							.08 (.03)	.03	.02							-.07 (.06)	-.01	.27
R^2		.19	<.001		.23	<.001		.23	<.001		.22	<.001		.25	<.001		.25	<.001

Note. T1, Time 1; T2, Time 2; CU, callous-unemotional; CP, conduct problems. Models regressed CU traits and CP assessed at T2 on threat sensitivity and affiliation. Table S6 presents replicated effects when measuring parent-reported CU traits at T3, and Table S7 shows replication of the main effects when threat sensitivity, affiliation, and CU traits were each measured via parent report at T3. Table S8 demonstrates that results are robust to ASD diagnosis (via statistical adjustment or listwise exclusion).

Table 2. Regression analyses examining child-reported threat sensitivity at T1 and parent-reported affiliation at T2 in relation to child-reported CU traits and CP at T3 in the ABCD Social Development sub-study (*n*=2,300)

	Child-reported CU traits (T3)									*Child-reported Aggression (T3)*								
	Model 1			**Model 2**			**Model 3**			**Model 1**			**Model 2**			**Model 3**		
Independent variables	*B (SE)*	*β*	*p*	*B (SE)*	*β*	*p*	*B (SE)*	*β*	*p*	*B (SE)*	*β*	*p*	*B (SE)*	*β*	*p*	*B (SE)*	*β*	*p*
Sex (T1)	-.10 (.02)	-.12	<.001	-.09 (.02)	-.11	<.001	-.09 (.02)	-.11	<.001	-.03 (.01)	-.07	<.001	-.03 (.01)	-.07	<.001	-.03 (.01)	-.07	<.001
Age (T1)	.00 (.00)	.08	<.001	.00 (.00)	.07	<.001	.00 (.00)	.07	<.001	.00 (.00)	.03	.09	.00 (.00)	.04	.07	.00 (.00)	.04	.07
Income (T1)	-.02 (.00)	-.10	<.001	-.01 (.00)	-.09	<.001	-.01 (.00)	-.09	<.001	-.01 (.00)	-.13	<.001	-.01 (.00)	-.12	<.001	-.01 (.00)	-.12	<.001
Child-reported aggression (T3)	.67 (.05)	.36	<.001	.68 (.05)	.36	<.001	.68 (.05)	.36	<.001									
Child-reported CU traits (T3)										.20 (.01)	.37	<.001	.20 (.01)	.37	<.001	.20 (.01)	.37	<.001
Child-reported threat sensitivity (T1)				-.04 (.01)	-.07	<.001	-.05 (.01)	-.07	<.001				.03 (.01)	.10	<.001	.03 (.01)	.10	<.001
Parent-reported affiliation (T2)				-.05 (.01)	-.08	<.001	-.04 (.01)	-.07	<.001				.00 (.01)	-.01	.76	.00 (.01)	-.01	.82
Threat x affiliation							-.01 (.02)	-.02	.40							-.01 (.01)	-.02	.47
R^2		.19	<.001		.20	<.001		.20	<.001		.18	<.001		.19	<.001		.19	<.001

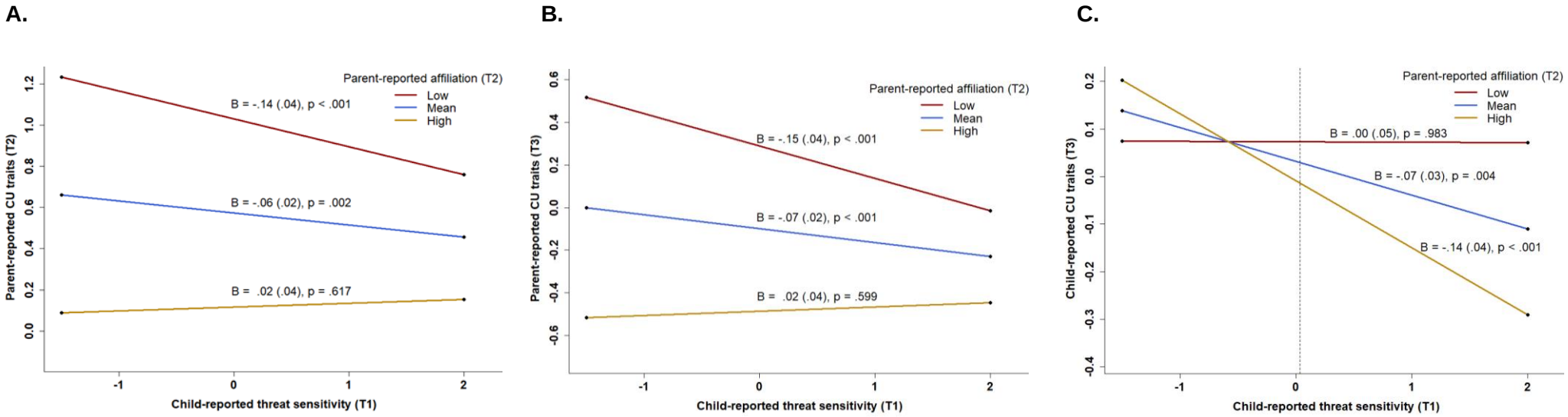
Note. T1, Time 1; T2, Time 2; T3, Time 3; CU, callous-unemotional; CP, conduct problems. Models regressed child-reported CU traits and CP at T3 on threat sensitivity and affiliation.

Table 3. Regression analyses examining child-reported threat sensitivity at T1 and parent-reported affiliation at T2 in relation to parent-reported anxiety and depression symptoms at T2 in the full ABCD sample (*N*=11,878)

	Parent-reported anxiety symptoms (T2)									*Parent-reported depression symptoms (T2)*								
	Model 1			**Model 2**			**Model 3**			**Model 1**			**Model 2**			**Model 3**		
Independent variables	*B (SE)*	*β*	*p*	*B (SE)*	*β*	*p*	*B (SE)*	*β*	*p*	*B (SE)*	*β*	*p*	*B (SE)*	*β*	*p*	*B (SE)*	*β*	*p*
Sex (T1)	.19 (.04)	.04	<.001	.20 (.03)	.04	<.001	.20 (.03)	.04	<.001	-.24 (.03)	-.05	<.001	-.15 (.03)	-.03	<.001	-.15 (.03)	-.03	<.001
Age (T1)	-.01 (.00)	-.03	.001	-.01 (.00)	-.03	<.001	-.01 (.00)	-.03	<.001	.01 (.00)	.03	.001	.01 (.00)	.02	.019	.01 (.00)	.02	.019
Income (T1)	.01 (.01)	.01	.451	.02 (.01)	.02	.057	.02 (.01)	.02	.064	-.05 (.01)	-.06	<.001	-.03 (.01)	-.03	<.001	-.03 (.01)	-.03	<.001
Parent-reported depression (T2)	.70 (.01)	.62	<.001	.63 (.01)	.56	<.001	.63 (.01)	.56	<.001									
Parent-reported anxiety (T2)										.55 (.01)	.61	<.001	.46 (.01)	.52	<.001	.46 (.01)	.52	<.001
Child-reported threat sensitivity (T1)				.24 (.03)	.06	<.001	.24 (.03)	.06	<.001				.01 (.03)	.00	.840	.01 (.02)	.00	.844
Parent-reported affiliation (T2)				-.42 (.04)	-.12	<.001	-.42 (.04)	-.12	<.001				-.84 (.04)	-.26	<.001	-.84 (.04)	-.26	<.001
Threat x affiliation							-.08 (.05)	-.02	.082							-.01 (.05)	.00	.899
R^2		.38	<.001		.40	<.001		.40	<.001		.39	<.001		.44	<.001		.44	<.001

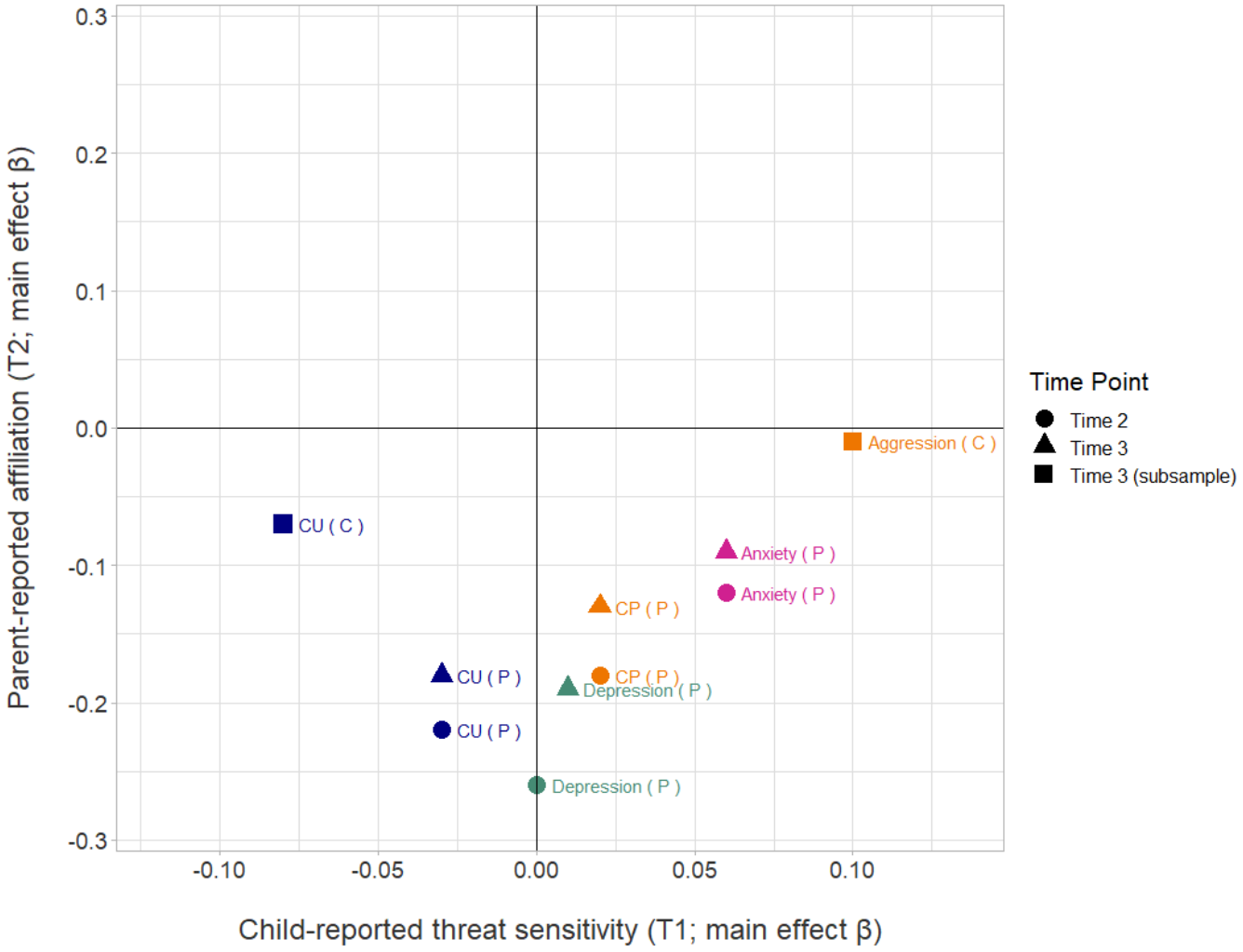
Note. T1, Time 1; T2, Time 2. CU, callous-unemotional; CP, conduct problems. Models regressed parent-reported depression and anxiety symptoms at T2 on threat sensitivity and affiliation. Table S11 shows replication when controlling for CU traits and CP. Table S12 demonstrates replicated findings when parent-reported anxiety and depression were assessed at T3.

Figure 1. Interactions between threat sensitivity and affiliation in relation to parent- and child-reported CU traits both cross-sectionally and longitudinally



Note. Region-of-significance analyses indicated that differences in simple slopes were significant at threat sensitivity values <3.19 for parent-reported CU traits at T2 (Panel A) and <2.53 at T3 (Panel B), meaning for all levels of threat sensitivity. For child-reported CU traits at T3, DBD group, simple slopes were significantly different at threat sensitivity values >-.03 (dotted line; 45% of the DBD subsample fell in the significant range).

Figure 2. Distribution of the standardized beta coefficients from main effects models for each of the dependent variables of CU traits, CP, anxiety, and depression across the hypothesized STAR model dimensions (Waller & Wagner, 2019).



Note. CU, callous-unemotional traits; CP, conduct problems; P, parent report; C, child report. Child-reported data were collected as part of the ABCD Social Development sub-study. The pattern of findings echoes the conceptual figure presented in Waller & Wagner (2019).