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Research paper

Affective theory of mind impairments linked with callous-unemotional traits implicate cognitive control: A pre-registered double-blind randomized controlled trial with a dual-task paradigm

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ABSTRACT

Introduction: Youth antisocial behavior strongly associates with conduct problems (CP) and callous-unemotional (CU) traits. While CP has links to broad cognitive impairments, CU traits have specific links with cognitive control and affective theory of mind (ToM) difficulties. Evidence suggests cognitive control limitations impact affective processing in ToM amongst youth with elevated CU traits. Here we sought to improve on those initial findings by leveraging a randomized dual-task (within-trial) design to replicate and extend prior findings.
Methods: In this double-blind, randomized controlled trial, 85 participants (47 % female) were stratified by sex and CU trait severity. The study employed a ToM task with cognitive, affective, and physical conditions, combined with an inhibitory processing task to tax cognitive control. Participants completed single and dual-task trials, counterbalanced to test within-subject effects. Primary hypotheses were tested with both CP and CU traits in the same model using repeated measure mixed effects to examine changes in accuracy and reaction time.
Results: CU traits were uniquely associated with greater impairments in affective ToM under dual-task conditions, reflecting increased difficulty integrating affective information when cognitive demands were increased. CP associated with lower single ToM performance but no change during dual-task trials. Notably, participants resilient to dual-task effects reported fewer antisocial behaviors, even with elevated CU traits.
Limitations: While appropriately powered for study aims, the sample was underpowered to detect any potential primary and secondary variant interactions on study outcomes.
Conclusions: These findings support a CU trait specific cognitive-affective interaction as a mechanism critical for understanding youth antisocial behavior.

1. Introduction

1.1. Theory of mind, cognition, and youth antisocial phenotypes

Theory of mind (ToM) refers to the ability to recognize and infer others mental (cognitive ToM) and emotional (affective ToM) state (Shamay-Tsoory et al., 2010). Greater ToM is linked to actions that aim to help others (i.e., prosocial behavior) and inversely related to acts that violate laws and human rights or harm others (i.e., antisocial behavior; Imuta et al., 2016). Youth phenotypes linked to antisocial behavior include conduct problems (CP; i.e., antisocial patterns of disruptive and aggressive behaviors linked with antisocial lifestyle features in adult psychopathy) and callous-unemotional (CU) traits (i.e., profound impairments in prosocial emotions of guilt, remorse, and empathy linked with affective deficits in adult psychopathy; Frick and White, 2008). These phenotypes are a public health concern due to their link with criminal convictions for serious crimes (> 50 % of convictions), aggression, and substance use as well as an increased economic burden on the public compared to those without CP or CU (Blair et al., 2014; Foster, Jones and Group, 2005; Gatner et al., 2023; Kahn et al., 2013; Rivenbark et al., 2018; Sakki et al., 2023; Winters et al., 2020).

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1.2. Youth antisocial phenotype similarities and distinctions

CP and CU traits often co-occur but are conceptually distinct, can present independently, and are associated with different types of antisocial outcomes (Baskin-Sommers et al., 2015). Given this related but distinct relationship, it stands to reason that functional impairments differentiate these phenotypes in specific processes rather than broad and general domains of impairment. For example, where general ToM deficits account for variance in both CP (Holl et al., 2021) and CU traits (Gillespie et al., 2018; Song et al., 2016), CU traits have a specific link with affective ToM impairments (Song et al., 2023). Relatedly, where general cognitive deficits are more strongly linked to CP (Baskin-Sommers et al., 2022; Gillespie et al., 2022), CU traits have a specific link with deficits in cognitive control (i.e., regulating behavior by inhibition, monitoring context, resolving conflicts, and organizing actions; Botvinick et al., 2001) during conflict between competing stimuli (Gluckman et al., 2016; Winters et al., 2023c). However, it is important to note a critical nuance in the relationship between CU traits and cognition including the types of cognitive processes that are measured. Some have argued that CU traits are associated with better performance on cognitive tasks, such as those involving action restraint or passive inhibition (e.g., Dotterer et al., 2021), and others support that better cognitive performance during cognitive interference predicts worse outcomes in youth elevated in CU traits (e.g., Baskin-Sommers et al., 2015), which highlights the importance of further examining these nuanced relationships. These distinctions in cognition and ToM between CP and CU traits are important considerations clinically, as the demonstrated limitations in efficacy of available treatments indicate a need to refine phenotypic specific targets aimed to redress underlying antisocial etiology (see reviews: Perlstein et al., 2023; White et al., 2022).

1.3. Antisocial etiology bifurcation and the need for cognition-affect investigations

Traditional etiological perspectives on CU traits have bifurcated focus on either affect (Blair, 2005; Lykken, 2013) or cognitive (reviews: Baskin-Sommers and Newman, 2013; Glass and Newman, 2009) difficulties. This dichotomy could be resolved by considering substantive evidence from other fields demonstrating interactions between cognition and affect in the etiology of behavior (e.g., Brosch et al., 2013; reviews: Pessoa, 2008; Pessoa, 2010). For example, affective deficit models propose that CU traits arise from deficient empathy that precludes learning from negative environmental cues (e.g., harm or punishment, including anger, fear, and sadness expressed by others: Blair, 2005; Lykken, 2013). However, this view overlooks literature showing that empathy is rooted in cognitive functioning (Krishnan et al., 2016; Waller and Wagner, 2019), affective processing interacts closely with cognitive processes in the brain (Duncan and Barrett, 2007), and that those elevated in CU have been shown to empathize accurately (e.g., Rijnders et al., 2021). In contrast, cognitive models of psychopathy in adults (e.g., response modulation hypothesis) argue that intact capacity for affective processing is impacted when stimuli fall outside primary attentional focus (Newman and Lorenz, 2003). This view has been extended into the attention bottleneck hypothesis, which suggests selective attention limits contextual information processing (Baskin-Sommers and Brazil, 2022; Tillem et al., 2021). Critiques of these models question the attention model used rather than a limitation in computational resources as well as a lack of consideration of affect (Blair and Mitchell, 2009). Additions to the cognitive models may have redressed these concerns as affect processing has been included in cognitive models implicating a cognitive-affective interaction (e.g., Baskin-Sommers et al., 2022; Baskin-Sommers and Newman, 2013) and the load on cognitive resource has been recognized as an important feature for disentangling cognition and affect (Baskin-Sommers and Brazil, 2022).

However, prior work has largely focused on adult psychopathy, and we lack rigorous tests of these models in youth, which could provide insights in the developmental pathways from CP and CU traits to severe antisocial behavior and psychopathy. In particular, the notion of resource allocation for cognitive control appears particularly relevant for understanding the specific cognition-affect computations that might underpin CU traits. The computation influencing the probability of using available resources for cognitive control, named the expected value of control, balances the cost and payoff of allocating resources to processes involving control (Shenhav et al., 2013). This computation can include an affective value that interacts with cognitive function (cognitive control and perception), which is the point at which affect and cognition compete for resources and interact (Pessoa, 2010). This computation is hypothesized to relate to CU traits via a cognitive resource vulnerability where lower cognitive demands make resources more scarce and less probable to be allocated for processing others affect (Winters and Sakai, 2023), potentially explaining the etiological basis of CU traits such as low empathy, remorse, and guilt.

1.4. Limited prior work on antisocial limitations in cognitive-affective interactions

To date, a handful of studies provide insight into the link between CU traits and limitations in resources for cognitive control. In a series of behavioral studies, adolescents aged 9-13 elevated in CU traits uniquely associated with difficulties in resource availability for cognitive control (Gluckman et al., 2016; Winters and Sakai, 2023). Moreover, CU traits, but not CP, were uniquely related to difficulties allocating resources for affective ToM as competing cognitive control processes were increased (Winters and Sakai, 2023). From the neuroimaging literature, CU traits have been linked to disrupted connectivity between regions involved excepted value evaluation and attention conflict resolution (Pessoa, 2010; Shenhav et al., 2013). For example, amongst adolescents ages 13-17, CU traits have been linked to disrupted connectivity of the anterior cingulate cortex (ACC) with the lateral prefrontal cortices (Winters et al., 2023a; Winters et al., 2023; Winters et al., 2022; Winters et al., 2021) as well as the ACC and amygdala and anterior insula (Winters and Hyde, 2022; Winters et al., 2023b). Moreover, one study found aberrant ACC connectivity is implicated in cognitive controls influence with ToM (Winters et al., 2023c). Together, these findings support CU trait specific resource limitations that impact cognitive-affective processes and are, in part, supportive of cognitive-affective adult models (e.g., Baskin-Sommers et al., 2022; Baskin-Sommers and Newman, 2013).

1.5. Considerations to link antisocial phenotypes with cognitive-affective difficulties

However, to better evaluate cognitive-affective models in relation to CU traits and CP in youth, studies are needed that adopt dual-task designs, which offer advantages over pre-post-designs when studying cognition. Cognitive processes in humans such as response selection, attention, and cognitive load have been found to be constrained by limitations in central information processing and resources when tested with dual-tasks (Dux et al., 2006; Tombu et al., 2011). Dual-tasks (e.g., within trial increases of cognitive control demands to test effect on ToM) provide multiple advantages over pre-post designs (i.e., paradigm loading cognitive control with pre and post ToM) when testing central information processing that includes: (1) within trial tests that provide multiple datapoints providing a more reliable estimate; (2) within-subject concurrent performance that improves isolation of cognitive processes being tested; and (3) the ability test different processes on primary task of interest in one task. Evidence of these advantages in neurotypical samples demonstrate reaction time changes after imposing a load between 0 and 500 ms but not when delays are longer after the loading task (e.g., 1100 ms; Dux et al., 2006; Tombu et al., 2011). In a sample elevated in psychopathy, however, Tillem et al. (2021) demonstrated that effects persisted from 300 ms to at least 1100 ms indicating a greater difficulty recovering from additional load. Given prior work using a pre-post design implicates a similar effect in early adolescents (Winters and Sakai, 2023), using a dual-task design offers the ability to replicate and extend these prior findings.

Additional considerations to improve inferences on cognitive-affective interactions involve designing the dual-task, statistical controls, and sample recruitment. For design, incorporating a control sample that does not receive the exposure; the use of a double-blind randomized clinical trial; and leveraging a ToM task that tests cognitive, affective, and physical conditions to isolate the separate components of ToM would improve inferences at the design level. For statistical controls, including ADHD, IQ, and internalizing to better isolate variance specific to CU and CP. For the sample, recruiting from the community as opposed to comparing incarcerated and non-incarcerated samples can improve estimates by affording (1) adequate sample variance to detect ToM and cognition effects that are commensurate with incarcerated samples (e.g., Andover et al., 2011; Gillespie et al., 2018; Viding and McCrory, 2012); (2) less bias that is unaccounted for (e.g., omitted variable bias: Wilms et al., 2021) due to non-random differences that characterize incarcerated samples such as chronic health conditions, demographic, and socioeconomic origins that effect both health and cognition (e.g., Ahalt et al., 2012; Massoglia et al., 2013); and (3) robust isolation of phenotypic associations by eschewing ceiling effects on incarcerated samples mental health and trauma symptoms (Wolff and Shi, 2012). The present study builds on prior work by implementing the improvements listed above in a preregistered data collection and analysis (https://doi.org/10.17605/OSF.IO/BHWEU).

2. Methods

2.1. Power analyses

Two a priori power analyses were conducted for sample size determination. The first was based on Tillem et al. (2021) adult dual-task findings testing cognitive performance association with psychopathy to determine the sample needed for an omnibus test comparing against controls using G*Power (Faul et al., 2009), which indicated 72 participants provided 80 % power as an omnibus test. A second power analysis ran 1000 simulations of the proposed repeated measures mixed effects model in simr (Green et al., 2017), which indicated 80 participants afforded at least 90 % power to detect repeated measure phenotypic specific effects. This motivated a recruitment goal of 100 participants to account for up to 20 % attrition.

2.2.–2.4. Recruitment, study procedures, and randomization and blinding

See supplementary methods.

2.5. Transparency and openness

See supplementary methods. Study preregistration is available at https://doi.org/10.17605/OSF.IO/BHWEU as well as data, task and analysis code, and output is available at https://doi.org/10.17605/OSF.IO/7G8CJ or https://github.com/drewwint/pub_dual-task_tom_cog-ctrl_rct.

2.6. Sample

The final sample (see Supplemental Fig. 1) consisted of 85 adolescents (ages 12-14, 13 ± 0.83) balanced on sex (female 47 %, male 53 %) with an IQ > 70 (IQ 94.84 ± 17.02) and predominately White (White 67 %, Asian 12 %, Mixed Race 8 %, Black 7 %, Hispanic 5 %, American Indian 1 %; see Table 1). Clinically indicated sample proportions (identified via self-report cut-offs) were: CU traits 48 %, CP 18 %, ADHD 26 %, and internalizing 8 %. Phenotype-specific proportions by CU trait severity can be found in Supplemental Table 1.

2.7. Measures

2.7.1 Self-report measures

The Inventory of Callous-Unemotional Traits (ICU; Frick, 2004; Sample $\Omega = 0.861$). The 24-item ICU asks participants to rate items such as “I do not care who I hurt to get what I want” on a Likert scale from 0 (“not true at all”) to 3 (“definitely true”) with higher scores indicating higher CU traits. Consistent with Kimonis et al. (2015) we removed 2

Table 1
Sample descriptives.

		Descriptives	Group		t or X^2	Correlation Table							
		Sample	Control	Test									
		Mean ± SD or N(%)	Mean ± SD or N(%)		p	2	3	4	5	6	7	8	9
1	CU traits	16.18 ± 6.92	16.93 ± 7.49	15.17 ± 6.06	0.232	0.476*	0.034	-0.013	-0.064	0.034	0.022	0.533*	0.367
2	CP	1.61 ± 1.69	1.55 ± 1.72	1.69 ± 1.68	0.333		-0.154	-0.069	-0.056	0.025	0.084	0.645*	0.470*
3	Sex (Male)				0.846			-0.056	0.106	0.092	-0.115	-0.074	-0.300
	Male	45(53 %)	25(29 %)	20(24 %)									
	Female	40(47 %)	24(28 %)	16(19 %)									
4	Race (White)				0.765				-0.023	-0.173	-0.129	0.033	-0.213
	White	57(67 %)	34(40 %)	23(27 %)									
	Non-White	28(33 %)	15(18 %)	13(15 %)									
5	IQ	94.84 ± 17.02	92.1 ± 14.6	98.5 ± 19.4	0.101					0.000	0.025	-0.116	0.132
6	Age	13.04 ± 0.84	13.02 ± 0.82	13.05 ± 0.86	0.851						-0.090	-0.035	0.059
7	Response	0.18 ± 0.38	0.16 ± 0.37	0.19 ± 0.40	0.717							-0.001	0.081
8	ADHD	4.14 ± 2.87	3.87 ± 2.74	4.5 ± 3.02	0.333								0.459*
9	Internalizing	5.33 ± 3.70	4.65 ± 3.43	6.25 ± 3.90	0.060								

* $p < 0.05$.

items from the measure due to poor psychometrics prior to calculation of the total score used in analysis. During screening, we identified those elevated in CU traits using the 9-item split coding method (Kimonis et al., 2015; Sakai et al., 2016), which has better reliability (0.72 versus the other methods 0.42–0.7; Kimonis et al., 2015) and commensurate with prior work testing this effect (Winters and Sakai, 2023).

Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997; Goodman et al., 2003; total score sample $\Omega = 0.910$). Conduct problems ($\Omega = 0.770$), ADHD ($\Omega = 0.847$), and internalizing ($\Omega = 0.779$) symptoms were assessed using the 25-item SDQ. Participants rate items such as "I take things that are not mine from home, school or elsewhere" on a scale of 0 ("not True") to 2 ("Certainly True"). Higher scores indicate greater symptoms.

Delinquency Scale (Pechorro et al., 2019). Antisocial behavior was assessed with the Add Health Self-Report Delinquency Scale. This 17-item index of delinquent behavior assesses frequency of violent and nonviolent acts. Participants rate items on a 4-point ordinal scale from 0 (none) to 3 (five or more times) on items such as ("get into a serious physical fight?") with higher scores indicating a greater frequency of antisocial acts.

Shipley Institute of Living Scale-2 (Zachary and Shipley, 1986). This IQ measure involves 60-items across vocabulary and abstract thinking subscales that were used to derive a metric indexing IQ.

2.7.2. Dual-task paradigm behavioral tasks

Stimulus Selective Stop Signal Task (SSSST; Sánchez-Carmona et al., 2021): The SSSST is a modified version of a stop signal task involving inhibition along with an added response selection during stop trials. The SSSST has three conditions involving the traditional go (60 % of trials where participants press the spacebar when they see a single arrow down) and non-response inhibit trials (i.e., passive control; 20 % of trials where participants don't press anything when they see a green square) along with a stop and select trial (i.e., selective control; 20 % of trials where participants press 'k' when they see a red diamond). This additional trial type leverages principles of stimulus-driven attention (Corbetta and Shulman, 2002) for an active inhibitory response that is more desirable for the effect being tested because (1) passive control trials are ineffective as a cognitive load during dual tasks (Van Nuland and Rogers, 2016) and (2) those elevated in CU traits show more consistent decrement in cognitive control when selectively inhibiting (e.g., Gluckman et al., 2016). The SSSST employs both passive and selective components of cognitive control (Goghari and MacDonald III, 2009) that modulate ToM (Corbetta et al., 2008; Vetter et al., 2013; Wade et al., 2018) making it the ideal secondary task for the present dual-task paradigm (Supplemental Fig. 2-A).

Cognitive and Affective ToM Task CAToon (Borbás et al., 2021): CAToon consists of 30 hand-drawn stories, including two experimental conditions targeting affective ToM and cognitive ToM and physical causality as a control condition without cognitive or affective information. Each condition comprises 10 stories with different backgrounds and similar visual complexity. The conditions were designed to differentially motivate affective versus cognitive aspects of ToM reasoning. During affective trials participants must infer how a character would react to a fellow character's emotions. During cognitive trials participants infer how characters would act based on another character's intentions or beliefs. Physical trials serve as a control condition, requiring a basic understanding of cause and effect and basic physical laws. Trials start with three consecutively presented images, followed by a single image displaying three possible endings from which to select (Supplemental Fig. 2-B).

Dual-task paradigm: The present dual-task design is based on testing cognitive load theory (Sweller et al., 1998) grounded in evidence that there are independent subcomponents of cognition with limited capacity to handle multiple sources of information. This dual-task paradigm involves completing the SSSST and ToM task simultaneously with the SSSST as the secondary task requiring additional demands on cognitive control (selective control: Goghari and MacDonald III, 2009) known to compete with ToM (Corbetta et al., 2008; Vetter et al., 2013; Wade et al., 2018).

This paradigm involves the completion of five SSSST trials (go 60 %, passive control 20 %, and selective control 20 %) prior to each of the three scenes for each ToM trial. To test cognitive factors for ToM rather than decision making, the dual-task SSSST trials were only presented before the three ToM scenes. Thus, 15 SSSST trials were completed for every one of the 30 ToM trials resulting in a total of 450 SSSST trials. Each trial (both SSSST and ToM) was presented randomly with each ToM scene presented for 1100 ms. The 1100 ms scene timing was chosen to minimize recovery time from load on cognitive control (up to 1100 ms for psychopathic triats: Tillem et al., 2021) while allowing adequate time to for ToM. The intertrial interval (ITI) had a 2000 ms jittered mean within 1500-2500 ms to prevent patterned responses and trial spillover effects (Supplemental Fig. 2-C).

2.7.3. Calculated measures

Careless Respondents. To redress issues with inattentive responses, participants with patterned responses were identified using the 'careless' package (Yentes and Wilhelm, 2018). Specifically, a three-pronged approach identified 1) long-string – the length of same response with larger values indicating carelessness, 2) item-variability - how variable responses are with both extremely high [completely random] or low [consistent similarity] indicates carelessness, and 3) even-odd – similarity of even and odd item items with more similarity indicating carelessness (Dunn et al., 2018; Johnson, 2005). With these metrics, careless participants were defined with highly conservative criteria of 3*median absolute deviation (Leys et al., 2013) to regress out this confound.

Dual-Task Effects. In secondary analyses we tested a within-individual measure of change under the loaded dual-task relative to the single ToM task with the Longhurst et al. (2022) equation $\frac{(Dual\ Task - Single\ Task)}{Single\ Task}$. Higher scores indicate the dual-task was less challenging whereas low scores indicate greater dual-task difficulty.

Inverse Efficiency. To supplement findings from the primary analyses on accuracy and reaction time separately, we conducted supplementary analyses that account for speed accuracy trade-offs using inverse efficiency using the formula outlined in Akhtar and Enns (1989); and Bruyer and Brysbaert (2011) $\frac{Reaction\ Time}{Percent\ Correct}$. This metric is interpreted as the average energy consumed (Townsend and Ashby, 1983, p. 204) with high values suggesting more resource consumption and lower values suggest less resource consumption.

2.8. Covariates

All analyses controlled for race, IQ, sex at birth, careless responses, ordering of tasks, ADHD, and internalizing symptoms. Race was included to account for variation in identifying emotions in those outside one's racial identity (Chiroro and Valentine, 1995). Race was dichotomized to represent the most represented racial category (White) because 1) ToM vignettes (although racially ambiguous) used a lighter skin tone for all actors that could be interpreted as an individual of European descent and 2) to have adequate representation to regress out race-related impact on ToM task. Task order accounted for potential learning effects. ADHD is implicated in cognitive performance (Godinez et al., 2015; Longhurst et al., 2022) and often associated with externalizing behavior (Ahmad and Hinshaw, 2017). Finally, internalizing accounted for relationship with CU traits (Derks et al., 2024), ToM (Konrad et al., 2024) and cognition (Blanken et al., 2017; Vedechkina et al., 2023).

CU, CP, and ADHD were significantly related and were in our sample (Table 1). To ensure we retained adequate variance for analysis, we quantified the amount of variance retained with a multiple correlation coefficient formula CU (x), CP (y), and ADHD (z): ${R^2}_{x*xy} = 1 - \frac{r_{xz}^2 + r_{yx}^2 - 2r_{xz}, r_{yx}, r_{xy}}{1 - r_{xy}^2} = 1 - \frac{0.412 + 0.284 - 0.327}{0.774} = 0.52$ or 52 % of retained variance in both CU traits and CP. This is commensurate with other studies (e.g., Fontaine et al., 2023; Saunders et al., 2019). Concerns regarding collider and suppression effects were also ruled out.

2.9. Analysis

Analytic approach. Using 'lme4' (Bates et al., 2014) and 'lmertest' (Kuznetsova et al., 2019), repeated measures mixed effects accounting for individual variation was used to test primary hypotheses on dual-task effects on ToM accuracy and reaction time as preregistered.

Analyzing accuracy and reaction time separately allows for a more precise examination of distinct cognitive processes that might be conflated in combined metrics (Bruyer and Brysbaert, 2011). Combined metrics, such as inverse efficiency scores, capture different aspects of cognitive processing than when accuracy and reaction time are examined independently (Townsend and Ashby, 1983). In our study, we aim to test differences in successful theory of mind performance (accuracy) and processing speed (reaction time) separately. This approach is consistent with prior dual-task analyses (Van Nuland and Rogers, 2016) as well as studies on psychopathic traits (Tillem et al., 2021). To bolster robustness for the analysis, a supplemental analysis was conducted using inverse efficiency that combines these metrics.

To test phenotypic implications in dual-task effects, interactions of time*group*phenotype were derived using the residual centering approach (Geldhof et al., 2013; Little et al., 2006). All model parameters were bootstrapped with 10,000 non-parametric random effect block resamples using 'lmersample' (Loy and Korobova, 2021) to both bolster confidence in interaction tests and bias correct p values. This approach bolsters our statistical inferences by accounting for individual variation that redresses missing variable bias (Ghose, 2019) while improving generalizability (Yarkoni, 2020).

Assumption Checking. In accordance with Antonakis et al. (2021), we tested whether assumptions were met regarding endogeneity, heteroskedasticity, residual distribution, autocorrelation, and outliers that would influence results for all analyses using the 'performance' package (Lüdecke et al., 2021). There are no assumption violations to report.

3. Results

3.1. No sample or task abnormalities

Phenotype distribution consistent with norms and between groups. The current sample had distributions for the ICU (16.18 ± 6.92) and SDQ CP (1.61 ± 1.69), hyperactivity-inattention (4.14 ± 2.87), and internalizing (5.33 ± 3.70) that were within expected distributions for community samples in the sampled age range (Essau et al., 2006) and population norms (https://sdqinfo.org/norms/USNorm1.pdf). Importantly, the distribution of clinical cut-offs for these symptoms was not statistically different by group and order assignment (CU traits: $X^2 = 1.07$, $p = 0.78$; CP: $X^2 = 2.37$, $p = 0.50$; ADHD; $X^2 = 2.32$, $p = 0.51$; Internalizing; $X^2 = 5.94$, $p = 0.19$; Supplemental Fig. 3).

Phenotype associations commensurate with literature. Phenotype associations demonstrated expected positive associations between CU traits, CP, ADHD, and internalizing (Table 1). There were expected associations for CU traits and CP, with both relating to higher delinquency as well as lower prosociality and mentalizing (Supplemental Fig. 4).

No bias found in ToM or dual-task performance. There was no detected baseline between group differences in ToM (F(3, 42.93) = 50, $p = 0.68$; Supplemental Fig. 5; Note baseline ToM differences between groups would suggest bias by group assignment). The dual-task performed as expected as evidenced by (1) the odds ratio (OR = 3.75) suggesting that test exposure reductions in ToM task performance is 3.75 times higher than those in the control condition and (2) participants in the control condition had shorter reaction times than the test condition (T(46.52) = -21.67, $p < 0.001$; Supplemental Fig. 6).

3.1.1. CU traits uniquely associate with cognitive control limitations impacting ToM

Overall ToM task *accuracy* and *reaction time* decrements specific to CU traits. Test participants higher in CU traits had a distinct association with decrements in overall ToM task during the dual-task (relative to the single ToM task) for both accuracy (β = -8.05, $p = 0.012$, $R^2 = 0.192$ [negative β indicates lower accuracy], Table 2, Fig. 1A; Supplemental Table 2) and reaction time (β = 2.067, $p = 0.185$, $R^2 = 0.061$ [positive β indicates longer reaction time], Table 2, Fig. 2A; Supplemental Table 6).

Affective ToM *accuracy* and *reaction time* decrements specific to CU traits. Test participants higher in CU traits had decrements in affective ToM accuracy (β = -5.477, $p = 0.002$, $R^2 = 0.165$, Table 2, Fig. 1B; Supplemental Table 3) and reaction time (β = 2.481, $p = 0.007$, $R^2 = 0.062$, Table 2, Fig. 2B; Supplemental Table 7).

Cognitive ToM *accuracy* unaffected, but *reaction time* decrements specific to CU traits. Test participants higher in CU traits associated with longer reaction times (β = 2.317, $p = 0.020$, $R^2 = 0.083$, Table 2, Fig. 2C; Supplemental Table 8), but no changes in cognitive ToM accuracy (β = -1.286, $p = 0.416$, $R^2 = 0.124$, Table 2, Fig. 1C; Supplemental Table 4).

No changes detected in physical trials. Dual-task effects on physical trials had no statistically meaningful associations (Table 2; Supplemental Tables 4 and 9).

CP ToM deficits are unrelated to cognitive control. CP associated with ToM accuracy decrements during single ToM task (Supplemental Tables 24-27) for baseline overall (β = -1.044, $p = 0.021$, $R^2 = 0.187$) and baseline affective trials (β = -0.449, $p = 0.022$, $R^2 = 0.133$); however, there were no statistically meaningful effects detected for those in the test group that were elevated in CP during the dual-task (Table 2).

CU traits uniquely associate with greater dual-task difficulty. Greater difficulty during the dual-task was specific to test participants higher in CU traits (β = -0.885, p = 0.022, $R^2 = 0.178$) as no effects were detected for CP (Table 3; Supplemental Table 13).

Table 2
ToM *Accuracy* change from single-task to dual-task.

Interactions[+]	β	se	t	p	Bootstrapped CI 95 % Lower	Upper
Accuracy						
Overall ToM Accuracy ~ ($R^2 = 0.192$)						
CU	-8.050*	3.332	-2.575	0.012	-14.600	-1.553
CP	-4.510	6.188	-0.776	0.440	-16.500	7.716
Affective ToM *Accuracy* ~ ($R^2 = 0.165$)						
CU	-5.475*	1.852	-3.142	0.002	-9.099	-1.836
CP	-3.068	3.423	-0.947	0.346	-9.689	3.686
Cognitive ToM *Accuracy* ~ ($R^2 = 0.124$)						
CU	-1.286	1.697	-0.818	0.416	-4.556	2.048
CP	0.034	3.122	0.011	0.992	-6.129	6.088
Physical Trials Accuracy ~ ($R^2 = 0.206$)						
CU	-1.287	1.720	-0.801	0.425	-4.649	2.133
CP	-1.474	3.196	-0.492	0.624	-7.686	4.917
Reaction Time (RT)						
Overall ToM RT ~ ($R^2 = 0.061$)						
CU	2.067*	0.922	2.404	0.019	0.276	3.914
CP	2.226	1.725	1.392	0.168	-1.166	5.528
Affective ToM *RT* ~ ($R^2 = 0.062$)						
CU	2.483*	0.970	2.736	0.008	0.583	4.417
CP	2.192	1.820	1.300	0.197	-1.433	5.758
Cognitive ToM *RT* ~ ($R^2 = 0.083$)						
CU	2.318*	1.058	2.369	0.020	0.245	4.442
CP	2.600	1.966	1.429	0.157	-1.312	6.453
Physical Trials RT ~ ($R^2 = 0.066$)						
CU	1.402	0.979	1.518	0.133	-0.496	3.311
CP	1.890	1.840	1.099	0.275	-1.741	5.463

Notes: (1) Tables only show effects of interest involving interactions with group (test vs control) by repeated measures (single to dual-task) and phenotype (CU and CP). Full tables can be found in Supplemental Material (Supplemental Tables 2-5); (2) Parameters are bootstrapped corrected using 10,000 resamples.

[+] All levels of interaction were tested in the model, but only the tested interactions are listed.

[*] Statistically significant ($p < 0.05$) for two-tailed test with bootstrapped corrected p-values.

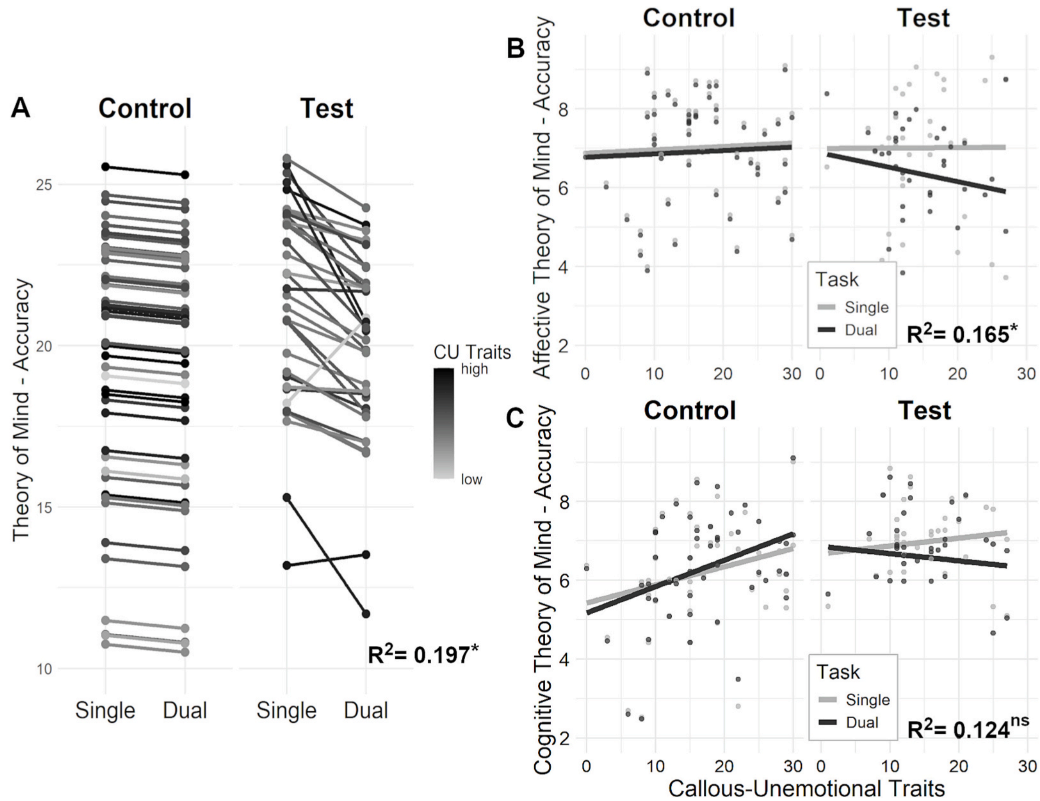

Fig. 1. Depicting callous-unemotional traits association with theory of mind accuracy across repeated measures for control and test groups. A) overall task, B) Affective Trials, C) Cognition Trials.

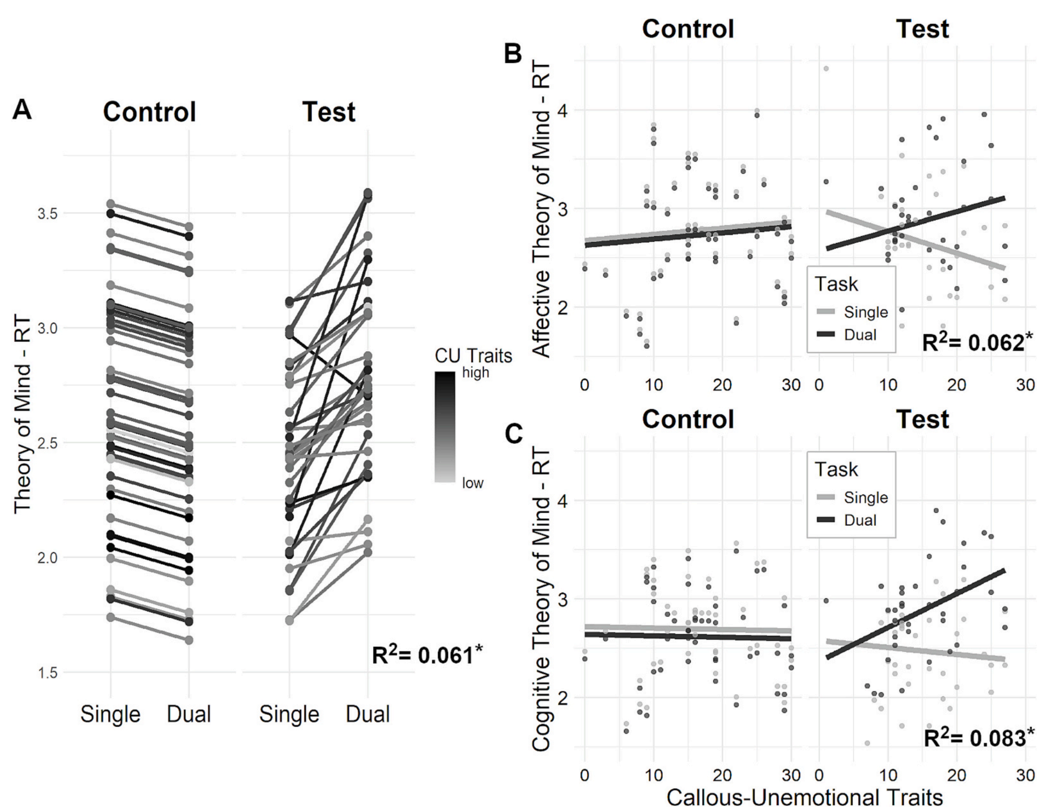

Fig. 2. Depicting callous-unemotional traits association with theory of mind reaction time across repeated measures for control and test groups. A) overall task, B) Affective Trials, C) Cognition Trials.

Table 3
Secondary analyses.

Interactions[+]	β	se	t	p	Bootstrapped CI 95 % Lower	Upper
Dual-Task Effects from Single to Dual-Task						
Dual-Task Effects ~ (R^2 = 0.223)						
CU	-0.885*	0.377	-2.345	0.022	-1.584	-0.207
CP	-0.273	0.155	-1.767	0.082	-0.558	0.007
Contrast Change from Single-Task to Dual-Task						
Affective > Physical ~ (R^2 = 0.119)						
CU	-4.812*	1.935	-2.663	0.009	-8.573	-0.972
CP	-2.309	3.544	-0.688	0.494	-9.197	4.643
Cognitive > Physical ~ (R^2 = 0.095)						
CU	-0.543	1.949	-0.302	0.763	-4.339	3.327
CP	0.887	3.595	0.264	0.792	-6.230	7.946
Affective > Cognitive ~ (R^2 = 0.136)						
CU	-4.858*	1.922	-2.694	0.009	-8.593	-1.126
CP	-3.085	3.565	-0.920	0.360	-10.050	3.873
Dual-Task Effects for Affective ToM by Trial Type						
Passive Control Trials ~ (R^2 = 0.207)						
CU	0.111	0.127	0.876	0.384	-0.142	0.365
CP	0.336	0.293	1.147	0.255	-0.248	0.921
Selective Control Trials ~ (R^2 = 0.321)						
CU	-0.343*	0.148	-2.314	0.024	-0.638	-0.048
CP	0.421	0.344	1.224	0.225	-0.265	1.108
Delinquency as a function of Affective ToM Change from Single to Dual-Task						
Delinquency ~ Resilience to Load[+++] ~ (R^2 = 0.338)						
CU	-1.168*	0.549	-2.129	0.037	-2.126	-0.210
CP	0.286	0.151	1.899	0.062	-0.023	0.550

Notes: (1) Tables only show effects of interest involving interactions with group (test vs control) by repeated measures (single to dual-task) and phenotype (CU and CP) and complete tables can be found in Supplemental Material (Supplemental Tables 10-14); (2) Parameters are bootstrapped corrected using 10,000 resamples; (3) for dual-task effects negative values indicate greater difficulty for the dual-task (greater dual-task effect).

[+] All levels of interaction were tested in the full model, but the tested interactions are listed.

[+++] Interactions include phenotype listed * Group * change after load.

[*] Statistically significant ($p < 0.05$) for two-tailed test with bootstrapped corrected *p*-values.

3.2. Selective control impacts affective ToM for CU traits

Cognitive control links to Affective ToM decrements for CU traits. Contrasts between ToM trials revealed that CU traits were associated with lower accuracy during Affective > Physical trials (β = -4.811, p = 0.009, R^2 = 0.138) and Affective > Cognitive (β = -4.860, p = 0.008, R^2 = 0.138) but not Cognitive > Physical trials. These effects were unique to CU traits and not found for CP (Table 3; Supplemental Tables 10-12).

Selective control distinctly impacts affective ToM for CU traits. Dual-task effects examined by trial type demonstrated that passive control trials did not impact affective ToM (Table 3, Supplemental Table 14); however, selective control trials revealed that CU traits were associated with greater difficulty during affective ToM (β = -7.33, p = 0.018, R^2 = 0.288; Table 3, Supplemental Table 15) and trial specific effects were detected for CP.

3.3. Cognitive resilience associated with less delinquency for CU traits

Resilience to inhibition manipulation during affective ToM trials (defined as no decrease in affective ToM from single to dual-task amongst those in the test group) was associated with lower delinquency for those elevated in CU traits (β = -1.168, p = 0.037, R^2 = 0.338; Fig. 3, Table 3, Supplemental Table 16).

3.4. Greater resource consumption associated with CU traits

Resource consumption from single to dual task was associated with higher CU traits amongst those in the test group for overall ToM (β = 7.249, p = 0.017, R^2 = 0.194; Table 3, Supplemental Table 17), affective ToM (β = 13.664, p = 0.001, R^2 = 0.160; Table 3, Supplemental Table 18), and cognitive ToM (β = 6.708, p = 0.031, R^2 = 0.180; Table 3, Supplemental Table 19), but no changes in resource consumption were detected for physical trials (Supplemental Table 20). CP did not associate with changes in resource consumption for all trials (Supplemental Tables 17-20).

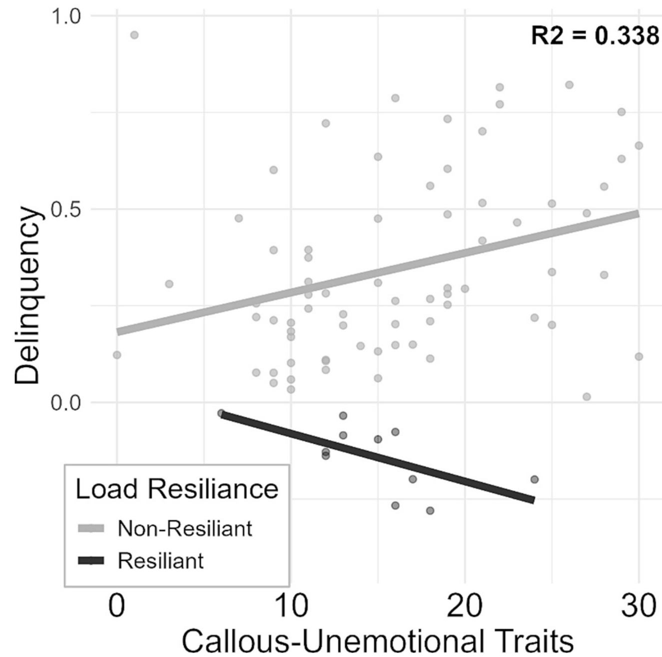

Fig. 3. Depicting the relationship between delinquency and callous-unemotional traits for those non-resilient and resilient to cognitive load.

4. Discussion

The current double-blind clinical trial with a community sample of early adolescents oversampled for elevated CU traits and balanced between sex at birth finds support for a cognitive-affective interaction implicated in antisocial behavior that is unique to CU traits. Adolescents elevated in CU traits demonstrate resource limitations in cognitive control that (1) impacted ToM, (2) were specific to demands of selective control, and (3) related to their self-reported antisocial behavior. These results extend previous work by isolating cognitive control in a dual-task design in a randomized clinical trial while isolating components of ToM and controlling for known confounds. This study adds to the mounting evidence that cognitive-affective interactions are important for the study of antisocial behavior, particularly pathways involving CU traits.

4.1. Callous-unemotional affective theory of mind deficits involve cognitive control

CU traits uniquely associated with ToM decrements after loading cognitive control. CU traits were associated with decrements in ToM from single ToM to the dual-task after manipulating cognitive control but not the single ToM trials. This finding is consistent with the notion that those elevated in CU traits can superficially appear to infer and understand emotional states of others (e.g., Rijnders et al., 2021), but that more consistent decrements are found when adding additional cognitive demands (review: Baskin-Sommers and Brazil, 2022). Additional demands in the form of complex emotions (requiring more cognitive resources to process: Yates et al., 2010) have also shown ToM decrements uniquely associating with CU traits during a single task in prior work (Sharp et al., 2015; Winters and Sakai, 2023). While informative, these prior efforts could not isolate the specific cognitive processes implicated in ToM deficits. While the ToM task in the present study had some complex emotions, these have not been formalized as in the task used in prior work with adequate trials to detect these effects. This is a plausible explanation as to why single ToM trials did not associate with CU, but instead elevated cognitive demands and evidence CU related ToM decrements involving the change from the single to dual-task implicate limitations in cognitive control. This result replicates Winters and Sakai (2023) initial findings and extends it to within-trial changes in both accuracy and processing speed during ToM.

CU trait cognitive control limitations linked distinctly to affective processing. Affective ToM decrements unique to CU traits were observed for both accuracy and reaction time as well as contrasts of affective ToM over cognitive ToM and physical trials. Thus, our results suggest that CU traits are specifically associated with difficulties inferring affect rather than physical or spatial inferences, with cognitive control resource limitations. Specifically, vulnerability to greater cognitive demands during selective control trials impacts the propensity to take in affective information from others.

Selective control is a cognitively demanding function that differs from interference control or passive action restraint tasks, highlighting an important consideration for studying cognition in psychopathic traits. Specifically, passive inhibitory tasks, such as the stop-signal and go/no-go tasks, are generally less demanding (Van Nuland and Rogers, 2016). Given the conflicting findings associated with these tasks they may not be as relevant for understanding CU traits as selective control. Our findings align with prior research on selective control in youth (Gluckman et al., 2016) as well as adults (Anderson et al., 2018; Anderson et al., 2015), but extend this work by linking impairments in selective control to deficits in affective processing— a core characteristic of CU traits.

This study replicates prior work (Winters and Sakai, 2023) and may support adult psychopathy models proposed by Baskin-Sommers et al. (2022) implicating affect in cognitive function. Results also speak to the assertion of Baskin-Sommers and Brazil (2022) that cognitive resources are involved in affective processing. The current affective ToM finding may also be developmentally specific in early adolescents that later result in learned cognitive strategies proposed in the attention-bottleneck model for adults elevated in psychopathy (e.g., Baskin-Sommers and Brazil, 2022). In an attempt to conserve resources a serial processing strategy may be used as it appears to consume less resources initially, but it is shown to expend greater resources in the long-term (Fischer and Plessow, 2015). Such an approach may train one to limit the scope of attention that information is processes to counteract resource limitations throughout early development and become a learned strategy impacting cognitive-affective competition for brain resources (e.g., Pessoa, 2010). This interpretation is initially evidenced by the current findings that (1) those elevated in CU traits had greater resource consumption and (2) dual-task effects were distinctly more difficult and unique to selective control for those elevated in CU traits.

Cognitive ToM trials revealed a decrement in processing speed that did not impact accuracy. This finding supports Drayton et al. (2018) findings that there is a limitation in automaticity for cognitive ToM that does not necessarily impact accuracy. The present study extends this by linking cognitive control limitations to early adolescents elevated in CU traits. Additionally, CU traits associated with stronger dual-task effects without impacting cognitive ToM. This supports the notion that cognitive control is uniquely implicated in affect processing difficulties at elevated CU traits and evidence specific processes for a psychological cognitive-affective mechanism unique to CU traits.

4.2. CP decrements in affective ToM unrelated to cognitive control

CP were unrelated to ToM changes from single to dual-task but were related to decrements during the single ToM task. Importantly, this was specific to affective ToM trials. This is consistent with work implicating CP with decrements in ToM (Holl et al., 2021) and extends it by clarifying that cognitive control is not implicated in ToM in those elevated in CP. CP (precursor to the antisocial lifestyle features of adult psychopathy) is associated with stronger, pervasive, and profound cognitive impairments, which are thought to underpin risky impulsive antisocial acts (Baskin-Sommers et al., 2022). That is, there may be non-specific and pervasive cognitive impairments associated with CP are plausibly unrelated to understanding others affective and emotional state, but rather behavioral impulsivity implicated in delinquent acts. It may also be that there are floor effects on specific cognitive functions given the stronger relationships with cognitive impairments that make manipulation on cognitive control less effective for those elevated in CP. Thus, CP may be more related to difficulties in affective ToM at baseline because of pervasive cognitive limitations that are not specific to affect processing. This interpretation is consistent with conceptual definition of CP that can present without the affective deficits defining CU traits. The present results differentiate CU traits from CP in the specific cognition-affect interactions between cognitive control and affective ToM unrelated to CP are implicated in CU.

4.3. Cognitive resilience related to less delinquency for callous-unemotional traits

Secondary analysis found a subgroup of participants in the test group with little to no change in affective ToM that associated with lower delinquency. This result is consistent with dual-task studies in adults, which suggests that performance on during dual-task interference changes the relationship between psychopathic traits and delinquency (Tillem et al., 2021). While some findings indicate that better cognitive performance is associated with worse outcomes in individuals with elevated CU traits (e.g., Baskin-Sommers et al., 2015), the present findings—consistent with other dual-task studies on psychopathic traits—suggest that cognitive demands and the ability to manage multiple tasks simultaneously may play a distinct role in shaping antisocial outcomes. While not the primary focus of this study and only representing < ¼ of participants – this promising initial finding indicates that being resilient to impositions on cognitive control associate with lower real word antisocial behavior. This suggests ways to counteract the vulnerability on cognitive resources associated with CU traits and may have real world implications on antisocial outcome reduction.

5. Limitations

The present study must be interpreted under some limitations. First, the timing of secondary task to load the performance on the primary task (1100 ms) was decided a priori. While this decision was sound and based on prior literature, we are unable to identify timing between load and stimulus that may be phenotype-specific. Second, we were unable to include self-report puberty as preregistered due to a technical error during collection. Pubertal development is an important consideration for the study of CU as early pubertal development is a feature predicting CU trait severity (e.g., Winters et al., 2023b). This may have been mitigated by including internalizing because it is closely tied pubertal onset (Patton et al., 2008; Pfeifer and Allen, 2021) given that age has an inconsistent link with puberty and less suitable for the study of a limited age range < 5 years (Parent et al., 2003). Third, the measure of CU traits has, in some samples, shown highly correlated residuals that are likely related to sample characteristics (Morales-Vives et al., 2019) suggesting some potential limitations in smaller samples; however, prior work has shown the ICU is most relevant for the prediction of aggression, CP, and serious crime (Ray et al., 2016) indicating it was most appropriate for the current study. Future studies could build on these results by using alternative multidimensional measures to see if we can reach the same conclusions and parse multicomponent features of psychopathy in relation to these results (Salekin, 2017). Fourth, this study was underpowered for interactions involving primary and secondary symptom variants. While we controlled for internalizing symptoms that partially account for this, we acknowledge larger samples are needed to determine if there are mechanistically unique features specific to each variant for cognitive-affective interactions that are clinically relevant. It is important to acknowledge the limitations associated with self-report measures, particularly for assessing ADHD symptoms (Sibley et al., 2010). The reliability and validity of self-report instruments have been debated, with studies highlighting a wide range of psychometric properties across different measures and populations (e.g., Caqueo-Urízar et al., 2022; Rosenman et al., 2011). Moreover, the utility of self-report versus other measurement approaches can vary considerably (e.g., Cyders and Coskunpinar, 2011; Dang et al., 2020). A recurring theme in this literature is the necessity of verifying the factor structure and reliability of the measures employed, regardless of the data collection method, to support accurate inferences (e.g, Rosenman et al., 2011; Thornberry and Krohn, 2000). The current study took many measures to improve inferences made including being adequately powered for the test of primary hypotheses, accounting for variance in those that may have responded carelessly, as well as testing the factor structure and reliability of the measures used in the current sample to mitigate these concerns. Additionally, because the study was conducted entirely online, some inconsistencies inherent to remote data collection may not have been fully controlled. For example, in the case of adolescents with externalizing behaviors, one could argue that the lack of in-person supervision might compromise the accuracy of their responses. Conversely, the absence of direct oversight by authority figures in a controlled environment, these adolescents feel less pressure to conform and may therefore provide more honest answers. Finally, the current sample included community adolescents that, as described above, provides adequate variance necessary to detect nuanced effects while also representing similar deficits as those who are incarcerated; however, results may not reflect the profound impairments of incarcerated or clinical samples.

6. Conclusions

In conclusion, the present double-blind preregistered clinical trial supports a cognitive-affective interaction unique to CU traits during early adolescence that is specific to selective control during affective ToM. This effect was implicated in real-world antisocial outcomes where those vulnerable to cognitive demands reported more antisocial behavior and a resilient subsample reported less antisocial behavior. Preregistered hypotheses (numbered as preregistered) were mostly supported such that Hypothesis 2 ("Affective ToM will demonstrate a substantial decrement after a cognitive load as a function of CU traits") affective ToM saw greater decrements in accuracy and processing speed as well as an increase in resource consumption unique to higher CU traits after manipulating cognitive control, and Hypothesis 3: ("There will be no impact on physical causality trials") physical trials saw no change. Cognitive ToM Hypothesis 1: ("Cognitive ToM trials will remain stable after a cognitive load as a function of CU traits") was partially supported in that accuracy did not change but we did find a decrement in processing speed and an increase in resource consumption after manipulating cognitive control. While not initially expected – this cognitive ToM finding further adds to the notion that CU traits associate with cognitive control limitations that are more vulnerable to higher cognitive demands; but specifies that the primary domain of impact of CU trait specific cognitive control limitations during ToM is affective processing. Affect processing deficits distinguish CU traits from CP and the present findings implicate a psychological cognitive-affective mechanism in early adolescents that may be an important consideration as an early risk in the development of cognitive and affective processing etiology supported in adult psychopathy. Thus, further work on the cognitive-affective decrements specific to CU traits in early adolescents involving resource limitations on cognitive control may facilitate new understanding of these traits and their development that can lead to more efficacious new interventions to redress persistent antisocial behavior.

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CRediT authorship contribution statement

Drew E. Winters: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Juliet Spitz:** Writing – review & editing, Project administration, Investigation. **Kristen Raymond:** Writing – review & editing, Project administration. **Crystal Natvig:** Writing – review & editing, Project administration. **Rebecca Waller:** Writing – review & editing, Supervision. **Susan K. Mikulich-Gilbertson:** Writing – review & editing, Supervision, Methodology. **Joseph T. Sakai:** Writing – review & editing, Supervision, Resources, Conceptualization.

Declaration of competing interest

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Juliet Spitz has nothing to declare

Kristen Raymond has nothing to declare

Crystal Natvig has nothing to declare

Susan K. Mikulich-Gilbertson has nothing to declare

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jad.2025.04.154.

References

Ahalt, C., Binswanger, I.A., Steinman, M., Tulsky, J., Williams, B.A., 2012. Confined to ignorance: the absence of prisoner information from nationally representative health data sets. J. Gen. Intern. Med. 27, 160–166.

Ahmad, S.I., Hinshaw, S.P., 2017. Attention-deficit/hyperactivity disorder, trait impulsivity, and externalizing behavior in a longitudinal sample. J. Abnorm. Child Psychol. 45, 1077–1089.

Akhtar, N., Enns, J.T., 1989. Relations between convert orienting and filtering in the development of visual attention. J. Exp. Child Psychol. 48, 315–334.

Anderson, N.E., Steele, V.R., Maurer, J.M., Bernat, E.M., Kiehl, K.A., 2015. Psychopathy, attention, and oddball target detection: new insights from PCL-R facet scores. Psychophysiology 52, 1194–1204.
Anderson, N.E., Maurer, J.M., Steele, V.R., Kiehl, K.A., 2018. Psychopathic traits associated with abnormal hemodynamic activity in salience and default mode networks during auditory oddball task. Cogn. Affect. Behav. Neurosci. 18, 564–580.
Andover, M.S., Schatten, H.T., Crossman, D.M., Donovick, P.J., 2011. Neuropsychological functioning in prisoners with and without self-injurious behaviors: implications for the criminal justice system. Crim. Justice Behav. 38, 1103–1114.
Antonakis, J., Bastardoz, N., Rönkkö, M., 2021. On ignoring the random effects assumption in multilevel models: review, critique, and recommendations. Organ. Res. Methods 24, 443–483.
Baskin-Sommers, A., Brazil, I.A., 2022. The importance of an exaggerated attention bottleneck for understanding psychopathy. Trends Cogn. Sci. 26, 325–336.
Baskin-Sommers, A.R., Newman, J.P., 2013. Differentiating the Cognition-Emotion Interactions that Characterize Psychopathy Versus Externalizing.
Baskin-Sommers, A.R., Waller, R., Fish, A.M., Hyde, L.W., 2015. Callous-unemotional traits trajectories interact with earlier conduct problems and exec-utive control to predict violence and substance use among high risk male adolescents. J. Abnorm. Child Psychol. 43, 1529–1541. https://doi.org/10.1007/s10802-015-0041-8.
Baskin-Sommers, A., Ruiz, S., Sarcos, B., Simmons, C., 2022. Cognitive–affective factors underlying disinhibitory disorders and legal implications. Nat. Rev. Psychol. 1, 145–160.
Bates, D., Mächler, M., Bolker, B., Walker, S., 2014. Fitting linear mixed-effects models using lme4. arXiv preprint arXiv:1406.5823.
Blair, R.J.R., 2005. Applying a cognitive neuroscience perspective to the disorder of psychopathy. Dev. Psychopathol. 17, 865–891.
Blair, R.J., Mitchell, D.G., 2009. Psychopathy, attention and emotion. Psychol. Med. 39, 543–555. https://doi.org/10.1017/s0033291708003991.
Blair, R.J., Leibenluft, E., Pine, D.S., 2014. Conduct disorder and callous-unemotional traits in youth. N. Engl. J. Med. 371, 2207–2216. https://doi.org/10.1056/NEJMra1315612.
Blanken, L.M., White, T., Mous, S.E., Basten, M., Muetzel, R.L., Jaddoe, V.W., Wals, M., van der Ende, J., Verhulst, F.C., Tiemeier, H., 2017. Cognitive functioning in children with internalising, externalising and dysregulation problems: a population-based study. Eur. Child Adolesc. Psychiatry 26, 445–456.
Borbás, R., Fehlbaum, L.V., Rudin, U., Stadler, C., Raschle, N.M., 2021. Neural correlates of theory of mind in children and adults using CAToon: introducing an open-source child-friendly neuroimaging task. Dev. Cogn. Neurosci. 49, 100959.
Botvinick, M.M., Braver, T.S., Barch, D.M., Carter, C.S., Cohen, J.D., 2001. Conflict monitoring and cognitive control. Psychol. Rev. 108, 624–652. https://doi.org/10.1037/0033-295x.108.3.624.
Brosch, T., Scherer, K., Grandjean, D., Sander, D., 2013. The impact of emotion on perception, attention, memory, and decision-making. Swiss Med. Wkly. 143 w13786-w13786.
Bruyer, R., Brysbaert, M., 2011. Combining speed and accuracy in cognitive psychology: is the inverse efficiency score (IES) a better dependent variable than the mean reaction time (RT) and the percentage of errors (PE)? Psychologica Belgica 51.
Caqueo-Urízar, A., Urzua, A., Villalonga-Olives, E., Atencio-Quevedo, D., Irarrázaval, M., Flores, J., Ramirez, C., 2022. Children's mental health: discrepancy between child self-reporting and parental reporting. Behav. Sci. 12, 401.
Chiroro, P., Valentine, T., 1995. An investigation of the contact hypothesis of the own-race Bias in face recognition. Q. J. Exp. Psychol. A 48, 879–894. https://doi.org/10.1080/14640749508401421.
Corbetta, M., Shulman, G.L., 2002. Control of goal-directed and stimulus-driven attention in the brain. Nat. Rev. Neurosci. 3, 201–215. https://doi.org/10.1038/nrn755.
Corbetta, M., Patel, G., Shulman, G.L., 2008. The reorienting system of the human brain: from environment to theory of mind. Neuron 58, 306–324.
Cyders, M.A., Coskunpinar, A., 2011. Measurement of constructs using self-report and behavioral lab tasks: is there overlap in nomothetic span and construct representation for impulsivity? Clin. Psychol. Rev. 31, 965–982.
Dang, J., King, K.M., Inzlicht, M., 2020. Why are self-report and behavioral measures weakly correlated? Trends Cogn. Sci. 24, 267–269.
Derks, L.M., Becker, E.S., Lange, W.-G., Rinck, M., Dapprich, A.L., Holtmann, M., Legenbauer, T., 2024. The relationship between callous-unemotional traits and internalizing psychopathology in adolescent psychiatric inpatients: a network analysis. Child Adolesc. Psychiatry Ment. Health 18, 1–16.
Dotterer, H.L., Tomlinson, R.C., Burt, S.A., Weigard, A.S., Klump, K.L., Hyde, L.W., 2021. Neurocognitive abilities associated with antisocial behavior with and without callous-unemotional traits in a community sample. Neuropsychology 35, 374.
Drayton, L.A., Santos, L.R., Baskin-Sommers, A., 2018. Psychopaths fail to automatically take the perspective of others. Proc. Natl. Acad. Sci. 115, 3302–3307. https://doi.org/10.1073/pnas.1721903115.
Duncan, S., Barrett, L.F., 2007. Affect is a form of cognition: a neurobiological analysis. Cognit. Emot. 21, 1184–1211.
Dunn, A.M., Heggestad, E.D., Shanock, L.R., Theilgard, N., 2018. Intra-individual response variability as an indicator of insufficient effort responding: comparison to other indicators and relationships with individual differences. J. Bus. Psychol. 33, 105–121.
Dux, P.E., Ivanoff, J., Asplund, C.L., Marois, R., 2006. Isolation of a central bottleneck of information processing with time-resolved FMRI. Neuron 52, 1109–1120. https://doi.org/10.1016/j.neuron.2006.11.009.
Essau, C.A., Sasagawa, S., Frick, P.J., 2006. Callous-unemotional traits in a community sample of adolescents. Assessment 13, 454–469.
Faul, F., Erdfelder, E., Buchner, A., Lang, A.-G., 2009. Statistical power analyses using G*Power 3.1: tests for correlation and regression analyses. Behav. Res. Methods 41, 1149–1160. https://doi.org/10.3758/BRM.41.4.1149.
Fischer, R., Plessow, F., 2015. Efficient multitasking: parallel versus serial processing of multiple tasks. Front. Psychol. 6, 1366.
Fontaine, N.M., Rozéfort, A., Bégin, V., 2023. Associations between callous-unemotional traits and psychopathology in a sample of adolescent females. J. Can. Acad. Child Adolesc. Psychiatry 32, 14.
Foster, E.M., Jones, D.E., Group, C.P.P.R, 2005. The high costs of aggression: public expenditures resulting from conduct disorder. Am. J. Public Health 95, 1767–1772.
Frick, P.J., 2004. The Inventory of Callous-Unemotional Traits. Unpublished rating scale.
Frick, P.J., White, S.F., 2008. Research review: the importance of callous-unemotional traits for developmental models of aggressive and antisocial behavior. J. Child Psychol. Psychiatry 49, 359–375.
Gatner, D.T., Douglas, K.S., Almond, M.F., Hart, S.D., Kropp, P.R., 2023. How much does that cost? Examining the economic costs of crime in North America attributable to people with psychopathic personality disorder. Personal. Disord. Theory Res. Treat. 14, 391.
Geldhof, G.J., Pornprasertmanit, S., Schoemann, A.M., Little, T.D., 2013. Orthogonalizing through residual centering: extended applications and caveats. Educ. Psychol. Meas. 73, 27–46.
Ghose, A., 2019. Problems of endogeneity in social science research. In: Research Methodology for Social Sciences. Routledge India, pp. 218–252.
Gillespie, S.M., Kongerslev, M.T., Sharp, C., Bo, S., Abu-Akel, A.M., 2018. Does affective theory of mind contribute to proactive aggression in boys with conduct problems and psychopathic tendencies? Child Psychiatry Hum. Dev. 49, 906–916.
Gillespie, S.M., Lee, J., Williams, R., Jones, A., 2022. Psychopathy and response inhibition: a meta-analysis of go/no-go and stop signal task performance. Neurosci. Biobehav. Rev. 104868.
Glass, S.J., Newman, J.P., 2009. Emotion processing in the criminal psychopath: the role of attention in emotion-facilitated memory. J. Abnorm. Psychol. 118, 229.
Gluckman, N.S., Hawes, D.J., Russell, A.M.T., 2016. Are callous-unemotional traits associated with conflict adaptation in childhood? Child Psychiatry Hum. Dev. 47, 583–592. https://doi.org/10.1007/s10578-015-0593-4.
Godinez, D.A., Willcutt, E.G., Burgess, G.C., Depue, B.E., Andrews-Hanna, J.R., Banich, M.T., 2015. Familial risk and ADHD-specific neural activity revealed by case-control, discordant twin pair design. Psychiatry Research: Neuroimaging 233, 458–465.
Goghari, V.M., MacDonald III, A.W., 2009. The neural basis of cognitive control: response selection and inhibition. Brain Cogn. 71, 72–83.
Goodman, R., 1997. The strengths and difficulties questionnaire: a research note. J. Child Psychol. Psychiatry 38, 581–586.
Goodman, R., Ford, T., Simmons, H., Gatward, R., Meltzer, H., 2003. Using the Strengths and Difficulties Questionnaire (SDQ) to screen for child psychiatric disorders in a community sample. Int. Rev. Psychiatry 15, 166–172.
Green, P., MacLeod, C., Alday, P., 2017. simr-power analysis for generalised linear mixed models by simulation. R package version 1.0. 3.
Holl, A.K., Vetter, N.C., Elsner, B., 2021. Disentangling the relations of theory of mind, executive function and conduct problems. J. Appl. Dev. Psychol. 72, 101233.
Imuta, K., Henry, J.D., Slaughter, V., Selcuk, B., Ruffman, T., 2016. Theory of mind and prosocial behavior in childhood: a meta-analytic review. Dev. Psychol. 52, 1192.
Johnson, J.A., 2005. Ascertaining the validity of individual protocols from web-based personality inventories. J. Res. Pers. 39, 103–129.
Kahn, R.E., Byrd, A.L., Pardini, D.A., 2013. Callous-unemotional traits robustly predict future criminal offending in young men. Law Hum. Behav. 37, 87–97. https://doi.org/10.1037/b0000003.
Kimonis, E.R., Fanti, K.A., Frick, P.J., Moffitt, T.E., Essau, C., Bijttebier, P., Marsee, M.A., 2015. Using self-reported callous-unemotional traits to cross-nationally assess the DSM-5 'with limited prosocial emotions' specifier. J. Child Psychol. Psychiatry 56, 1249–1261. https://doi.org/10.1111/jcpp.12357.
Konrad, A.C., Förster, K., Stretton, J., Dalgleish, T., Böckler-Raettig, A., Trautwein, F.M., Singer, T., Kanske, P., 2024. Risk factors for internalizing symptoms: the influence of empathy, theory of mind, and negative thinking processes. Hum. Brain Mapp. 45, e26576.
Krishnan, A., Woo, C.-W., Chang, L.J., Ruzic, L., Gu, X., López-Solà, M., Jackson, P.L., Pujol, J., Fan, J., Wager, T.D., 2016. Somatic and vicarious pain are represented by dissociable multivariate brain patterns. elife 5, e15166.
Kuznetsova, A., Brockhoff, P., Christensen, R., 2019. Package 'lmertest'. Version 3.1-0.
Leys, C., Ley, C., Klein, O., Bernard, P., Licata, L., 2013. Detecting outliers: do not use standard deviation around the mean, use absolute deviation around the median. J. Exp. Soc. Psychol. 49, 764–766.
Little, T.D., Bovaird, J.A., Widaman, K.F., 2006. On the merits of orthogonalizing powered and product terms: implications for modeling interactions among latent variables. Struct. Equ. Model. Multidiscip. J. 13, 497–519. https://doi.org/10.1207/s15328007sem1304_1.
Longhurst, J.K., Rider, J.V., Cummings, J.L., John, S.E., Poston, B., Held Bradford, E.C., Landers, M.R., 2022. A novel way of measuring dual-task interference: the reliability and construct validity of the dual-task effect battery in neurodegenerative disease. Neurorehabil. Neural Repair 36, 346–359.
Loy, A., Korobova, J., 2021. Bootstrapping Clustered Data in R using lmeresampler. arXiv preprint arXiv:2106.06568.
Lüdecke, D., Ben-Shachar, M.S., Patil, I., Waggoner, P., Makowski, D., 2021. Performance: an R package for assessment, comparison and testing of statistical models. J. Open Source Softw. 6.
Lykken, D.T., 2013. The Antisocial Personalities. Psychology Press.

Massoglia, M., Firebaugh, G., Warner, C., 2013. Racial variation in the effect of incarceration on neighborhood attainment. Am. Sociol. Rev. 78, 142–165.
Morales-Vives, F., Cosi, S., Lorenzo-Seva, U., Vigil-Colet, A., 2019. The inventory of callous-unemotional traits and antisocial behavior (inca) for young people: development and validation in a community sample. Front. Psychol. 10, 713.
Newman, J.P., Lorenz, A.R., 2003. Response modulation and emotion processing: implications for psychopathy and other dysregulatory psychopathology. Handbook of affective sciences 904–929.
Parent, A.-S., Teilmann, G., Juul, A., Skakkebaek, N.E., Toppari, J., Bourguignon, J.-P., 2003. The timing of normal puberty and the age limits of sexual precocity: variations around the world, secular trends, and changes after migration. Endocr. Rev. 24, 668–693. https://doi.org/10.1210/er.2002-0019.
Patton, G.C., Olsson, C., Bond, L., Toumbourou, J.W., Carlin, J.B., Hemphill, S.A., Catalano, R.F., 2008. Predicting female depression across puberty: a two-nation longitudinal study. J. Am. Acad. Child Adolesc. Psychiatry 47, 1424–1432.
Pechorro, P., Moreira, K., Basto-Pereira, M., Oliveira, J.P., Ray, J.V., 2019. The self-report delinquency scale from the national longitudinal study of adolescent to adult health among at-risk for delinquency youths. Violence Vict. 34, 120–135.
Perlstein, S., Fair, M., Hong, E., Waller, R., 2023. Treatment of childhood disruptive behavior disorders and callous-unemotional traits: a systematic review and two multilevel meta-analyses. J. Child Psychol. Psychiatry 64, 1372–1387.
Pessoa, L., 2008. On the relationship between emotion and cognition. Nat. Rev. Neurosci. 9, 148–158.
Pessoa, L., 2010. Emergent processes in cognitive-emotional interactions. Dialogues Clin. Neurosci. 12, 433–448.
Pfeifer, J.H., Allen, N.B., 2021. Puberty initiates cascading relationships between neurodevelopmental, social, and internalizing processes across adolescence. Biol. Psychiatry 89, 99–108.
Ray, J.V., Pechorro, P., Gonçalves, R.A., 2016. A comparison of self-report measures of callous-unemotional traits among incarcerated youth: associations with aggression, conduct disorder, and offending behavior. Crim. Justice Behav. 43, 1293–1309.
Rijnders, R.J., Terburg, D., Bos, P.A., Kempes, M.M., van Honk, J., 2021. Unzipping empathy in psychopathy: empathy and facial affect processing in psychopaths. Neurosci. Biobehav. Rev. 131, 1116–1126.
Rivenbark, J.G., Odgers, C.L., Caspi, A., Harrington, H., Hogan, S., Houts, R.M., Poulton, R., Moffitt, T.E., 2018. The high societal costs of childhood conduct problems: evidence from administrative records up to age 38 in a longitudinal birth cohort. J. Child Psychol. Psychiatry 59, 703–710.
Rosenman, R., Tennekoon, V., Hill, L.G., 2011. Measuring bias in self-reported data. Int. J. Behav. Healthc. Res. 2, 320–332.
Sakai, J.T., Mikulich-Gilbertson, S.K., Young, S.E., Rhee, S.H., McWilliams, S.K., Dunn, R., Salomonsen-Sautel, S., Thurstone, C., Hopfer, C.J., 2016. Adolescent male conduct-disordered patients in substance use disorder treatment: examining the "limited prosocial emotions" specifier. J. Child Adolesc. Subst. Abuse 25, 613–625. https://doi.org/10.1080/1067828X.2016.1175983.
Sakki, H., St Clair, M., Hwang, S., Allen, J.L., 2023. The association between callous-unemotional traits and substance use in childhood and adolescence: a systematic review and meta-analysis. J. Affect. Disord. 338, 502–517.
Salekin, R.T., 2017. Research review: what do we know about psychopathic traits in children? J. Child Psychol. Psychiatry 58, 1180–1200.
Sánchez-Carmona, A.J., Rincón-Pérez, I., López-Martín, S., Albert, J., Hinojosa, J.A., 2021. The effects of discrimination on the adoption of different strategies in selective stopping. Psychon. Bull. Rev. 28, 209–218.
Saunders, M.C., Anckarsäter, H., Lundström, S., Hellner, C., Lichtenstein, P., Fontaine, N. M., 2019. The associations between callous-unemotional traits and symptoms of conduct problems, hyperactivity and emotional problems: a study of adolescent twins screened for neurodevelopmental problems. J. Abnorm. Child Psychol. 47, 447–457.
Shamay-Tsoory, S.G., Harari, H., Aharon-Peretz, J., Levkovitz, Y., 2010. The role of the orbitofrontal cortex in affective theory of mind deficits in criminal offenders with psychopathic tendencies. Cortex 46, 668–677.
Sharp, C., Vanwoerden, S., Van Baardewijk, Y., Tackett, J., Stegge, H., 2015. Callous-unemotional traits are associated with deficits in recognizing complex emotions in preadolescent children. J. Pers. Disord. 29, 347–359.
Shenhav, A., Botvinick, M.M., Cohen, J.D., 2013. The expected value of control: an integrative theory of anterior cingulate cortex function. Neuron 79, 217–240.
Sibley, M.H., Pelham, W.E., Molina, B.S., Waschbusch, D.A., Gnagy, E.M., Babinski, D.E., Biswas, A., 2010. Inconsistent self-report of delinquency by adolescents and young adults with ADHD. J. Abnorm. Child Psychol. 38, 645–656.
Song, J.-H., Waller, R., Hyde, L.W., Olson, S.L., 2016. Early callous-unemotional behavior, theory-of-mind, and a fearful/inhibited temperament predict externalizing problems in middle and late childhood. J. Abnorm. Child Psychol. 44, 1205–1215.
Song, Z., Jones, A., Corcoran, R., Daly, N., Abu-Akel, A., Gillespie, S.M., 2023. Psychopathic traits and theory of mind task performance: a systematic review and meta-analysis. Neurosci. Biobehav. Rev. 105231.
Sweller, J., van Merrienboer, J.J.G., Paas, F.G.W.C., 1998. Cognitive architecture and instructional design. Educ. Psychol. Rev. 10, 251–296. https://doi.org/10.1023/A:1022193728205.
Thornberry, T.P., Krohn, M.D., 2000. The Self-Report Method for Measuring Delinquency and Crime. Measurement and Analysis of Crime and Justice: Criminal Justice, 4.
Tillem, S., Weinstein, H., Baskin-Sommers, A., 2021. Psychopathy is associated with an exaggerated attention bottleneck: EEG and behavioral evidence from a dual-task paradigm. Cogn. Affect. Behav. Neurosci. 21, 881–893. https://doi.org/10.3758/s13415-021-00891-z.
Tombu, M.N., Asplund, C.L., Dux, P.E., Godwin, D., Martin, J.W., Marois, R., 2011. A unified attentional bottleneck in the human brain. Proc. Natl. Acad. Sci. 108, 13426–13431. https://doi.org/10.1073/pnas.1103583108.
Townsend, J.T., Ashby, F.G., 1983. Stochastic Modeling of Elementary Psychological Processes. CUP Archive.
Van Nuland, S.E., Rogers, K.A., 2016. E-learning, dual-task, and cognitive load: the anatomy of a failed experiment. Anat. Sci. Educ. 9, 186–196.
Vedechkina, M., Bennett, M., Holmes, J., 2023. Dimensions of internalizing symptoms are stable across early adolescence and predicted by executive functions: longitudinal findings from the Adolescent Brain and Cognitive Development (ABCD) study. Dev. Psychopathol. 1–10.
Vetter, N.C., Altgassen, M., Phillips, L., Mahy, C.E., Kliegel, M., 2013. Development of affective theory of mind across adolescence: disentangling the role of executive functions. Dev. Neuropsychol. 38, 114–125. https://doi.org/10.1080/87565641.2012.733786.
Viding, E., McCrory, E.J., 2012. Genetic and neurocognitive contributions to the development of psychopathy. Dev. Psychopathol. 24, 969–983. https://doi.org/10.1017/s095457941200048x.
Wade, M., Prime, H., Jenkins, J.M., Yeates, K.O., Williams, T., Lee, K., 2018. On the relation between theory of mind and executive functioning: a developmental cognitive neuroscience perspective. Psychon. Bull. Rev. 25, 2119–2140.
Waller, R., Wagner, N., 2019. The Sensitivity to Threat and Affiliative Reward (STAR) model and the development of callous-unemotional traits. Neurosci. Biobehav. Rev. 107, 656–671.
White, B.A., Dede, B., Heilman, M., Revilla, R., Lochman, J., Hudac, C.M., Bui, C., White, S.W., 2022. Facial affect sensitivity training for young children with emerging CU traits: an experimental therapeutics approach. J. Clin. Child Adolesc. Psychol. 1–13.
Wilms, R., Mäthner, E., Winnen, L., Lanwehr, R., 2021. Omitted variable bias: a threat to estimating causal relationships. Methods in Psychology 5, 100075.
Winters, D.E., Hyde, L.W., 2022. Associated functional network connectivity between callous-unemotionality and cognitive and affective empathy. J. Affect. Disord. https://doi.org/10.1016/j.jad.2022.08.103.
Winters, D.E., Sakai, J.T., 2023. Affective theory of mind impairments underlying callous-unemotional traits and the role of cognitive control. Cognit. Emot. 1–18.
Winters, D.E., Brandon-Friedman, R., Yepes, G., Hinckley, J.D., 2020. Systematic review and meta-analysis of socio-cognitive and socio-affective processes association with adolescent substance use. Drug Alcohol Depend. 108479. https://doi.org/10.1016/j.drugalcdep.2020.108479.
Winters, D.E., Sakai, J.T., Carter, M.R., 2021. Resting-state network topology characterizing callous-unemotional traits in adolescence. NeuroImage: Clinical 32, 102878. https://doi.org/10.1016/j.nicl.2021.102878.
Winters, D.E., Pruitt, P., Damoiseaux, J., Sakai, J.T., 2022. Callous-unemotional traits in adolescents moderate neural network associations with empathy. Psychiatry Res. Neuroimaging 320, 111429. https://doi.org/10.1016/j.pscychresns.2021.111429.
Winters, D.E., Guha, A., Sakai, J.T., 2023. Connectome-based predictive modeling of empathy in adolescents with and without the low-prosocial emotion specifier. Neurosci. Lett. 812, 137371.
Winters, D.E., Dugré, J.R., Sakai, J.T., Carter, R.M., 2023a. Executive Function and Underlying Brain Network Distinctions for Callous-Unemotional Traits and Conduct Problems in Adolescents. bioRxiv.
Winters, D.E., Leopold, D., Sakai, J., Carter, R.M., 2023b. Efficiency of heterogenous functional connectomes explains variance in callous-unemotional traits after computational lesioning of cortical midline and salience regions. Brain Connectivity 13 (7), 410–426.
Winters, D.E., Leopold, D.R., Carter, R.M., Sakai, J.T., 2023c. Resting-state connectivity underlying cognitive control's association with perspective taking in callous-unemotional traits. Psychiatry Research: Neuroimaging 331. https://doi.org/10.1016/j.pscychresns.2023.111615.
Wolff, N., Shi, J., 2012. Childhood and adult trauma experiences of incarcerated persons and their relationship to adult behavioral health problems and treatment. Int. J. Environ. Res. Public Health 9, 1908–1926. https://doi.org/10.3390/ijerph9051908.
Yarkoni, T., 2020. The generalizability crisis. Behav. Brain Sci. 1-37. https://doi.org/10.1017/S0140525X20001685.
Yates, A., Ashwin, C., Fox, E., 2010. Does emotion processing require attention? The effects of fear conditioning and perceptual load. Emotion (Washington, D.C.) 10, 822–830. https://doi.org/10.1037/a0020325.
Yentes, R.D., Wilhelm, F., 2018. Careless: procedures for computing indices of careless responding. R packages version 1.2.0. https://github.com/ryentes/careless.
Zachary, R.A., Shipley, W.C., 1986. Shipley Institute of Living Scale: Revised Manual. WPS, Western Psychological Services.