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Transdiagnostic processes linking anxiety symptoms and substance use problems among adolescents

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Abstract

Background—Numerous anxiety syndromes co-occur with substance use problems in adolescents, though the mechanisms underlying these comorbidities are not well understood. Three transdiagnostic processes—anxiety sensitivity (fear of anxiety-related sensations), distress tolerance (capacity to withstand emotional distress), and negative urgency (propensity to respond impulsively to negative emotion)—have been implicated in various anxiety and substance use problems.

Aims—To examine whether anxiety sensitivity, distress tolerance, and negative urgency statistically mediated relations between symptoms of three different anxiety disorders (social anxiety, generalized anxiety, and panic disorders) and alcohol and cannabis use problems.

Methods—Cross-sectional analysis of high school students in Los Angeles (N = 3002) assessed via paper and pencil questionnaires.

Results—When mediators were entered simultaneously, negative urgency accounted for a significant 33% to 85% of the covariance between anxiety symptomatology and substance use problems over and above the other transdiagnostic processes. This pattern was consistent across all three anxiety syndromes and both alcohol and cannabis problems. Anxiety sensitivity and distress tolerance did not account for positive associations between anxiety symptoms and substance use problems.

Discussion—Negative urgency may be an important mechanism underlying the relationship between various types of anxiety and substance use problems in adolescence, and thus represents a possible target for preventive interventions targeting adolescent anxiety and substance use.

Keywords

Transdiagnostic mechanisms; anxiety; cannabis; alcohol; adolescents

INTRODUCTION

The relationship between anxiety and substance use problems in adolescence is well-documented^{1, 2} but not well understood. There is an elevated prevalence of a variety of anxiety disorders among those with substance use problems,³ yet it is unlikely that this comorbidity is explained by disorder-specific links. Rather, transdiagnostic processes common to various anxiety disorders are likely to account for the comorbidity with substance use problems observed across the anxiety disorders in adolescence.⁴

We propose that elevations in certain transdiagnostic traits that alter the experience of and reaction to negative affect may give rise to a number of anxiety- and substance-related problems in adolescence. The tendency to engage in reactive strategies to reduce negative emotion is a risk factor for the onset of anxiety disorders as well as a maintaining or exacerbating factor for anxiety.⁵ Indeed, individuals with anxiety disorders experience stronger reactions to negative emotions when they attempt to suppress or avoid them,^{6, 7} and negative interpretations of anxiety increase the duration and intensity of the emotions.⁸ Thus, both the experience of negative affect *and* the adverse reaction to negative affect (i.e., maladaptive cognitive or behavioral efforts to cope with negative affect) appear to be at the core of anxiety disorder etiology and maintenance.⁵

Among transdiagnostic factors implicated in anxiety pathologies, anxiety sensitivity (AS), distress tolerance (DT), and negative urgency (NU) have also been associated with substance use problems, and in some cases, have been found to account for (i.e., statistically mediate) associations between anxiety symptoms and substance use severity.^{9–11} These constructs reflect the tendency for individuals to experience negative affect as aversive and respond to it maladaptively, such as by using substances to cope with distress. The literature we describe below supports the idea that it is not anxiety symptoms or disorders in and of themselves that give rise to maladaptive substance use, but rather, these transdiagnostic processes that are elevated across the anxiety disorders. In particular, we hypothesize that the transdiagnostic affective vulnerability traits of AS, DT, and NU account for the association between multiple anxiety syndromes and problematic use of the two most commonly used substances in adolescence: alcohol and cannabis.¹²

AS is characterized by the degree to which an individual is prone to appraise the physical sensations of anxiety as having harmful consequences.¹³ AS is elevated across many manifestations of pathological anxiety¹⁴ and is a prospective risk factor for the development of anxiety symptoms in adolescence.^{15, 16} AS also is related to alcohol and cannabis use problems in adolescents^{17, 18} and prospectively predicts substance use disorder onset in young adults.¹⁹ AS may increase motivation to use substances as a means of diminishing anxiety symptoms that are perceived to be threatening, in line with work indicating that AS is associated with motivation to use substances to cope with negative affect.^{18, 20}

In one study, AS statistically mediated relations between different manifestations of anxiety and drinking problems in adolescents.¹⁰ Hence, prior research suggests that AS may help explain the co-occurrence of adolescent anxiety and alcohol problems. To our knowledge, however, a study has yet to explore the interrelation between AS, anxiety, and cannabis use problems in adolescents.

DT reflects as an individual's perceived capacity to withstand distress.²¹ In young adults, perceived distress *intolerance* (herein referred to as low DT) is associated with both anxiety disorder symptoms^{22, 23} and alcohol and cannabis use problems.^{24, 25} Like AS, low DT is also associated with negative affect coping motives for alcohol and cannabis use,^{26, 27} meaning that individuals low in DT tend to use substances to cope with or reduce negative emotions such as anxiety, presumably because of their perceived difficulties with tolerating distress.

One study found that DT statistically mediated the association between depression and alcohol and cannabis problems in young adults,²⁴ but another study found that DT did not mediate the association between anxiety symptoms and alcohol problems in adolescents.¹⁰ Given that base rates of alcohol problems are low in younger adolescents, larger samples may be required to provide sufficient power to test DT as a potential mediator linking anxiety and substance use problems. Furthermore, extending results to cannabis use problems in adolescents is warranted, given prior results linking DT and cannabis use problems in adults.^{24, 26}

NU refers to an individual's propensity to engage in impulsive behavior while experiencing distress.²⁸ NU correlates with anxiety symptoms in children and adults^{29, 30} and alcohol and cannabis use problems in adolescents and young adults,^{25, 31} though scant research has investigated NU in relation to anxiety in adolescence. Two studies in young adults found that the relation between NU and alcohol problems was statistically mediated by negative affect coping motives,^{32, 33} suggesting that individuals with high NU may be prone to use substances to reduce negative affect. Thus, NU might play a role in comorbidity between emotional symptomatology (i.e., anxiety and depression symptoms) and substance use. Indeed, two other studies found that NU statistically mediated associations between depressive symptoms and alcohol use initiation and problems.^{34, 35} However, we are unaware of any study examining NU as a potential mediator of the association between anxiety pathology and substance use.

To our knowledge, only one study has examined transdiagnostic processes as potential mediators of the association between multiple anxiety pathologies and substance use problems in adolescents.¹⁰ This study found that AS (but not DT) statistically mediated the association between several manifestations of anxiety and alcohol problems.¹⁰ The current study in a new sample of adolescents extends this prior report in a number of ways. First, we employ a larger sample, allowing us greater statistical power to detect effects. Second, in addition to assessing AS and DT, we also examine NU, which is a possible transdiagnostic mechanism in anxiety-substance comorbidity that has not been studied in relation to anxiety problems in adolescents. Third, we additionally examine problematic cannabis use, which is an important public health issue in adolescents, given the resurgence in the popularity of

cannabis and decreasing perceptions of cannabis risk among adolescents.¹² Finally, with a larger sample size, we also have sufficient power to test multiple mediator models by entering proposed mediators simultaneously. Hence, we aim to investigate if proposed mediators *uniquely* mediate anxiety associations with both alcohol- and cannabis-related problems in adolescence when accounting for the variance explained by each of the other proposed mediators. Although these putative mediators are conceptually unique, they are moderately correlated (with the absolute values of correlations falling within the range of $.3 < r < .5$),^{25, 27, 30} and prior work has typically examined one construct at a time. Yet, little is known about which transdiagnostic factor uniquely stands out as explaining the association between anxiety and substance use problems above and beyond the shared variance with other transdiagnostic factors, which could be explained by a higher order “emotional sensitivity and tolerance” factor.²³

We hypothesized that all three traits would be positively associated both with anxiety symptom and problematic substance use measures. Given the paucity of prior work on the comparative roles of AS, DT, and NU in anxiety-substance comorbidity, we did not hypothesize which (if any) of the transdiagnostic factors would uniquely mediate relations between anxiety symptomatology and substance use problems after accounting for other potential mediators.

METHOD

Participants and Procedures

Participants (54.1% female; $M_{\text{age}} = 14.1$ years, $SD = .41$) were recruited from 10 public high schools in the Los Angeles area. Schools were recruited based on proximity to the institution and sufficient representation of demographic diversity (see Results, below, for details). Data collection took place on-site across two separate 40-minute in-classroom survey administrations during fall 2013. Some students ($n=381$) did not provide data for key measures for a number of reasons, resulting in a final sample of 3002 participants.^[Footnote 1] Schools, but not individual students, were financially compensated for participation, and each received \$2400 in total. All procedures were approved by the University of Southern California’s Institutional Review Board on May 12, 2012, protocol number HS-12-00180. The study was funded by the National Institutes of Health.

Measures

Revised Children’s Anxiety and Depression Scale (RCADS).³⁶—The RCADS measures frequency of *DSM-IV* anxiety and depression symptoms using a 4-point scale from 0 (*never*) to 3 (*always*). The RCADS includes social phobia (SP; $\alpha = .92$ in this sample), generalized anxiety disorder (GAD; $\alpha = .89$), and panic disorder (PD; $\alpha = .90$) subscales (9, 6, and 9 items, respectively). Continuous measures were used for mediational analyses. Proportions of participants surpassing clinical threshold scores are reported for descriptive purposes. The RCADS has shown strong psychometric properties, including

Footnote 1: There were no significant differences in demographic variables between the 3002 participants who completed the assessment and the 381 students who did not.

internal consistency and a factor structure that distinguishes items loading onto individual anxiety disorders, consistent with their intended subscale designation.³⁷

Rutgers Alcohol Problem Index (RAPI).³⁸—The 23-item RAPI measures problem drinking in adolescents. Participants reported the frequency of alcohol-related problems on a scale from 0 (*never*) to 4 (*10 or more times*) in the past 12 months. Because the distribution of sum scores was positively skewed with a high proportion of participants in the sample reporting no or minimal alcohol problems, we applied a cutoff for “high problem drinkers” using RAPI scores ≥ 15 , with scores < 15 indicating “low problem and non-drinkers” as in prior work.^{10, 39} The RAPI has adequate psychometric properties including good test-retest reliability, internal consistency, and convergent validity.^{38, 40}

Cannabis Abuse Screening Test (CAST).⁴¹—The 6-item CAST measures cannabis use problems. Participants responded to questions such as “Have you ever tried to reduce or stop your marijuana use without succeeding?” using a 5-point scale ranging from 0 (*never*) to 4 (*very often*), indicating frequency of occurrence within the past 12 months ($\alpha = .92$ in this sample). As in prior work and due to the skewed zero-inflated distribution of cannabis use problems in this sample, we used a conservative cutoff (CAST ≥ 4) indicating possible *DSM-IV* cannabis use disorder.⁴¹ The CAST has demonstrated good psychometric properties, including good internal consistency and concurrent validity.^{41, 42}

Childhood Anxiety Sensitivity Index (CASI).¹³—The 18-item CASI measures fearfulness of anxiety symptoms in children and adolescents ($\alpha = .88$ in this sample). Participants reported the extent to which they agreed with items such as “It scares me when my heart beats fast” on a 3-point scale ranging from 1 (*none*) to 3 (*a lot*). The CASI has demonstrated satisfactory psychometric properties, including good convergent validity.^{43, 44}

Distress Tolerance Scale (DTS).²¹—The 15-item DTS measures capacity to tolerate emotional distress. Participants reported the extent to which they agreed with items such as “Feeling distressed or upset is unbearable to me” on a 5-point Likert scale ranging from 1 (*strongly agree*) to 5 (*strongly disagree*), with higher scores indicating a higher tolerance for emotional distress ($\alpha = .83$ in this sample). The DTS has shown good internal consistency and construct validity.^{10, 21}

The UPPS Impulsive Behavior Scale—Negative Urgency Subscale (UPPS).²⁸—This 12-item subscale measures the tendency to act impulsively during negative affect. Participants reported how much they agreed with statements such as “When I feel bad, I will often do things I later regret in order to make myself feel better now” on a 4-point scale ranging from 1 (*agree strongly*) to 4 (*disagree strongly*), with higher values indicating higher levels of negative urgency ($\alpha = .89$ in this sample). The NU subscale of the UPPS has displayed good internal consistency and construct validity.^{28, 35}

Statistical Analysis

Primary analyses were conducted in SPSS 22.0 using the PROCESS macro for mediation.⁴⁵ The dichotomized RAPI cutoff score indicating drinking problems vs. no or low drinking

problems was entered as the dependent variable (DV) in the first set of primary analyses scores. The dichotomized CAST cutoff score indicating cannabis use problems vs. no cannabis use problems in adolescents was entered as the DV in the second set of analyses. In all analyses, the continuous score of each of the three RCADS anxiety subscales (SP, GAD, and PD) were entered individually as the independent variables (IVs) in separate models. CASI, UPPS, and DTS scores were entered as mediators (Ms) simultaneously in all models to examine the extent to which each variable significantly and uniquely mediated the associations between anxiety symptoms and substance use problems after accounting for the variance explained by the other potential mediators.

To identify demographic covariates that may precede and influence primary variables and thus may be confounders, gender, ethnicity, and parental education level (highest level between parents) were entered as predictors of each DV. Only parental education was associated with these variables and was entered as a covariate in all models. Because of a high prevalence of either non-response/missing ($n=19$) or selecting the “don't know” category in response to the parental education questions ($n=365$), we used dummy variable adjustment to allow these participants to be included in the analyses (Cohen & Cohen, 1985). The intraclass correlation coefficients between RAPI score and school ($-.001$, $p = .58$) and between CAST score and school ($-.02$, $p = .91$) were minimal. However, we did observe small but significant interactions between each of the three transdiagnostic mediator variables and School on CAST cutoff status (p s $< .05$) and thus a small but significant UPPS×School interaction on RAPI cutoff status. Thus, we also included school as a covariate in all models.

The unstandardized parameter estimates (b -values), 95% confidence intervals (CIs), and corresponding p -values are reported for the following: the total effects of X (RCADS subscales) on Y (RAPI cutoff status/CAST cutoff status), the effect of X (RCADS subscales) on Ms (CASI, UPPS, DTS), the effect of Ms entered as simultaneous predictors (CASI, UPPS, DTS) on Y (RAPI cutoff status/CAST cutoff status) while statistically adjusting for X, the indirect effect of X (RCADS subscales) on Y (RAPI cutoff status/CAST cutoff status) through Ms (CASI, UPPS, DTS), and the direct effect of X (RCADS subscales) on Y (RAPI cutoff status/CAST cutoff status) after adjusting for all three Ms as simultaneous covariates (CASI, UPPS, DTS). P -values for the indirect (“mediated”) effects are derived from the Sobel test. Because of the multiple tests conducted, we reduced the likelihood of Type I error by setting our $\alpha = .01$.

RESULTS

Tables 1 and 2 report sample characteristics, descriptive statistics, and intercorrelations among variables. The directions and magnitudes of the correlations between AS, DT, and NU variables were similar to those obtained in prior research.^{25, 27, 30} 31.1% of participants ($SD = 19.7$, range: 8.0% – 68.2%) across the schools were eligible for free or reduced lunch. Participants were 47.4% Hispanic or Latino, 16.6% Asian, 16.1% White, 6.7% Multiracial, 4.9% African American, 4.1% Native Hawaiian or Pacific Islander, and 1% American Indian or Alaska Native. Students not enrolled in special education or English as a Second

Language programs were eligible for study participation. Of the 4,100 eligible students, 3,395 (82.8%) provided assent and written parental consent prior to study enrollment.

The $M(SD)$ of RAPI scores was 5.14 (8.86), and 12% of the sample were categorized as high problem drinkers (RAPI ≥ 15). The $M(SD)$ of CAST scores was 0.91 (2.89), and 9.4% of the sample exceeded the clinical cutoff on the CAST. Based on recommended age and gender normed cutoffs from the RCADS,⁴³ the proportions of participants who surpassed borderline clinical and full clinical thresholds for each subscale were as follows: GAD (borderline/sub-clinical or higher: 22.9%, clinical: 15.0%), PD (borderline/sub-clinical: 17.8%, clinical: 11.5%), and SP (borderline/sub-clinical: 18.0%, clinical: 10.6%). This distribution of RCADS scores is similar to distributions reported in other school samples.⁴³

Mediation analyses of relations between anxiety symptoms and alcohol problems^[Footnote 2]

A series of mediation models was run with each of the three RCADS subscales as the IV and all three proposed mediators entered simultaneously into the models. As shown in Table 3, a consistent pattern of findings was observed. There were significant effects of each X (RCADS subscales) on M (each of the three mediators; all $ps < .001$). There were also significant total effects of each of the three RCADS subscales on RAPI cutoff score ($p < .001$), as well as direct effects of RCADS GAD and RCADS PD on the RAPI cutoff score ($p < .001$) after accounting for the proposed mediators. In the model with RCADS SP as the IV, the direct effect of RCADS SP on the RAPI cutoff score after accounting for the proposed mediators was not statistically significant ($p = .87$). In each of the three models, the effect of M (mediator variable) to Y (RAPI cutoff) was only significant for NU ($p < .001$) and not significant for DT or AS in the model with all three proposed mediators ($ps > .12$). Consequently, there was a significant indirect effect of X on Y through M (NU) in all three models, [$b = .09$, $z(3024) = 11.45$, $p < .001$ in the RCADS GAD model, $b = .07$, $z(3012) = 11.15$, $p < .001$ in the RCADS PD model, and $b = .06$, $z(3003) = 11.91$, $p < .001$ in the RCADS SP model], with no other significant indirect effects ($ps > .12$).

We obtained the magnitude of the mediating effect of NU by adding the absolute value of each indirect effect coefficient in the model with the absolute value of the coefficient of the direct effect in order to obtain a new total effect. Using the absolute value of each coefficient overcomes the ambiguity of the total effect in a multiple mediator model that has both positive and negative coefficients. We then divided the coefficients of the indirect effect of NU by the new coefficient of the total effect. This approach^{46,47} allowed us to identify the percentage of the total effect that was mediated by NU. Percentages across the three models were 56.3%, 50.0%, and 85.7% in the RCADS GAD, RCADS PD, and RCADS SP models, indicating that NU explained at least half of the mediated effects (and explained the large majority of the effect in the case of the RCADS SP model).

Footnote 2: We examined the possibility that NU was the only statistically significant mediator to emerge because its mediational variance did not overlap with the other two mediators, whereas shared variance of DT and AS may have reduced the effect of each in the model with all three proposed mediators. A series of post hoc analyses were conducted with only NU and AS mediators, and then only NU and DT as mediators. Results of this analysis examining the mediating effects of the transdiagnostic variables explaining the associations between anxiety symptoms (RCADS subscales) and alcohol-use problems (RAPI cutoff status) showed that NU continued to be the only statistically significant unique mediator in each model (all ps for AS and DT indirect effects $> .06$).

Mediation analyses of relations between anxiety symptoms and cannabis problems^[Footnote 3]

A parallel set of models was run with CAST cutoff status as the DV and all three proposed mediators entered simultaneously into the models. As shown in Table 4, there was a significant effect of each X (RCADS subscales) on each of the three proposed mediators (all $ps < .001$). The total effects of X (RCADS subscales) on Y (CAST cutoff status) either attained or approached significance in all models ($ps < .05$). The direct effect of RCADS GAD on CAST clinical cutoff status did not attain statistical significance ($p < .08$), whereas the direct effects of RCADS PD and RCADS SP on CAST cutoff were significant ($ps < .001$). The effects of AS and NU on CAST cutoff status were significant in the models with RCADS GAD and RCADS PD ($ps < .001$) but in opposite directions, such that higher NU was associated with exceeding the clinical cutoff on the CAST indicating cannabis problems, whereas higher AS was associated with CAST scores *not* exceeding the clinical cutoff (i.e., none or mild cannabis use problems). The effect of NU on CAST cutoff status was also significant in the RCADS SP model ($p < .001$), but the effect of AS on CAST cutoff status was not significant in this model ($p = .25$). The association between DT and CAST cutoff status was not significant in any of the models ($ps > .23$).

There were significant indirect effects of X (RCADS subscales) on Y (CAST cutoff status) through *lower* AS [$b = -.04$, $z(3002) = -3.88$, $p < .001$ for GAD and $b = -.04$, $z(2995) = -4.83$, $p < .001$ for PD] and through *higher* NU [$b = .06$, $z(3002) = 8.06$, $p < .001$ for GAD, $b = .04$, $z(2995) = 7.57$, $p < .001$ for PD, and $b = .04$, $z(2981) = 9.44$, $p < .001$ for SP]. As indicated by the negative direction of the AS mediating effect, AS was a suppressor variable in that more GAD and PD symptoms were associated with greater AS, which in turn was associated with no/mild cannabis use problems. There were no significant indirect effects of any of the RCADS subscales on CAST cutoff status through DT (all $ps > .23$). We obtained the magnitude of the mediating effect of NU and AS by calculating the proportion of the total effect that was accounted for by each mediator in the way described above. Percentages of the total effect mediated by NU across the three models were 42.9% (RCADS GAD), 33.3% (RCADS PD model), and 36.3% (RCADS SP model). These findings indicated that at least one-third of the total effect was explained by NU. Percentages of the total effect explained by AS across the two models in which AS was a significant mediator were 28.6% (RCADS GAD) and 26.7% (RCADS PD), indicating that AS accounted for a moderate proportion of the indirect effect.

DISCUSSION

In this large cross-sectional study of adolescents, our primary finding was that NU statistically mediated the associations between levels of symptomatology across multiple anxiety manifestations and problems with two substances. This was true for all three anxiety manifestations examined, both drinking- and cannabis-related problems, and after

Footnote 3: A parallel series of post hoc analyses were conducted with only AS and NU and then DT and NU as mediators in the models in order to examine whether null finding with AS and DT were due to significantly shared variance between AS and DT, but with cannabis-use problems (CAST cutoff status) as the DV. Findings were identical to the models with all three proposed mediators, with one exception: An indirect effect of RCADS PD on CAST cutoff through DT approached but did not attain statistical significance, $b = -.01$, $z = -2.26$, $p < .05$. In this model, as with the others, NU remained a significant mediator as well.

statistically adjusting for the two other putative transdiagnostic mediators. There was no evidence that higher levels of AS and DT empirically accounted for the positive association between anxiety symptoms and substance use problems. These results indicate that NU is a transdiagnostic process that uniquely explains the association between anxiety symptomatology and alcohol and cannabis use problems.

Although a growing body of research reveals associations between NU and substance use severity,^{25, 31} little research has explored NU in relation to anxiety; and no prior studies to our knowledge have examined the role of NU in the association between anxiety symptoms and substance use problems. Current findings suggest that adolescents with anxiety problems may develop problematic substance use in part because of a tendency to impulsively respond to negative affect in an effort to reduce it.

We posit that one way in which high-NU adolescents with anxiety symptoms might express this impulsivity is by using alcohol or cannabis in response to states of high anxiety, which negatively reinforces both anxiety and substance problems. Both alcohol and cannabis have anxiolytic properties that dissipate following acute intoxication,^{48, 49} which may promote learning among those high in NU that the behavioral response of alcohol or cannabis use alleviates emotional distress.^{50, 51} Broadly, NU may account for the associations between numerous types of anxiety pathology and substance use problems by promoting impulsive negative reinforcing behaviors (e.g., substance use) that may reduce anxiety symptoms in the short-term but exacerbate anxiety pathology in the long-term. If current results are replicated in a longitudinal design whereby NU is shown to precede anxiety-substance comorbidity, this would point toward a potentially malleable target for intervention: That is, targeting NU by improving emotion regulation among adolescents with anxiety symptoms (with an emphasis on decreasing impulsivity in response to anxiety) may decrease substance-related problems in this population. Notably, although this robust indirect effect was observed across all of the manifestations of anxiety examined in this study and with both alcohol and cannabis use, the particularly high proportion of the total effect explained by NU in the model examining the association between social phobia symptoms and alcohol use was striking and may highlight a specific target population for future research.

Low DT was associated with each type of anxiety and substance problem, but low DT did not account for the covariance between anxiety and substance problems over and above NU. The null mediational finding involving DT and alcohol is consistent with our previous work in a smaller adolescent sample¹⁰ and suggests that, at least in this developmental period, DT does not appear to stand out as a robust explanatory variable over and above NU. Given that previous work has demonstrated an association between low DT and coping motives for drinking,^{27, 52} one possibility is that coping motives may moderate the effect of DT as a mediator explaining the association between anxiety and substance problems. Specifically, DT may only serve as a mediator among those who endorse motivation to drink in order to relieve negative affect. Future research should explore the potential moderating role of coping motives for drinking in mediational models. Another possibility is that low DT may become increasingly important to the development of substance problems as individuals approach late adolescence and enter adulthood, given that studies have linked DT to alcohol problems in young adult samples,^{24, 53, 54}

As expected, higher AS was associated with greater anxiety symptomatology and higher likelihood of alcohol problems. However, mediational analyses provided no evidence that AS empirically explained anxiety-alcohol relations. These null results are in contrast to our previous study that found AS statistically mediated the associations of SP, GAD, and PD symptoms with adolescent drinking problems.¹⁰ Unexpectedly, AS appeared to act as a suppressor variable of GAD and PD relations with cannabis problems. In other words, the direction of mediation via AS was negative, such that higher AS was associated with fewer cannabis problems after accounting for the variance explained by GAD and PD symptoms as well as NU and DT. This pattern raises the possibility that aspects of AS not shared with NU may have minimal relation or be inversely related to the development of cannabis use problems in early adolescence. In the tobacco literature, high (vs. low) AS individuals report greater concerns about the negative health consequences of smoking.⁴ Because this study partialled out NU, which may more directly tap motivation to use substances for negative affect relief that may be seen in AS and anxiety, perhaps the remaining role of AS (which was statistically significant but did not explain a large proportion of the association between anxiety symptoms and cannabis use) is protective because of concerns about harm from cannabis.

In addition, some previous work found AS to be unrelated to or protective against alcohol and cannabis consumption in early adolescent samples,^{55–59} suggesting this pattern could be specific to the developmental period under investigation. If AS is associated with conformity motives for *using* substances,^{20, 27} perhaps high-AS individuals would also be more likely to *refrain* from use if cannabis use is viewed as deviant in one's adolescent peer group.

This study has limitations worth noting. Most importantly, this study was cross-sectional, which precludes us from drawing temporal or causal conclusions. Associations between anxiety and substance use are likely to be dynamic, bidirectional, and mutually maintain one another.⁶⁰ Thus, examining the trajectories of these associations is likely to change as adolescents move into ages when heavier use is more likely to occur.^{61–63} Still, despite the cross-sectional nature of this investigation, the focus on adolescents during a developmental period when anxiety pathology often begins to onset⁶¹ while base rates of alcohol and cannabis use disorders remain low⁶³ helps us to generate preliminary models to understand which specific transdiagnostic factors present among adolescents elevated in anxiety may serve to increase problematic substance use. A future study to build upon these cross-sectional findings could follow adolescents longitudinally into young adulthood to examine whether AS and DT mediate anxiety and substance use problems at later developmental periods and if associations among transdiagnostic constructs, anxiety symptoms, and substance use problems change as substance use increases in later years. A longitudinal study could also provide support for a causal pathway model in which these transdiagnostic vulnerability traits predict subsequent substance use problems, rather than simply demonstrating an association. This study was also limited by reliance exclusively on self-report. Although this increased feasibility of recruiting and collecting data from a large sample and is consistent with methodologies of most similar studies, future research may benefit from including a sub-sample of participants who complete behavioral measures of these constructs, such as a CO₂ challenge to measure AS⁶⁴ or a mirror tracing task to measure DT.⁶⁵ In addition, the relatively low base rates of alcohol and cannabis use may

have influenced our results. For example, low base rates could potentially limit power to detect effects. However, our large sample likely overcame this limitation. Finally, it is unclear how these findings may generalize beyond the population of students in Los Angeles schools that were sampled. Future studies should investigate these associations in adolescents across the United States, using representative sampling procedures rather than convenience samples.

Taken together, a substantial body of research has emerged examining AS and DT and their role in understanding anxiety and substance use comorbidity. Yet, our findings suggest that other understudied mechanisms (particularly NU) may play a role in understanding these links and deserve further investigation. The development of interventions that target NU in adolescents may prevent the onset of problematic alcohol and cannabis use. Thus, another important study that could be developed from these findings would involve the development and evaluation of a brief substance use prevention program for adolescents that focuses on teaching skills for managing negative affect, with an emphasis on resisting impulsivity. Still, despite our findings with NU as a mediator explaining anxiety-substance use problem associations, the remaining direct effect of anxiety on substance problems after accounting for other transdiagnostic processes remained significant in most models, suggesting there is still much we do not know about how these problems are linked. These relations likely involve complex interactions with substance use motives, peer influence, and other environmental factors, as well as deficits in key regulatory processes and common biological factors.

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Table 1

Alcohol and Cannabis Use Prevalence and Characteristics

	Overall Sample (N = 3002)		Lifetime Alcohol Users	Lifetime Cannabis Users
	Alcohol Use	Cannabis Use	(N = 751)	(N = 430)
Past 30 day use, %	12.7	7.6	50.2	52.6
1–2 days	7.9	2.9	31.4	19.8
3–5 days	2.5	1.4	9.9	9.8
6–9 days	1.1	.7	4.4	4.7
10–14 days	.4	.6	1.6	4.4
15–19 days	.4	.7	1.5	4.9
20–24 days	.2	.4	.7	3.0
25–29 days	.1	.4	.3	2.8
All 30 days	.1	.5	.5	3.3
Average drinks per episode %				
1–2 drinks	7.2	-	28.8	-
3 drinks	1.8	-	7.1	-
4 drinks	.9	-	3.6	-
5 drinks	.9	-	3.7	-
6–7 drinks	.9	-	3.7	-
8–9 drinks	.2	-	.9	-
10 or more drinks	.6	-	2.3	-
Average joints, bowls, or equivalent per occasion %				
Less than 1 joint per day	-	2.8	-	19.5
1 a day	-	1.6	-	10.9
2–3 a day	-	2.2	-	14.9
4–6 a day	-	.5	-	3.5
7–10 a day	-	.1	-	.9
11 or more a day	-	.4	-	3

Table 2
Descriptive Statistics, Correlations, and Cronbach's Alpha Coefficients^a for Study Variables

	<u>M (SD) or %</u>	<u>Correlation Coefficients</u>							
		1.	2.	3.	4.	5.	6.	7.	8.
1. CASI	30.29 (7.20)	<u>.88</u>							
2. CAST cutoff	9.4%	<.01	<u>.92</u>						
3. DTS	2.80 (1.12)	-.39***	-.01	<u>.83</u>					
4. RAPI cutoff	11.9%	.13***	.26***	-.08***	<u>.91</u>				
5. RCADS GAD	0.38 (0.73)	.39***	.07***	-.22***	.15***	<u>.89</u>			
6. RCADS PD	0.29 (0.66)	.42***	.11***	-.21***	.20***	.37***	<u>.90</u>		
7. RCADS SP	0.22 (0.64)	.42***	-.02	-.25***	.09***	.45***	.34***	<u>.92</u>	
8. UPPS	1.96 (0.65)	.44***	.16***	-.31***	.30***	.33***	.36***	.30***	<u>.89</u>

Note. CASI=Childhood Anxiety Sensitivity Index (sum score); CAST cutoff=dichotomous variable indicating exceeding screening cutoff for problematic cannabis use (1=yes, 0=no) weighted to account for missing data; DTS=Distress Tolerance Scale (mean item score); UPPS=UPPS Impulsive Behavior Scale-Negative Urgency Subscale (mean item score); RAPI cutoff=dichotomous variable indicating problem drinking (1=yes, 0=no); RCADS=Revised Children's Anxiety and Depression Scale; RCADS GAD= generalized anxiety disorder symptoms (mean item score on RCADS GAD subscale); RCADS PD=panic disorder symptoms (mean item score on RCADS PD subscale); RCADS SP=social phobia symptoms (mean item score on RCADS SP subscale);

 $p < .001$;

^aCronbach's alphas are underlined and reported on the diagonal of the correlation matrix.

Table 3

Parameter estimates from analyses examining transdiagnostic constructs as potential mediators of the association between anxiety and alcohol use problems

Outcome Variable	Predictor Variable				Mediation			
	RCADS Subscale	CASI	DTS	UPPS	Indirect effect of RCADS subscale on RAPI cutoff through CASI	Indirect effect of RCADS subscale on RAPI cutoff through DTS	Indirect effect of RCADS subscale on RAPI cutoff through UPPS	Remaining direct effect of RCADS subscale
Model with RCADS GAD as the IV								
CASI	.81 (.76-.85) ***							
DTS	-.08 (-.09--.07) ***							
UPPS	.06 (.06-.07) ***							
RAPI cutoff	.12 (.10-.14) ***	-.01 (-.03-.01)	.08 (-.04-.20)	1.37 (1.16-1.58) ***	-.01 (-.03-.01)	-.01 (-.02-.002)	.09 (.07-.10) ***	.05 (.02-.08) ***
Model with RCADS PD as the IV								
CASI	.72 (.68-.76) ***							
DTS	-.06 (-.07--.06) ***							
UPPS	.06 (.05-.06) ***							
RAPI cutoff	.10 (.08-.12) ***	-.02 (-.04-.01)	.09 (-.03-.21)	1.33 (1.12-1.54) ***	-.01 (-.03-.01)	-.01 (-.01-.002)	.07 (.06-.09) ***	.05 (.03-.08) ***
Model with RCADS SP as the IV								
CASI	.56 (.53-.59) ***							
DTS	-.06 (-.06--.05) ***							
UPPS	.04 (.04-.04) ***							
RAPI cutoff	.05 (.04-.07) ***	.001 (-.02-.02)	.06 (-.06-.18)	1.45 (1.24-1.66) ***	.002 (-.02-.02)	-.003 (-.01-.004)	.06 (.05-.06) ***	.002 (-.02-.02)

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Note. Analyses adjusted for school, highest parental education level, and the dummy code to account for missing parental education data.

p < .001;

CASI=Childhood Anxiety Sensitivity Index; DTS=Distress Tolerance Scale; UPPS=UPPS Impulsive Behavior Scale-Negative Urgency Subscale; RAPI cutoff=dichotomous variable indicating high alcohol-related problems (1=yes, 0=no); RCADS=Revised Children's Anxiety and Depression Scale; RCADS GAD= generalized anxiety disorder symptoms (mean item score on RCADS GAD subscale); RCADS PD=panic disorder symptoms (mean item score on RCADS PD subscale); RCADS SP=social phobia symptoms (mean item score on RCADS SP subscale); 95% CIs=95% confidence intervals; IV=independent variable

Table 4

Parameter estimates from analyses examining transdiagnostic constructs as potential mediators of the association between anxiety and cannabis use problems

Predictor Variable			Mediation				
RCADS Subscale	CASI	DTS	UPPS	Indirect effect of RCADS subscale on CAST cutoff through CASI	Indirect effect of RCADS subscale on CAST cutoff through DTS	Indirect effect of RCADS subscale on CAST cutoff through UPPS	Remaining direct effect of RCADS subscale
Outcome Variable	<i>b</i> (95% <i>CI</i> s)	<i>b</i> (95% <i>CI</i> s)	<i>b</i> (95% <i>CI</i> s)	<i>b</i> (95% <i>CI</i> s)	<i>b</i> (95% <i>CI</i> s)	<i>b</i> (95% <i>CI</i> s)	<i>b</i> (95% <i>CI</i> s)
Model with RCADS GAD as the IV							
CASI	.82 (.77-.86) ***						
DTS	-.08 (-.09- -.07) ***						
UPPS	.06 (.06-.07) ***						
CAST cutoff	.05 (.02-.08) ***	-.04 (-.07--.02) ***	.07 (-.06-.20) ***	.95 (.73-1.17) ***	-.04 (-.06--.02) ***	-.01 (-.02-.01) ***	.06 (.05-.07) ***
Model with RCADS PD as the IV							
CASI	.73 (.68-.77) ***						
DTS	-.06 (-.07- -.06) ***						
UPPS	.06 (.05-.06) ***						
CAST cutoff	.06 (.04-.08) ***	-.06 (-.08- -.03) ***	.08 (-.05-.21) ***	.89 (.67-1.11) ***	-.04 (-.06--.02) ***	-.005 (-.01-.003) ***	.05 (.04-.06) ***
Model with RCADS SP as the IV							
CASI	.57 (.54-.59) ***						
DTS	-.06 (-.06- -.05) ***						
UPPS	.04 (.04-.04) ***						
CAST cutoff	-.02 (-.04- -.002) *	-.01 (-.04-.01)	-.01 (-.14-.11)	1.14 (.92-1.36) ***	-.01 (-.02-.01) ***	.001 (-.01-.01)	.04 (.04-.05) ***
							-.06 (-.08- -.04) ***

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Note. All analyses adjusted for school, highest parental education level and the dummy code to account for missing parental education data.

 $p < .001$;
**
 $p < .001$;
*
 $p < .05$;
 $p < .10$

CAS=Childhood Anxiety Sensitivity Index; DTS=Distress Tolerance Scale; UPPS=UPPS Impulsive Behavior Scale–Negative Urgency Subscale; CAST cutoff=dichotomous variable indicating exceeding screening cutoff for cannabis use disorder (1=yes, 0=no) weighted to account for missing data, indicating problem cannabis use; RCADS=Revised Children’s Anxiety and Depression Scale; RCADS GAD=generalized anxiety disorder symptoms (mean item score on RCADS GAD subscale); RCADS PD=panic disorder symptoms (mean item score on RCADS PD subscale); RCADS SP=social phobia symptoms (mean item score on RCADS SP subscale); 95% CIs=95% confidence intervals; IV=independent variable