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Deficits in Access to Reward are Associated with College Student Alcohol Use Disorder

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Abstract

Background—Reward deprivation has been implicated in major depressive disorder and severe substance abuse, but its potential relation to alcohol use disorder (AUD) symptoms in non-treatment seeking young adult drinkers is less clear. Depression is often comorbid with alcohol misuse, so relations of AUD with reward deprivation might be due in part to the presence of depressive symptoms in young adults. Behavioral economic theory views addiction as a state that is related in part to deficits in drug-free rewards, and therefore requires an investigation into whether reward deprivation has a direct relation to alcohol misuse that is, at least partially, independent of mood.

Method—The current paper evaluates the contribution of two facets of reward deprivation (reward availability and experience) to alcohol use, AUD symptoms, and depression in a sample of young adult heavy episodic drinkers. Data were collected from 392 undergraduates (60.4% female, 85.1% Caucasian) who reported recent heavy drinking (83.7% with at least one AUD symptom).

Results—Low reward availability (environmental suppression) was significantly associated with both DSM-5 AUD symptoms and alcohol-related problems after controlling for age, gender, depressive symptomatology, and drinking level.

Conclusions—The current study provides support for behavioral economic models that emphasize reward deprivation as a unique risk factor for AUD that is independent of mood and drinking level. Limited access to natural rewards may be a risk and/or maintaining factor for alcohol use disorder symptoms in college student drinkers.

Keywords

Reward; Alcohol Use Disorder; Young Adult Drinking; Alternative Reinforcers; College

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Introduction

Alcohol use disorder (AUD) is highly disabling and associated with multiple psychological and psychiatric comorbidities (Grant et al., 2015). According to a report by the National Institute on Alcohol Abuse and Alcoholism (NIAAA), alcohol use has been implicated in approximately 600,000 assaults, 70,000 sexual assaults, 500,000 injuries, and 1,400 deaths on college campuses annually (Hingson et al., 2009). Extant research has shown that AUD symptoms are more likely to occur in college students than in their non-college peers (Slutske, 2005), but relatively little research has examined risk factors for AUD among college students. The goal of the present study is to explore the role association between reward deprivation, defined as a lack of access to, and/or an inability to experience enjoyment from natural rewards, and AUD symptoms. Although experimental studies show that severe substance use is most likely when access to alternative sources of reward is restricted (Carroll et al., 2009; Bickel et al., 2014), and one of the diagnostic criteria for AUD specifically concerns foregoing substance-free rewarding activities in favor of drinking alcohol, the potential role of reward deprivation among young adults with emerging AUD symptoms is less clear (Ahmed, 2005).

Reward Deprivation in Substance Abuse

Multiple behavioral economic models conceptualize addiction as a reinforcement pathology (Bickel et al., 2012; 2014; Jarmolowicz et al., 2015) that is characterized by a high relative valuation for drug rewards relative to other stimuli in an individual's environment, a process that is perpetuated by a tendency to devalue future rewards associated with drug-free activities. Consistent with allostatic theories of addiction, these models suggest that, over time, substance misuse is associated with diminished sensitivity to substance-free reward (Koob & LeMoal, 2008). One study found that heavy heroin users reported less subjective pleasure and impaired neural responses to the presentation of naturally rewarding stimuli compared to controls (Lubman et al. 2009), and another study found that a preference for viewing cocaine related pictures relative to naturally reinforcing pictures predicted current and future cocaine misuse (Moeller et al., 2013). Diminished sensitivity to natural rewards may also contribute to adolescent smoking. Audrain-McGovern et al. (2011) found that anhedonia predicts smoking onset through a pathway of the lack of alternative reinforcement. This is consistent with other research demonstrated that "toxic environments" that are deprived of natural sources of reward (e.g., adequate work, recreation, or social opportunities) are associated with increased drug and alcohol use (Bickel et al., 2012; Bezard et al., 2003; Higgins et al., 2004; Hart et al., 2000; Vuchinich & Tucker, 1988). Taken together, these data suggest that reward deprivation may contribute to substance misuse.

Research on the role of reward deprivation specifically in young adult heavy drinking is inconsistent and has not examined the relation to AUD symptoms specifically. Most studies with young adults have used "reinforcement survey" approaches that define reinforcement as the product of recent activity participation and enjoyment and do not differentiate between reward availability and the ability to experience reward (anhedonia). Skidmore and Murphy (2010) reported no association between overall substance-free reinforcement and heavy

drinking in a sample of college students, and actually found *positive* relations between heavy drinking and substance-free peer and sexual activity. Indeed, much of college drinking occurs in social situations (Borsari & Carey, 2001; Murphy et al., 2006) and often facilitates more and greater quality social and peer interactions (Sayette et al., 2012).. Another study reported that college students who reduce their drinking also experience an increase in academic reinforcement and a decrease in reinforcement from substance-free peer interactions (Murphy et al., 2005). This is consistent with other research showing that engagement in academics, volunteering, or exercise, are inversely related to substance use (Vaughan et al., 2009). Meshesha and colleagues (2015) recently examined problems associated with polysubstance use in college students and found that students who used multiple classes of drugs reported less engagement in, and less enjoyment of, substance-free activities compared to those with lighter use patterns.

Measuring Reward Deprivation

Many researchers have noted that reward functioning tends to be oversimplified in the literature due to a lack of attention to the multi-faceted nature of the construct (Baskin-Sommers & Foti, 2015; Treadway & Zald, 2011). Reward-related constructs are often treated as unitary, when in fact they should be treated with much greater specificity due to separable facets that do not always converge. Carvalho and colleagues (2011) developed the Reward Probability Index (RPI) to capture two main facets of reward deprivation: 'Environmental Suppressors,' which indicates factors external to the individual preventing reward receipt (i.e., lack of reward availability), and 'Reward Probability,' which indicates the extent to which possible rewards could be enjoyed (actual experience of reward). It was developed with the intention of capturing Lewinsohn's theories of depression (Lewinsohn, 1974) that posit that deficits in response-contingent positive reinforcement (RCPR) are causally related to depression, with probability of reward serving as a surrogate of RCPR. This model has been widely supported in the depression literature, and has generated efficacious behavioral activation treatments that target RCPR (Gawrysiak, Nicholas, & Hopko, 2009). However, research on reinforcement based models of alcohol misuse has not differentiated the potential role of deficits in reward availability and deficits in the experience of reward. Clarification of the relative importance of these two domains to AUD could help to inform both etiological models and prevention approaches (Murphy et al., 2012).

Present Study: Reward Deprivation, Depression and AUDs

The current paper attempts to clarify the relationship between reward availability, reward experience, depression, and problematic alcohol use in a sample of college student drinkers. We hypothesized that both facets of reward deprivation would be related to alcohol-related consequences and with AUD symptoms even after controlling for the effects of depression. Additionally, in US college populations, a heavy episodic drinking pattern is often relatively normative and largely driven by social factors (O'Malley & Johnston, 2002; Neighbors et al., 2007). Thus, we predicted that reward deprivation would be related to problems with alcohol in a manner that is at least partially independent of drinking level. For these reasons, these relationships were tested in models that controlled for drinking level to examine whether reward deprivation uniquely predicted alcohol use disorder severity.

Materials and Methods

Participants

Participants were 392 undergraduate students from two large public US universities (39.6% male, *M* = 18.77 years old, *SD* = 1.06, 85.1% Caucasian), in their first or second year of college, who endorsed a minimum of two heavy drinking episodes (5/4 drinks for men/women) in the past month. Data were collected as part of the baseline assessment session of a larger alcohol intervention study with non-treatment-seeking college student heavy-episodic drinkers. All data were collected prior to any exposure to the study's intervention elements. Participants were recruited primarily from campus-wide research participation solicitation emails (<10% were psychology majors). They were compensated with extra course credit (for those in psychology courses) or cash payments ($25) for completing the two-hour assessment and brief intervention session.

Procedure

Upon arrival for their study appointment, participants were informed of the study's purpose, risks, and benefits. Once informed consent was obtained, participants completed a computerized assessment battery in a private room. Procedures for this project were approved by both universities' Institutional Review Boards (IRB).

Measures

Alcohol consumption—Weekly alcohol consumption was gathered via the Daily Drinking Questionnaire (DDQ; Collins et al., 1985). The DDQ asks for an estimation of how many drinks were consumed on average for each day of the week over the preceding month, and is then totaled for a weekly average. This measure is highly correlated with other measures of alcohol consumption and has been widely used in the college drinking literature (Kivlahan et al., 1990).

Alcohol Use Disorder Symptoms—Symptoms of past year alcohol use disorder were gathered using self-reported (yes/no response) DSM-5 criteria. Symptom counts were totaled into a count variable to be used in analyses, but are also separated by the severity specifier used in the DSM-5 manual for descriptive purposes in Figure 1.

Alcohol-Related Consequences—Alcohol-related consequences were measured with the Young Adult Alcohol Consequences Questionnaire (YAACQ; Read et al., 2006). This measure is commonly used in college alcohol research and indexes problems that young adults typically experience as a result of drinking alcohol. A follow-up study after the creation of the scale demonstrated the YAACQ's test-retest reliability, as well as concurrent validity with other measures of alcohol consequences (e.g. AUDIT) in college students (Read et al., 2007). Additionally, the YAACQ demonstrated strong internal consistency in this sample (α=.88). The YAACQ was included as a secondary measure of alcohol severity that is developmentally relevant to young adults and may capture a greater range of severity than AUD symptom count.

Reward Deprivation—The Reward Probability Index (RPI; Carvalho et al., 2011) is composed of two subscales and was used to gather reward deprivation data. The scale was designed to measure access to reward and experience of reward, and has displayed high internal consistency (α=.88 in our sample) and adequate test-retest reliability (*r*=.69 two weeks later in Carvalho et al., 2011). Convergent and discriminant validity were established with measures of related and unrelated content (i.e. depression, avoidance, reinforcement, social support, somatic anxiety). The *Environmental Suppressors* subscale focuses on obstacles to engaging in rewarding opportunities (e.g., "Changes have happened in my life that have made it hard to find enjoyment.." (reverse coded); "I wish I could find a place to live that brought more satisfaction to my life."), and the *Reward Probability* subscale focuses on the subjective sense of pleasure or accomplishment experienced when rewards are actually obtained (e.g., "I feel a strong sense of achievement."; "There are many activities that I find satisfying."). These subscales also display high internal consistency (reward probability, 11 items, α=.85 in this sample; environmental suppressors, 9 items, α=.84 in this sample). Taken together, scores on the RPI indicate overall reward experience in everyday life with lower scores reflecting relative reward deprivation and higher scores reflecting a high degree of experienced reward. Responses are scored on a Likert scale of 1–4 where participants indicate how much they disagree-agree, respectively, with the statement.

Depression—Depressive symptomatology was measured through the Depression, Anxiety, and Stress Scale-21 item version (DASS; Lovibond & Lovibond, 1995). There are 21 statements are responded to on a Likert scale from 1–4 describing to what degree the statement does/does not describe them. The validity of the measure was further examined by Crawford and Henry (2003) in a large (N=1,771) normative sample through discriminant and convergent relations with positive and negative affect and other anxiety and depression measures. Only the depression subscale was used for analysis in the current study. Though the authors of the DASS did not design the measure to fit diagnostic criteria of depression, the recommended cut-off scores for severity of depression are as follows: 0–9 = normal, 10–13 = mild, 14–20 = moderate, 21–27 = severe, and 28+ = extremely severe (Lovibond & Lovibond, 1995). This 7-item subscale displayed high internal consistency in this sample (α=.89).

Planned Analyses

Analyses were performed using Mplus version 7.3 (Muthén & Muthén, 1998–2014). Prior to analysis, the data was inspected for outliers (i.e., values 3.29 standard deviations above or below the mean), skew, and kurtosis. Skew and kurtosis values were found to be within normal limits for all continuous variables (Kline, 2015). AUDS was found to be overdispersed (i.e., variance exceeds mean; M = 2.80, σ^2 = 5.40), with a preponderance of zeroes (16.3%).

Multiple regression was used to assess the relationships between RPI total and subscale scores and alcohol problems (YAACQ), controlling for gender, age, drinks per week, and level of depression. However, because of the overdispersion and excess zeroes observed in the AUDS count data, negative binomial hurdle (NBH) regression was used to assess the

relationships between RPI total and subscale scores and AUDS, with an identical covariate model. NBH is a particularly appropriate approach when all participants are considered "at-risk" for an outcome (Atkins et al., 2013; Bandyopadhyay, DeSantis, Korte, & Brady, 2011). Indeed, we considered the participants in this study, all of whom reported past-month heavy drinking episodes, to be at-risk for exhibiting AUDS. The first step in NBH regression involves identifying sampling zeroes ("hurdle" part of the model). The second step examines those who cross the hurdle (count values > 0; 328 participants in our sample had at least one AUDS) and identifies the number of subsequent outcomes ("binomial" part of the model). In other words, our analyses separately predicted sampling zeroes (i.e., experiencing no AUDS) and counts > 0 (i.e., AUDS > 0). Unstandardized regression coefficients are presented in this text.

Results

Descriptive Statistics

Participants reported an average of 16.78 drinks per week (*SD* = 11.93) and 13.05 (*SD* = 7.88) past-month alcohol-related problems; 83.7% of participants reported experiencing one or more AUDS in the past year, and 31.6%, 19.5%, and 13.9% met criteria for a mild (two or three symptoms, moderate (four or five symptoms), and severe (six or more symptoms) past-year alcohol use disorder, respectively. Average DASS depression score was 8.43 (*SD* = 10.85); 31.1% of the sample scored above the threshold (10–13) for a mild level of depression. Of note, the Environmental Suppressors (reward availability) and Reward Probability (experienced reward) subscales only correlated .4 with each other, demonstrating their heterogeneity. There was no significant association between level of depression or RPI total score with drinking level (r=.03 and −.03, n.s., respectively). However, level of depression was significantly related to YAACQ total score (r=.35, p<.001). The Environmental Suppressors subscale and Reward Probability (experienced reward) subscale of the RPI correlated −.32 and −.23 with YAACQ total score, respectively. Bivariate correlations for study variables are presented in Table 1.

Regression models predicting YAACQ

Multiple regression revealed that, controlling for age, gender, drinks per week, and depressive symptoms, RPI total score significantly predicted YAACQ score (overall model R^2 = .317; see Table 2). Specifically, for every one-unit increase in RPI total score, YAACQ score decreased by .13. Similarly, with the same covariate model, the environmental suppressor subscale score significantly predicted YAACQ score (overall model R^2 = .319; see Table 2). Specifically, for every one-unit increased in environmental suppressor subscale score (fewer suppressors), YAACQ score decreased by .19. Reward probability (experienced reward) subscale score was not significantly associated with YAACQ score in the multivariate model.[1]

[1]A mediation analysis revealed that the relationship between the Reward Probability subscale and YAACQ total score was fully mediated by DASS Depression with age, gender, and DDQ as covariates in the model (Indirect Effect = −.1420, SE = .0319; 5000 bootstraps).

Regression models predicting AUDS

NBH regression revealed that, controlling for age, gender, drinks per week, and depressive symptoms, the association between RPI total score and AUDS was not significant ($p = .063$) in the hurdle part of the model. On the other hand, RPI total score significantly predicted AUDS count (binomial; see Table 3). Specifically, conditional that one or more AUDS were experienced (328 participants in our sample had ≥1 AUDS), for each additional one-unit increase in RPI total score, the count of AUDS endorsed decreased by .02. The environmental suppressor subscale score significantly predicted both the presence or absence of AUDS (hurdle, $p = .002$) and AUDS count (binomial, $p < .001$; see Table 3). Specifically, for each additional one-unit increase in environmental suppressor subscale score, the likelihood of experiencing no AUDS increased by .12. Further, conditional that one or more AUDS were experienced, for each additional one-unit increase in environmental suppressor subscale score, the count of AUDS endorsed decreased by .03. Reward probability (experienced reward) subscale score was not significant in the hurdle, nor the binomial, regressions. The effect of the Environmental Suppressors subscale of the RPI on AUD severity is depicted in Figure 1.

Discussion

The goal of this study was to examine the relation between reward deprivation, depression, and problematic alcohol use in a sample of college student heavy drinkers. Overall RPI score was related to alcohol-related problems and AUDS after controlling for alcohol consumption level and depressive symptoms, suggesting that individuals who are more likely to experience reward, generally experience fewer alcohol-related problems even after taking into account drinking level. Subscale analyses indicated that the Environmental Suppressors subscale of the RPI (low reward availability) was significantly related to alcohol-related problems and AUDS after controlling for consumption and depression, but the Reward Probability subscale (experienced reward) was not. The influence of diminished ability to experience reward on alcohol problem severity are likely due to depressive symptoms.

The findings that increased reward is linked to fewer alcohol-related problems and AUDS are consistent with previous research that suggests that low reinforcement levels are linked to substance use (Correia et al., 2003; Higgins et al., 2004) and is consistent with operant and behavioral economic models of substance use (Baum, 1974; Bickel et al., 2012). These models view substance abuse as a reinforcement pathology where drug rewards are overvalued relative to drug-free rewards, in part because many important substance-free rewards require sustained patterns of behavior before resulting in a reward that is experienced after some delay, with the delay resulting in a sharp devaluing of the reward value and a tendency to engage in behavior resulting in immediately reinforcing drug rewards (Bickel et al., 2014). Students with a low probability of experiencing general reward may turn to alcohol as their primary source of reward. Drinking itself actually tends to enhance the availability or experience of many positive rewards in college students, including social and sexual activity (Park, 2004), so it is plausible that the association between reward deprivation and alcohol problems controlling for drinking could be driven by efforts to experience reward through drinking that lead to riskier and more compulsive

use (e.g., behaving recklessly while drinking in pursuit of social/sexual reward, drinking faster higher alcohol drinks in order to experience greater euphoria).

Previous research with college students has shown that elevated alcohol reward value is linked with drinking and related problems (Murphy & Mackillop, 2006; Smith et al., 2010). The current study extends previous research by indicating that reward deprivation is linked to increased risk for alcohol-related problems beyond its relation with consumption level or depression symptoms. This is important because a lack of reinforcement or reward is an integral component of depression, and depression has been linked to problematic substance use in college students (Dennhardt & Murphy, 2011). Thus, these analyses show the importance of reward probability, and in particular access to reward, on problematic drinking above and beyond that accounted for by depression or drinking quantity.

The finding that the Environmental Suppressors subscale of the RPI, but not the Reward Probability subscale, was significantly related to alcohol-related problems and AUDS suggests that factors limiting reward receipt play a specific role in alcohol misuse in college students. Environmental suppression of reward could be related to poor social skills, lack of socialization opportunities, difficulties integrating into the campus environment or uncertainty related to major/career goals, limited campus or community recreational activities, or suboptimal living situations. These obstacles may make the effort of obtaining natural reward to be perceived as too costly in comparison with relatively easy access to alcohol for a college student. Interestingly, environmental suppression does not lead to elevated overall weekly drinking, but, as noted above, may reduce students' ability to regulate their drinking in order to avoid compulsive use and problems. Indeed, the current results dovetail well with existing work suggesting that drinking with the motive of mood enhancement often results in the style of drinking being different (e.g., drinking at a faster pace, which would raise BAC; Perry et al., 2006), which causes more problems due to alcohol use. Furthermore, this corresponds with robust laboratory findings documenting significant neurobehavioral changes due to environmental enrichment that decrease vulnerability to substance abuse in animal models (Stairs & Bardo, 2009; Puhl et al., 2012; Green, Gehrke, & Bardo, 2002). Thus, factors limiting access to reward receipt in the environment seem to play a specific role in development of problematic alcohol use. Though other literature seems to suggest blunted capacity for the experience of reward is related to tobacco and other substance misuse (Audrain-McGovern et al., 2011; Lubman et al., 2009), our results suggest that young adult heavy drinkers may have an intact ability to experience reward given access, but the limited access to natural rewards significantly influences problematic alcohol use (Bickel et al., 2012; Vuchinich & Tucker, 1988).

Implications

The link between reward deprivation (more specifically environmental suppression) and alcohol severity has implications for models of the etiology of AUD and for prevention approaches. First, these results provide support for behavioral economic models that emphasize the role of diminished access to alternatives as an important risk factor for substance misuse (Bickel et al., 2014; Higgins et al., 2004; Vuchinich & Tucker, 1988). Individuals with few rewarding alternatives to drinking may drink in a less controlled and

riskier manner than individuals with more alternatives even after taking into account weekly drinking level and depression. Second, heavy drinking students with AUD symptoms and/or high levels of alcohol problems should receive intervention approaches that attempt to increase access to rewards (Murphy et al., 2012; Reynolds et al., 2011), and the current results suggest that drinking severity may not impact the capacity to experience reward in this population. Research suggests that substance use may decrease if students increase their participation in substance-free activities (Correia, Benson, & Carey, 2005; Murphy et al., 2005), and one study that evaluated a behavioral economic intervention approach that attempts to increase substance-free reward found that students with baseline deficits in substance-free rewards showed greater binge drinking reductions in the behavioral economic intervention condition relative to an active control condition, and that in general, this approach was uniquely effective for reducing alcohol problems Murphy et al., 2012). Moreover, students with depression showed particular benefits from the reinforcement based intervention. Finally, campus and community-based prevention programs should attempt to increase the availability of reinforcement opportunities (intramural activities, campus-sponsored events, community service and internship opportunities), and attempt to decrease the aversive experiences that may hamper access to these rewarding activities (financial counseling, interpersonal skills training, stress management).

Limitations and Future directions

A significant limitation of this study is that is it cross-sectional and therefore the relationship between reward probability and substance use outcomes cannot be assumed to be causative. However, this present study extends laboratory research which has directly manipulated the presence of alternatives and found corresponding influences on substance-use levels (Higgins et al., 2004). Future research should examine these constructs longitudinally to assess directionality and observe potential changes over time. Another limitation of this study is the sample was composed entirely of heavy drinkers. Although the present sample included young adults with a wide range of AUD symptoms, the relationship between the Reward Probability (experienced reward) subscale and drinking level might have been significant in a sample including a wider range of drinkers (e.g., more moderate drinkers and young adults seeking AUD treatment). Future research should also expand the measurement approach to include laboratory-based measures of reward responsivity and prospective measurement of alcohol use, alcohol-related problems, and reward access and experience.

These limitations notwithstanding, these results extend the current literature by demonstrating the link between reward access, AUD symptoms, and alcohol-related problems beyond consumption level and depressive symptoms. This provides support for prevention approaches that attempt to increase access to rewards in high risk drinkers. Reward probability may be a useful indicator of substance abuse risk among young adults and could be used to target young adults who may benefit from intervention, particularly intervention that can increase access to substance-free rewards (Murphy et al., 2012; Reynolds et al., 2011).

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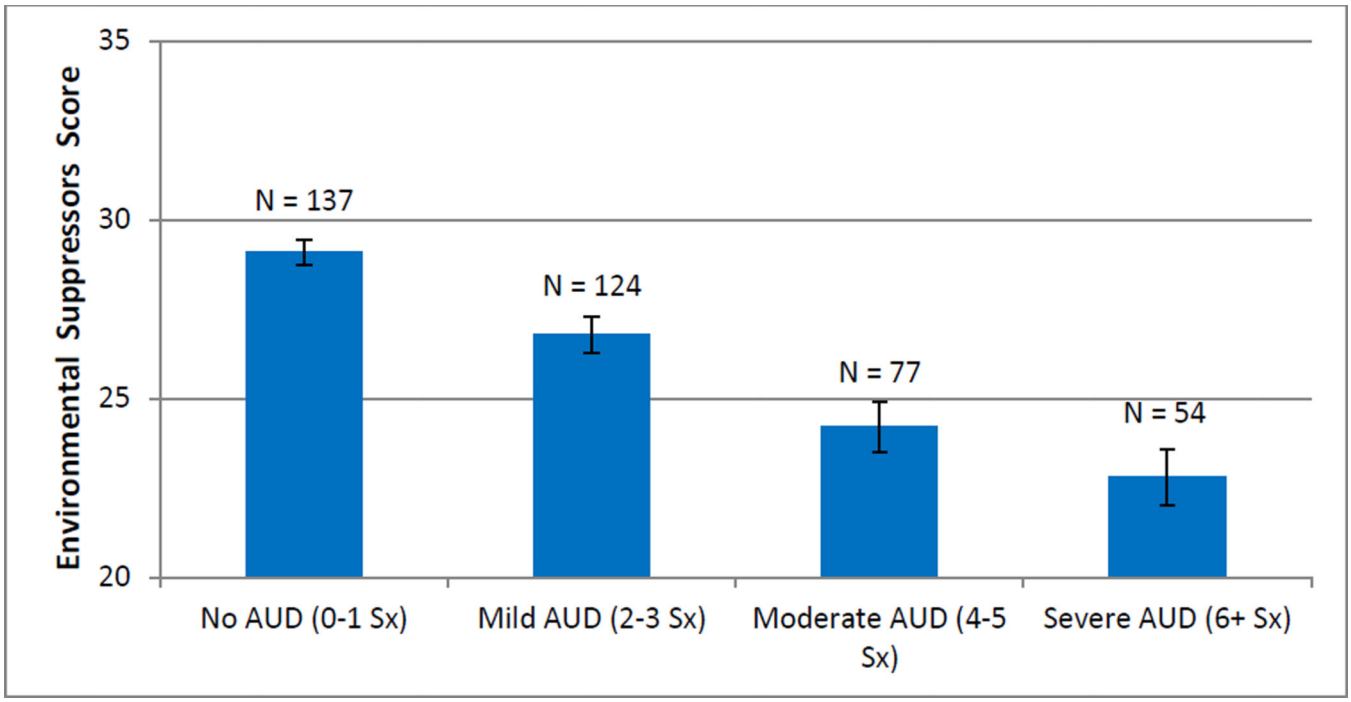

Figure 1.
RPI "Environmental Suppressors" subscale by DSM-5 AUD Severity category. Graph depicts mean value and error bars depict +/− 1 standard error of the mean. Larger values reflect greater availability of rewarding experiences.

Table 1

Bivariate Correlations between DDQ, YAACQ, RPITOT, RPI Subscales, and DASS

	DDQ	YAACQ	RPITOT	RPI-RP	RPI-ES
DDQ	-				
YAACQ	.382*	-			
RPITOT	−.029	−.329*	-		
RPI-RP	−.004	−.227*	.821*	-	
RPI-ES	−.043	−.320*	.855*	.407*	-
DASS	.026	.350*	−.649*	−.507*	−.578*

Note: DDQ = Daily Drinking Questionnaire; YAACQ = Young Adult Alcohol Consequences Questionnaire; RPITOT = Reward Probability Index total; RPI-RP = Reward Probability Index-Reward Probability subscale; RPI-ES = Reward Probability Index-Environmental Suppressors subscale; DASS = Depression, Anxiety, and Stress Scale.

* $p < .001$

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Table 2

Multiple Regression Models Predicting YAACQ

	Unstandardized Beta Weight	SE	*p*-value
YAACQ- RPITOT (N=374)			
Gender	3.307	.738	< .001
Age	−.120	.319	.708
DDQ	.284	.030	< .001
DASS	.161	.041	< .001
RPITOT	−.130	.048	.007
YAACQ- RPI subscales (N=374)			
Gender	3.278	.737	< .001
Age	−.120	.319	.707
DDQ	.282	.030	< .001
DASS	.159	.041	< .001
RPI-ES	−.193	.073	.008
RPI-RP	−.060	.076	.429

Note: AUDS = Alcohol Use Disorder Scale; RPITOT = Reward Probability Index Total; RPI-ES = Reward Probability Index-Environmental Suppressor subscale; RPI-RP = Reward Probability Index-Reward Probability subscale; DDQ = Daily Drinking Questionnaire; DASS = Depression, Anxiety, and Stress Scale.

Table 3

Negative Binomial Hurdle Regression Assessing the Relationships between AUDS & RPI and AUDS & RPI Subscales

	Hurdle			Binomial		
	Parameter estimate	**Robust SE**	***p*-value**	**Parameter estimate**	**Robust SE**	***p*-value**
AUDS - RPITOT						
Age	.018	.154	.909	.025	.032	.447
Gender	−1.006	.322	.002	.171	.088	.051
DDQ	−.091	.021	< .001	.018	.003	< .001
DASS	−.073	.034	.029	.011	.004	.003
RPITOT	.044	.024	.063	−.017	.005	.001
AUDS - RPI Subscales						
Age	.039	.157	.803	.025	.032	.421
Gender	−1.004	.326	.002	.177	.087	.042
DDQ	−.093	.021	< .001	.017	.003	< .001
DASS	−.075	.034	.029	.011	.004	.003
RPI-ES	.122	.040	.002	−.029	.008	< .001
RPI-RP	−.027	.036	.451	−.003	.008	.700

Note: AUDS = Alcohol Use Disorder Scale; RPITOT = Reward Probability Index Total; RPI-ES = Reward Probability Index-Environmental Suppressor subscale; RPI-RP = Reward Probability Index-Reward Probability subscale; DDQ = Daily Drinking Questionnaire; DASS = Depression, Anxiety, and Stress Scale.