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Self-Determined Motivation for Alcohol Use and Drinking Frequency, Intensity, and Consequences

J. B. Courtney[a,b], M. A. Russell[c] and D. E. Conroy[d,e]

[a]Department of Exercise and Sport Science, The University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA; [b]Edna Bennett Pierce Prevention Research Center, The Pennsylvania State University, University Park, Pennsylvania, USA; [c]Department of Biobehavioral Health, The Pennsylvania State University, University Park, Pennsylvania, USA; [d]Department of Kinesiology, The Pennsylvania State University, University Park, Pennsylvania, USA; [e]Department of Preventive Medicine, Northwestern University, Chicago, Illinois, USA

ABSTRACT

Objective: Drinking motives predict drinking behaviors and outcomes among adults. Drinking motives are rarely studied using self-determination theory (SDT), which aligns with harm-reduction approaches to alcohol use, but SDT can offer a complementary theoretical framework to existing drinking motives frameworks that may help explain the observed heterogeneity in drinking motives and account for more variance in drinking outcomes. This study examined the associations between five SDT-based drinking motives with drinking frequency, intensity, and consequences. *Method:* A total number of 630 adults (M_{age} = 21.5, 55% female, 88% undergraduates) rated drinking motives using the Comprehensive Relative Autonomy Index for Drinking (CRAI-Drinking) and the Drinking Motives Questionnaire (DMQ), typical alcohol consumption, and negative and positive drinking consequences. *Results:* Poisson regressions indicated that intrinsic (IRR = 1.13) and identified (IRR = 1.11) regulations were significantly associated with drinking frequency, identified (IRR = 0.94) and positive introjected (IRR = 1.07) regulations were significantly associated with drinking intensity, and amotivation (IRR = 1.16) and intrinsic regulation (IRR = 1.09) were associated with negative and positive consequences, respectively, after controlling for other CRAI-Drinking and DMQ scores, sex, and drinking intensity. After accounting for DMQ scores and sex, CRAI-Drinking scores accounted for 1.7%–9.9% additional deviance in drinking behaviors and consequences. *Conclusions:* Adults high in autonomous reasons for drinking reported low-risk, high-enjoyment drinking experiences. In contrast, adults with higher scores for amotivation for drinking reported more negative consequences, even after accounting for drinking intensity, suggesting that high amotivation for drinking may be a novel signal for future alcohol-related risks. These findings support the idea that SDT provides a useful framework for understanding drinking motives, behaviors, and consequences.

KEYWORDS
Alcohol drinking; motivation; self-determination theory; young adulthood; amotivation

Introduction

Alcohol use, misuse, and negative consequences are public health problems among young adults aged 18–29 years. Among U.S. young adults, 31% engaged in heavy episodic drinking (4+/5+ drinks for women/men) in the past month (Substance Abuse & Mental Health Services Administration Office of Applied Studies, 2021), which corresponds with 1.8–13.1 times higher odds of serious mental and physical consequences including depression, anxiety, overdoses, injuries, and drunk driving (CDC, 2020; Cherpitel et al., 2017; Hingson et al., 2009, 2017; Moure-Rodríguez et al., 2014; Terry-McElrath et al., 2014). Reducing alcohol use and related consequences requires an adequate understanding of the underlying reasons why people misuse alcohol (Patrick & Schulenberg, 2011). It is critically important to understand psychological motives for drinking because these motives represent a common pathway through which distal influences impact drinking behaviors (Cooper, 1994; Cox, 1990; Cox & Klinger, 1988).

Drinking motives predict both drinking behaviors and consequences (Cooper, 1994; Cox, 1990; Cox & Klinger, 1988). Drinking motives as they relate to drinking contexts, behaviors, and consequences are often studied using the Drinking Motives Questionnaire (DMQ) (Cooper, 1994; Gorka et al., 2017; Kuntsche et al., 2005; Kuntsche & Cooper, 2010; Kuntsche & Müller, 2012; Piasecki et al., 2014). The DMQ is based on Cox and Klinger's theory that characterizes drinking motives according to the valence (positive or negative) and source (internal or external) of the outcomes individuals expect to achieve by drinking (Cox & Klinger, 1988), which corresponds with the four DMQ factors of social, coping, conforming, and enhancing motives (Cooper, 1994; Gorka et al., 2017; Kuntsche et al., 2005; Kuntsche &

CONTACT Jimikaye B. Courtney jimikaye@unc.edu Department of Exercise and Sport Science, The University of North Carolina at Chapel Hill, G412 Fetzer Hall, Chapel Hill, North Carolina 27599, USA.
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Cooper, 2010; Kuntsche & Müller, 2012; Piasecki et al., 2014). Along with Cox and Klinger's theory, the psychological constructs underlying self-determination theory (SDT) can offer a complementary theoretical framework that may help explain the observed heterogeneity in drinking motives and account for more variance in drinking outcomes; however, SDT has rarely been used to study drinking motives.

SDT is a general theory of motivation grounded in humanistic psychology that proposes motives differ based on the level of autonomy and locus of control a person experiences when engaging in a behavior, with motives ranging across continua from low to high autonomy and impersonal to internal locus of control (Ryan & Connell, 1989; Ryan & Deci, 2000, 2017; Sheldon et al., 2017). SDT includes six motivational behavioral regulations that vary based on level of autonomy and perceived locus of control (Ryan & Connell, 1989; Ryan & Deci, 2000, 2017; Sheldon et al., 2017). These regulations are ordered along the relative autonomy continuum (RAC) from low to high levels of autonomy and external to internal locus of control (Ryan & Connell, 1989; Ryan & Deci, 2000, 2017; Sheldon et al., 2017) (Figure 1). Intrinsic regulation is completely autonomous motivation in which people engage in a behavior because it is inherently enjoyable or satisfying (Ryan & Connell, 1989; Ryan & Deci, 2000, 2017; Sheldon et al., 2017). Identified regulation is the most autonomous form of extrinsic motivation driven by valuing the outcomes of a behavior (Ryan & Connell, 1989; Ryan & Deci, 2000, 2017; Sheldon et al., 2017). Introjected regulation occurs when a person engages in a behavior to enhance their feelings of self-worth (i.e. positive introjection) or to avoid the loss of self-worth (i.e. negative introjection) (Assor et al., 2009; Sheldon et al., 2017). External regulation, the least autonomous form of extrinsic motivation, is driven by feelings of obligation or guilt (Ryan & Connell, 1989; Ryan & Deci, 2000, 2017; Sheldon et al., 2017). Amotivation is a completely non-autonomous regulation in which a person experiences no intentional motivation or has unclear motives for their behavior (Ryan & Connell, 1989; Ryan & Deci, 2000, 2017; Sheldon et al., 2017).

Despite SDT's robust theoretical underpinnings and its link with other substance use domains like tobacco cessation, SDT has rarely been used to study drinking motives and related outcomes (Levesque et al., 2007; Richards, Morera, et al., 2021; Richards, Pearson, et al., 2021; Ryan & Deci, 2000, 2017; Williams et al., 2016). SDT accounts for important psychological factors, such as autonomy and locus of control, that predict drinking behaviors and outcomes (Bhowmick et al., 2019; Chawla et al., 2009; Koski-Jännes, 1994; Lassi et al., 2019; Levesque et al., 2007; Nogg et al., 2021; Ryan & Deci, 2000, 2017; Williams et al., 2016). For example, lower autonomy predicts drinking for social approval and increased alcohol use (Chawla et al., 2009; Knee & Neighbors, 2002; Neighbors et al., 2003, 2004). Additionally, researchers have recently proposed using SDT as a framework that is uniquely suited from both theoretical and moral perspectives to understanding harm reduction alcohol use behaviors (Richards, Morera, et al., 2021; Richards, Pearson, et al., 2021; Sharma & Smith, 2011).

Previous studies assessing how SDT-based motives relate to drinking outcomes have focused on higher-order abstractions such as extrinsic *versus* intrinsic or controlled *versus* autonomous drinking motives (Chawla et al., 2009; Knee & Neighbors, 2002; Neighbors et al., 2004). The Treatment Self-Regulation Questionnaire examined how three individual behavioral regulations (introjected, external, and amotivation) and autonomous motivation for *responsible* drinking (e.g. drinking to take care of one's own health) were associated with protective behavioral strategies and alcohol use (Richards et al., 2020; Richards, Morera, et al., 2021; Richards, Pearson, et al., 2021). However, we are unaware of any study examining how the individual behavioral regulations underlying SDT are associated with the full scope of low- and high-risk drinking behaviors and consequences. Examining how each of these individual behavioral regulations relate to drinking behaviors and outcomes has the potential to inform future harm-reduction interventions during emerging adulthood focused on reducing negative drinking consequences (Richards, Morera, et al., 2021; Richards, Pearson, et al., 2021) and promoting transitions toward lower risk drinking behaviors.

The purpose of this study was to examine the associations between each of SDT's individual behavioral

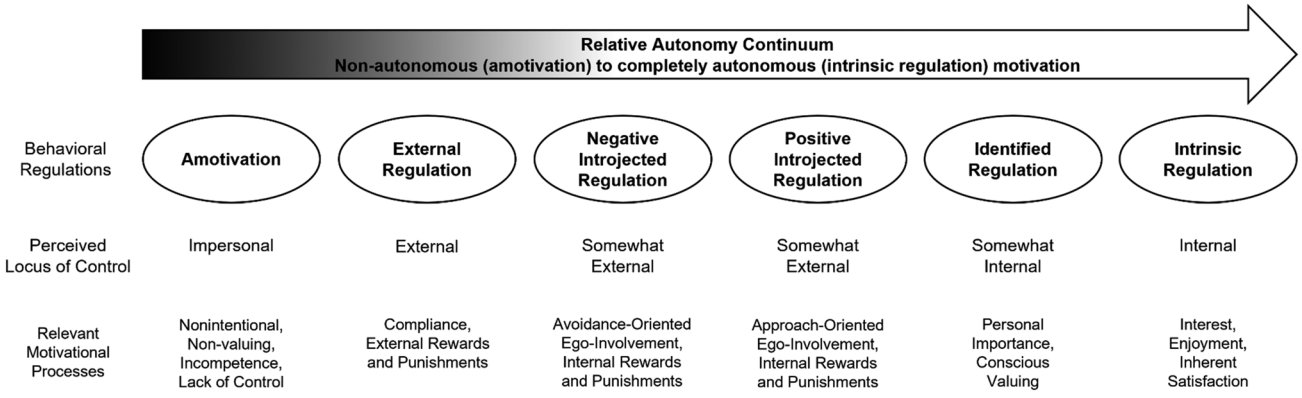

Figure 1. Self-determination theory – relative autonomy continuum, locus of control, and behavioral regulations.
Figure 1 shows self-determination theory's conceptualization of human motivation. This shows the six motivational behavioral regulations ranging in their level of autonomy from low (non-autonomous amotivation) to high (completely autonomous intrinsic regulation), their perceived locus of control from impersonal (amotivation) to completely external (external regulation) to completely internal (intrinsic regulation), and the relevant motivational processes for each individual behavioral regulation. Note that, based on research testing the internal validity of the CRAI-Drinking survey (Courtney et al., 2022), negative introjected regulation was not included in these analyses.

regulations for drinking with drinking frequency, intensity, and negative and positive drinking consequences using the Comprehensive Relative Autonomy Index for Drinking (CRAI-Drinking; Courtney et al., 2022). We hypothesized that regulations characterized by greater autonomy would correspond with more positive consequences and those characterized by lower autonomy would correspond with greater alcohol use and more negative consequences (Knee & Neighbors, 2002; Maggs, 1993; Patrick & Maggs, 2011). Data were collected from two samples to achieve an adequate sample size to test measurement invariance by sex and to cross-validate the psychometric properties of the SDT-based measure of drinking motives (Courtney et al., 2022).

Materials and methods

Participants and procedures

Participants included two convenience samples of adults 18 years or older (Sample 1: 18–57 years; 23.0 ± 6.6 [standard deviation (SD)]) or 18–25 years (Sample 2: 18–25 years; 20.4 ± 1.5 years) who consumed at least one drink/week. Participants were recruited via announcements in undergraduate classes and via social media posts. Participants were screened between November 2020 and December 2021, with 1026 individuals completing the online screening survey. Among those screened, 197 (19.2%) did not qualify. Of the 824 (80.3%) qualified individuals, 630 (76.5%) completed the online study survey and were compensated with extra credit or entered to win one of two $50 gift cards (Sample 1) or one of ten $30 gift cards (Sample 2). This study was approved by the University Institutional Review Board (Protocol #00016554). Participants provided informed consent to participate.

Measures

Self-determined motives for drinking

SDT-based drinking motives were assessed using the CRAI-Drinking, which demonstrates good structural validity (Courtney et al., 2022). The CRAI-Drinking was adapted from Sheldon et al.'s (2017) generic Comprehensive Relative Autonomy Index and originally included 24 items assessing self-determined motives for drinking. Participants were asked: "Why do I drink?", and they rated each item on a 5-point Likert scale from (0) *not true for me* to (4) *very true for me*. Based on prior testing of structural validity (Courtney et al., 2022), mean scores for the five factors of intrinsic (4 items, $\alpha = 0.82$), identified (3 items, $\alpha = 0.72$), positive introjected (4 items, $\alpha = 0.86$), external (4 items, $\alpha = 0.75$), and amotivated (4 items, $\alpha = 0.78$) behavioral regulations were used as independent variables in subsequent models.

Drinking motives questionnaire

The 20-item DMQ assessed four motives for drinking (Cooper, 1994): social ($\alpha = 0.87$), coping ($\alpha = 0.87$), enhancing ($\alpha = 0.84$), and conformity ($\alpha = 0.85$) motives. Participants rated each item on a 5-point Likert scale ranging from (1) *almost never/never* to (5) *almost always/always*. Average scores were calculated for each factor.

Alcohol use

Participants reported their alcohol use during a typical week using the Daily Drinking Questionnaire (Collins et al., 1985). A standard drink was defined in writing as 12 ounces (oz.) of 5% beer, 8–9 oz. of 7% beer, 4–5 oz. of wine, a 1.5 oz. shot of liquor (straight or in a mixed drink), or 12 oz. of hard seltzer and was accompanied by a picture. Participants reported the typical number of drinks consumed and hours they drank on each day of the week. Responses were used to calculate drinking volume (i.e. total drinks/week) and frequency (i.e. total drinking days/week) for a typical week. Drinking intensity (i.e. drinks/day) was calculated by dividing drinking volume by drinking frequency to estimate the average number of drinks consumed per drinking day (i.e. intensity = total drinks per week/total drinking days per week).

Negative and positive drinking consequences

Negative and positive drinking consequences were assessed using the 24-item Brief Young Adult Alcohol Consequences Questionnaire (Kahler et al., 2005) and 15 items from the Importance of Consequences of Drinking short form (Maggs, 1993; Patrick & Maggs, 2011), respectively. Participants responded "Yes" or "No" for having experienced each consequence and "Yes" responses were summed to calculate separate values for the total number of negative or positive consequences.

Demographics

Demographic characteristics were assessed using self-reports of age, biological sex at birth, ethnicity, race, education, work status, and student status.

Statistical analyses

We examined associations between the five CRAI-Drinking behavioral regulations for drinking (i.e. intrinsic, identified, positive introjected, external, and amotivated) with drinking behaviors and consequences in the combined sample by regressing typical drinking frequency (days/week), intensity (drinks/day), number of negative consequences, and number of positive consequences on all five CRAI-Drinking scores simultaneously, while controlling for DMQ scores. Each model also controlled for sample and sex due to sex differences in drinking behaviors and consequences, and the models for negative and positive consequences controlled for drinking intensity (drinks/day). Over-dispersed Poisson regressions accounted for the skewed distribution of alcohol use data. Incident rate ratios (IRR) and 95% CIs were calculated by exponentiating the model estimates. Models with and without the CRAI-Drinking scores were compared using

Table 1. Sample characteristics.

Demographic characteristics	Sample 1 ($N=274$)	Sample 2 ($N=356$)	Combined sample ($N=630$)
Race (n (%))[a]			
White	224 (81.8)	301 (84.6)	525 (83.3)
Asian	25 (9.1)	23 (6.5)	48 (7.6)
Black	11 (4.0)	3 (0.8)	14 (2.2)
American Indian/Alaskan Native	1 (0.4)	1 (0.3)	2 (0.3)
Other	1 (0.4)	4 (1.1)	5 (0.8)
Mixed	9 (3.3)	18 (5.1)	27 (4.3)
Education level (n (%))[b]			
High school degree or equivalent	93 (33.9)	134 (52.3)*	227 (36.0)
Some college or AA degree	118 (43.1)	203 (57.0)*	321 (50.8)
Bachelor's Degree	26 (7.0)	17 (4.8)*	43 (6.8)
Post-Graduate Degree	37 (13.5)	1 (0.3)*	38 (6.0)
Work Status (n (%))[c]			
Full-time	40 (14.6)	2 (0.6)*	42 (6.7)
Part-time	2 (0.7)	0 (0.0)	2 (0.3)
Unemployed/Looking for Work	1 (0.4)	0 (0.0)	1 (0.2)
Student, not working	121 (44.2)	155 (43.5)	276 (43.8)
Student, working	108 (39.4)	198 (55.6)*	306 (48.6)
Other work status	2 (0.7)	0 (0.0)	2 (0.3)
Student Type (n (%))[d]			
Undergraduate Student	208 (75.5)	347 (97.5)*	555 (88.1)
Post-Graduate Student	17 (6.2)	7 (2.0)*	24 (3.8)
Non-Student	43 (15.7)	2 (0.6)*	45 (7.1)
Alcohol Use Characteristics	Mean ± SD	Mean ± SD	Mean ± SD
Alcohol Use – Typical Week[e]			
Frequency – Days per Week	2.9 ± 1.4	3.5 ± 1.6*	3.2 ± 1.5
Volume – Total Drinks per Week	11.2 ± 8.4	18.2 ± 13.1*	15.2 ± 11.8
Intensity – Drinks per Day	3.9 ± 2.3	5.1 ± 2.8*	8.5 ± 4.9
Negative Drinking Consequences	6.1 ± 5.0	7.8 ± 6.2*	7.0 ± 5.8
Positive Drinking Consequences[f]	–	8.5 ± 4.9*	8.5 ± 4.9
CRAI-Drinking[g]			
Intrinsic Regulation	2.6 ± 0.9	2.9 ± 0.9*	2.8 ± 0.9
Identified Regulation	0.8 ± 0.8	1.2 ± 1.1*	1.0 ± 1.0
Positive Introjected Regulation	0.8 ± 0.8	1.3 ± 1.1*	1.1 ± 1.0
External Regulation	0.7 ± 0.7	0.8 ± 0.8*	0.9 ± 0.8
Amotivation	0.6 ± 0.7	0.9 ± 0.7*	0.8 ± 0.8
Drinking Motives Questionnaire[h]			
Social	3.2 ± 1.0	3.6 ± 1.0*	3.4 ± 1.0
Coping	2.0 ± 0.9	2.4 ± 1.1*	2.2 ± 1.0
Enhancing	2.8 ± 0.9	3.3 ± 1.0*	3.0 ± 1.0
Conforming	1.5 ± 0.7	1.7 ± 0.9	1.6 ± 0.8

Notes: *$p<0.01$ for difference between samples based on Chi-square test, t-test, or Wilcoxon test. SD: standard deviation; AA: Associate's Degree; Min: minimum; Max: maximum; 1QR: first quartile; 3QR: third quartile; CRAI-Drinking: Comprehensive Relative Autonomy Index for Drinking

[a]Missing data: Sample 1 = 3; Sample 2 = 6. [b]Missing data: Sample 1 = 0; Sample 2 = 1. Some college or AA degree includes some college education, Associate's degree, or trade school. Post-Graduate Degree includes Master's degree, Doctoral degree, and professional degree (e.g. medical doctor). [c]Missing data: Sample 1 = 1; Sample 2 = 0. Student, not working includes undergraduate and graduate students who are not working any part-time or full-time job. Student, working includes undergraduate and graduate students who are also working a part-time or full-time job. [d]Missing data: Sample 1 = 6; Sample 2 = 0. Post-Graduate Student includes graduate and professional students. [e]Drinking Frequency is the sum of the total number of days a person drank on a typical week. Drinking volume was the sum of number drinks per day for typical week, with outliers ($n=12$) winsorized to 3 SDs above the mean. Drinking intensity was average drinks per day, calculated as: frequency/volume. [f] Number of positive consequences over the past month only collected in Sample 2 ($n=356$). [g]Combined sample Cronbach's alpha (α) and 95% confidence intervals (CI). Intrinsic regulation $\alpha = 0.82$ (95% CI: 0.78, 0.84). Identified regulation $\alpha = 0.72$ (95% CI: 0.67, 0.76) (excludes IDENT_1 item). Positive introjected regulation $\alpha = 0.86$ (95% CI: 0.83, 0.87). External regulation $\alpha = 0.75$ (0.71, 0.78). Amotivation $\alpha = 0.78$ (0.74, 0.82). [h]Combined sample Cronbach's α and CI. Social motives $\alpha = 0.87$ (95% CI: 0.85, 0.89). Coping motives $\alpha = 0.87$ (95% CI: 0.85, 0.89). Enhancing motives $\alpha = 0.84$ (0.82, 0.86). Conforming motives $\alpha = 0.85$ (0.82, 0.88).

F-tests and deviance-based pseudo-R-squared values, which quantify the goodness of model fit to the data after including the CRAI-Drinking scores (Mittlböck & Waldhör, 2000). Statistical significance was set at $p<0.05$. Data were analyzed in R version 4.0.3 (R Core Team, 2020) and the package *ggplot*, version 3.2.1(Wickham, 2016).

Results

Participant characteristics

The combined sample ($N=630$) was 55.1% female, 90.6% non-Hispanic, 83.3% White, and 88.1% undergraduate students with a mean (±SD) age of 21.5 ± 4.7 years. Participants drank alcohol on 3.2 ± 1.5 d per week, consumed 8.5 ± 4.9 drinks per day, and experienced 7.0 ± 5.8 negative and 8.5 ± 4.9 positive drinking consequences. Participants reported high levels of social (3.4 ± 1.0) and low levels of conformity motives (1.6 ± 0.8) for drinking. Table 1 provides descriptive statistics for each sample and the combined sample, including scores for each of the CRAI-Drinking scales. Sample 2 was significantly younger, included more students, was less educated, reported greater alcohol consumption, more negative consequences, and higher levels of all motives except conformity motives.

Table 2 presents the correlation matrix for the CRAI-Drinking factors and average drinking frequency (days/week) and intensity (drinks/day) for a typical week and number of negative and positive drinking consequences. CRAI-Drinking factors characterized by higher levels of

Table 2. Correlation coefficient matrix of mean scores for all factors for the Comprehensive Relative Autonomy Index for Drinking and drinking frequency, intensity, and number of negative and positive drinking consequences[a].

	CRAI-drinking factors					Drinking outcomes		
	INT (1)	IDENT (2)	POSREG (3)	EXTREG (4)	AMOT (5)	Drinking frequency (6)	Drinking intensity (7)	Negative consequences (8)
CRAI-drinking factors								
INT (1)								
IDENT (2)	0.50*							
POSREG (3)	0.28*	0.53*						
EXTREG (4)	0.07	0.34*	0.58*					
AMOT (5)	0.01	0.23*	0.38*	0.49*				
Drinking outcomes								
Drinking frequency (6)[b]	0.36*	0.39*	0.24*	0.11	0.16*			
Drinking intensity (7)[c]	0.27*	0.22*	0.25*	0.14*	0.09	0.09		
Negative consequences (8)[d]	0.19*	0.28*	0.35*	0.35*	0.32*	0.31*	0.40*	
Positive consequences (9)[e]	0.21*	0.29*	0.35*	0.23*	0.17*	0.23*	0.24*	0.44*

Notes: *$p < 0.00139$. Bonferroni adjustment critical p for 36 tests = 0.00139; critical $r = 0.13$.
CRAI-Drinking: Comprehensive Relative Autonomy Index for Drinking; INT: intrinsic regulation; IDENT: identified regulation; POSREG: positive introjected regulation; NEGREG: negative introjected regulation; EXTREG: external regulation; AMOT: amotivation
[a]$N = 630$. [b]Days/week. [c]Drinks/day. [d]Sum of negative drinking consequences participant experienced over the past month. [e]Sum of positive drinking consequences participant experienced over the past month. Only collected in the cross-validation sample ($n = 356$).

Table 3. Poisson regressions with drinking frequency, intensity, and number of negative and positive drinking consequences regressed on Comprehensive Relative Autonomy Index for Drinking and Drinking Motives Questionnaire factors ($n = 630$).

Alcohol use outcomes	Drinking frequency – Days/week[a]	Drinking intensity – drinks/day[b]	Number of negative drinking consequences[c]	Number of positive drinking consequences[d]
CRAI-Drinking factors	IRR [95% CI]	IRR [95% CI]	IRR [95% CI]	IRR [95% CI]
Intrinsic regulation	1.14 [1.07, 1.20]***	1.01 [0.95, 1.08]	1.01 [0.93, 1.10]	1.09 [1.01, 1.18]*
Identified regulation	1.11 [1.06, 1.16]***	0.94 [0.89, 0.99]*	1.01 [0.94, 1.08]	1.02 [0.97, 1.08]
Positive introjected regulation	1.02 [0.96, 1.07]	1.07 [1.01, 1.15]*	1.02 [0.94, 1.10]	1.07 [1.00, 1.14]
External regulation	1.00 [0.93, 1.07]	1.01 [0.93, 1.10]	1.03 [0.93, 1.14]	1.00 [0.92, 1.09]
Amotivation	1.02 [0.97, 1.07]	1.00 [0.94, 1.06]	1.16 [1.08, 1.24]***	1.00 [0.94, 1.06]
DMQ factors				
Social motives	0.94 [0.89, 0.98]**	1.18 [1.12, 1.25]***	1.02 [0.95, 1.10]	1.07 [1.00, 1.14]*
Coping motives	1.05 [1.00, 1.10]*	0.97 [0.92, 1.02]	1.11 [1.04, 1.19]**	1.01 [0.96, 1.07]
Enhancing motives	1.01 [0.95, 1.07]	1.11 [1.03, 1.19]**	1.08 [0.99, 1.18]	0.98 [0.91, 1.05]
Conformity motives	0.99 [0.93, 1.06]	0.95 [0.88, 1.02]	1.08 [0.99, 1.18]	1.07 [1.00, 1.16]
Male	1.08 [1.01, 1.16]*	1.42 [1.31, 1.55]***	0.97 [0.87, 1.09]	0.91 [0.83, 1.00]
Sample (reference = 1)	0.94 [0.87, 1.01]	0.91 [0.84, 1.00]*	0.93 [0.84, 1.04]	
Drinks/day	–	–	1.09 [1.07, 1.11]***	1.01 [1.00, 1.03]

Notes: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.
IRR: incident rate ratio; CI: confidence interval; CRAI-Drinking: Comprehensive Relative Autonomy Index for Drinking; DMQ: Drinking Motives Questionnaire
[a]Dispersion parameter = 0.57. Pseudo-R-squared = 0.0989. [b]Dispersion parameter = 1.11. Pseudo R-squared = 0.0174. [c]Sum of negative drinking consequences participant experienced over the past month. Dispersion parameter = 2.82. Pseudo-R-squared = 0.0352. [d]Sum of positive drinking consequences participant experienced over the past month. Only collected in the cross-validation sample ($n = 356$). Dispersion parameter = 1.42. Pseudo R-squared = 0.0338.

autonomy were more highly correlated with drinking frequency than factors characterized by low or no autonomy (e.g. high autonomy intrinsic regulation and drinking frequency: $r = 0.36$ *versus* no autonomy amotivation and drinking frequency: $r = 0.16$). As hypothesized, CRAI-Drinking factors characterized by lower levels of autonomy were more highly correlated with negative drinking consequences than factors characterized by lower autonomy (e.g. low autonomy external regulation and negative consequences: $r = 0.35$ *versus* high autonomy intrinsic regulation and negative consequences: $r = 0.19$).

Table 3 presents the Poisson regressions for drinking frequency, intensity, and number of negative and positive drinking consequences regressed on CRAI-Drinking scores. All analyses adjusted for scores on the DMQ and sex. Figure 2(a,b) shows the IRR for associations between individual behavioral regulations and drinking frequency (2a), drinking intensity (2b), negative consequences (2c), and positive consequences (2d), and the results for each model are presented in detail below.

Drinking frequency

Higher intrinsic (IRR = 1.14, 95% CI [1.07, 1.20]) and identified (IRR = 1.11, 95% CI [1.06, 1.16]) regulations, the two highest autonomy CRAI-Drinking factors, were associated with greater drinking frequency – drinking on more days per week, above and beyond the effects of the DMQ factors and sex. Positive introjected regulation, external regulation, and amotivation were not associated with drinking frequency. Including CRAI-Drinking scores improved model fit ($F_{5,576} = 12.17$, $p < 0.001$). The model had a pseudo-R-squared value of 0.099, indicating that, after accounting for DMQ scores and sex, approximately 9.9% of deviance in drinking frequency was explained by CRAI-Drinking scores.

Drinking intensity

Higher identified regulation was associated with lower drinking intensity (i.e. consuming fewer drinks/day; IRR = 0.94, 95% CI [0.89, 0.99]), and higher positive introjection, a

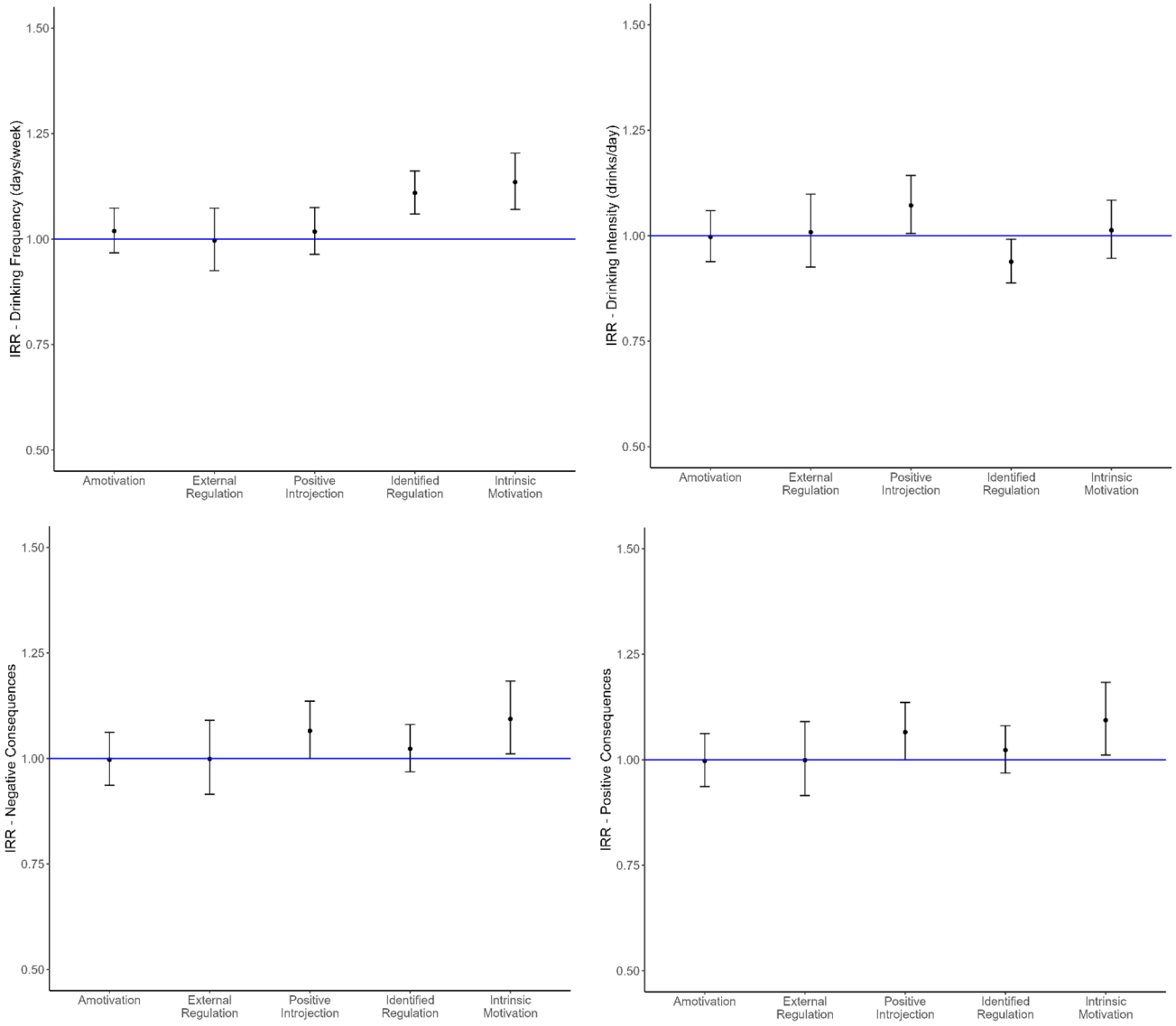

Figure 2. Incident rate ratios for associations between behavioral regulations for drinking and drinking behaviors and consequences.
Figure 2(a–d) shows the incident rate ratios (IRR) and 95% confidence intervals for the IRRs from the over-dispersed Poisson regression models testing associations between the CRAI-Drinking's individual behavioral regulations for drinking with drinking frequency (2a), drinking intensity (2b), negative drinking consequences (2c), and positive drinking consequences (2d). When the IRR and associated 95% confidence interval do not cross the blue line, this indicates a statistically significant association between individual behavioral regulation for drinking and the drinking-related outcome, with values above line indicating a positive association and values below the line indicating a negative association.

factor in the middle of the CRAI-Drinking autonomy continuum, was associated with greater drinking intensity (i.e. consuming more drinks/day; IRR = 1.07, 95% CI [1.01, 1.14]), above and beyond the effects of the DMQ factors and sex. Intrinsic regulation, external regulation, and amotivation were not associated with drinking intensity. Including CRAI-Drinking scores did not significantly improve model fit ($F_{5,576}$ = 2.00, $p = 0.08$). The model had a pseudo-*R*-squared value of 0.017, indicating that, after accounting for DMQ scores and sex, approximately 1.7% of deviance in drinking intensity was explained by CRAI-Drinking scores.

Negative drinking consequences

Higher amotivation (IRR = 1.16, 95% CI [1.08, 1.24]), a factor characterized by no autonomy, was associated with experiencing more negative drinking consequences, above and beyond the effects of the DMQ factors, sex, and alcohol consumption. Intrinsic, identified, positive introjected, and external regulations were not associated with negative drinking consequences. Including CRAI-Drinking scores improved model fit ($F_{5,576}$ = 4.74, $p < 0.001$). The model had a pseudo-*R*-squared value of 0.037, indicating that, after accounting for DMQ scores, sex, and alcohol consumption, approximately 3.7% of deviance in drinking frequency was explained by CRAI-Drinking scores.

Positive drinking consequences

Higher intrinsic regulation (IRR = 1.09, 95% CI [1.01, 1.18]), the highest autonomy factor, was associated with experiencing more positive drinking consequences, above and beyond the effects of the DMQ factors, sex, and alcohol consumption. Identified regulation, positive introjected regulation,

external regulation, and amotivation were not associated with positive drinking consequences. Including CRAI-Drinking scores improved model fit ($F_{5,576}$ = 4.89, $p < 0.001$). The model had a pseudo-R-squared value of 0.034, indicating that, after accounting for DMQ scores, sex, and alcohol consumption, approximately 3.4% of deviance in drinking frequency was explained by CRAI-Drinking scores.

Discussion

This study examined the associations between five individual self-determined behavioral regulations for drinking (intrinsic, identified, positive introjected, external, and amotivated regulations) with drinking behaviors and consequences in a sample of primarily young adults. To our knowledge, this is the first study examining associations with individual behavioral regulations for drinking, particularly amotivation, as previous research dichotomized self-determined motives for drinking (Chawla et al., 2009; Knee & Neighbors, 2002; Neighbors et al., 2004), or examined self-determined motives for responsible drinking (Richards et al., 2020, Richards, Morera, et al., 2021; Richards, Pearson, et al., 2021). We found that each of the five individual SDT-based behavioral regulations were uniquely associated with drinking behaviors and consequences. A novel contribution of this study was that greater amotivation (i.e. a lack of motivation) for drinking was associated with more negative drinking consequences, regardless of the amount of alcohol consumed. Overall, our findings were consistent with SDT such that autonomously-motivated drinking corresponded with low-risk, high-enjoyment drinking, whereas amotivated drinking corresponded with high-risk, low-enjoyment drinking behaviors and outcomes (Ryan & Connell, 1989; Ryan & Deci, 2000, 2017; Sheldon et al., 2017).

Higher intrinsic regulation was associated with greater drinking frequency but *not* with drinking intensity. This contrasts with one previous study that included all types of college student drinkers (Neighbors et al., 2004), but aligned with other studies indicating that greater autonomous motivation predicts more pre-partying drinking intentions and greater internal locus of control predicts less high-risk drinking (Caudwell & Hagger, 2015; Knee & Neighbors, 2002). Higher intrinsic regulation also corresponded with more positive drinking consequences, which was expected given that positive consequences include drinking for fun (i.e. intrinsic regulation) (Maggs, 1993; Patrick & Maggs, 2011). It also supports the idea that drinking for fun or enjoyment may increase the likelihood of experiencing positive drinking outcomes, thereby reinforcing subsequent drinking behavior. This aligns with SDT and with research across behavioral domains indicating that autonomous motivation is associated with healthier, less risky behaviors, and better behavioral outcomes (Bhowmick et al., 2019; Koski-Jännes, 1994; Lassi et al., 2019; S. W. Ng & Popkin, 2012; Ryan et al., 2008; Ryan & Connell, 1989; Ryan & Deci, 2000, 2017; Sheldon et al., 2017). These findings suggest that drinking due to intrinsic motives may support individuals in experiencing low-risk, enjoyable drinking experiences. Given increasing evidence that people can recover from harmful drinking behaviors without fully abstaining from drinking (Witkiewitz et al., 2020), this finding has important implications for harm reduction-based alcohol interventions. Future harm reduction interventions in high-risk drinkers could use existing SDT-based techniques, such as identifying barriers to change, that have been proven to be effective in enhancing intrinsic motivation and promoting positive health behavior change, as a means to promote low-risk, high-enjoyment drinking behaviors (Gillison et al., 2019; Ntoumanis et al., 2021; Patrick & Maggs, 2011; Richards, Morera, et al., 2021; Richards, Pearson, et al., et al., 2021; Ryan et al., 2008).

Higher identified regulation was associated with greater drinking frequency and, similar to prior literature, lower drinking intensity (Neighbors et al., 2004, 2007). Also consistent with prior literature (Knee & Neighbors, 2002; Neighbors et al., 2003), higher positive introjected regulation, a less autonomous form of motivation, was associated with greater drinking intensity. This pattern of findings aligns with prior research indicating that identified regulation is more strongly associated with positive behavioral patterns and outcomes than positive introjected regulation (Assor et al., 2009; Ryan & Deci, 2000). This has important implications for the role self-worth plays as a desired outcome *versus* motive for a behavior (Assor et al., 2009; Neighbors et al., 2004; Ryan & Brown, 2003). While stable self-esteem is desirable, if self-esteem is a primary motive for behavior it can create internal pressure and fragile feelings of self-worth that are potentially detrimental (Assor et al., 2009; Neighbors et al., 2004). Indeed, Neighbors et al. (2004) found that when self-esteem was a motive for behavior, it was associated with greater drinking frequency and negative consequences. In contrast, some research suggests that self-esteem motivation may be healthier or less toxic than researchers previously thought (Crocker & Park, 2004; Sheldon et al., 2017); however, the role of self-esteem as an outcome *versus* motive for behavior (i.e. identified *versus* positive introjected regulations) remains unclear. Additional research clarifying the role of self-esteem in predicting future drinking behaviors and consequences is needed to inform the selection of appropriate intervention strategies that enhance self-esteem in a way that facilitates lower-risk drinking behaviors.

In contrast with prior research, external regulation was not associated with drinking-related behaviors or outcomes. Previous research typically found that greater controlled motivation, which includes external regulation, was associated with greater alcohol use (Knee & Neighbors, 2002; Neighbors et al., 2004, 2007). This may be due to our models controlling for conformity motives which were highly correlated ($r = 0.76$) with external regulation and may have reduced our ability to detect effects of external regulation (Cooper, 1994; Gagné et al., 2015; Roth et al., 2006; Ryan & Connell, 1989; Ryan & Deci, 2000, 2017; Sheldon et al., 2017). Indeed, external regulation was significantly associated with more negative drinking consequences when not controlling for conformity motives, suggesting that the high collinearity impacted our findings (Supplemental Table 1). The lack of significant associations between external regulation and drinking may also be due to previous studies

combining introjected, external, and amotivated regulations to compare controlled *versus* autonomous motivation for drinking (Knee & Neighbors, 2002; Neighbors et al., 2004, 2007). Given that positive introjection and amotivation were consistently and positively associated with drinking intensity and negative consequences, respectively, our findings highlight the value of examining each of SDT's individual behavioral regulations. These behavioral regulations are independent constructs (Ng et al., 2012) and, in some cases, respond differently to the same intervention strategy (Ntoumanis et al., 2021). For example, a meta-analysis found that using an SDT-based strategy that supports an individual's ability to succeed increased controlled motivation (a combination of external and introjected regulation), but decreased amotivation (Ntoumanis et al., 2021). These differing responses highlight the need to disentangle individual behavioral regulations to inform clinical practice and harm reduction intervention development (Ntoumanis et al., 2021; Richards, Morera, et al., 2021; Richards, Pearson, et al., et al., 2021).

Among the behavioral regulations assessed *via* the CRAI-Drinking, amotivation is distinct because it represents a completely non-regulated form of motivation characterized by unclear or unknown reasons for drinking (Ryan & Connell, 1989; Ryan & Deci, 2000, 2017; Sheldon et al., 2017). Despite the unique nature of amotivation, no prior research (to our knowledge) has investigated how amotivation for drinking relates to drinking behaviors and consequences. We found that, regardless of how much alcohol an individual consumed, if they reported greater amotivation, they experienced more negative drinking consequences. This aligns with research indicating that greater amotivation for using protective behavioral strategies is associated with more negative consequences and less use of protective behavioral strategies (Richards, Morera, et al., 2021; Richards, Pearson, et al., et al., 2021). Individuals with greater amotivation may experience more negative drinking consequences due to using fewer protective behavioral strategies and/or due to their greater susceptibility to engage in risky drinking (Hagger & Hamilton, 2021; Hofmann et al., 2009). These potential behavioral and psychological explanations may be related to the neurological mechanisms underlying amotivation.

Amotivation is a commonly reported symptom of mood disorders, such as depression, and overlaps with other symptoms such as anhedonia (i.e. loss of interest or pleasure), fatigue, and indecisiveness, all of which negatively predict long-term outcomes (American Psychiatric Association, 2013; Calabrese et al., 2014; Lavretsky et al., 2007). These symptoms appear to be rooted in neurological dysfunctions of the mesocorticolimbic dopamine system and fronto-striatal region of the brain that blunt people's sensitivity to momentary and anticipated rewards and punishments, which are also accompanied by abnormal behavioral responses, such as impaired decision making (Cella et al., 2010; Eshel & Roiser, 2010; Martin-Soelch, 2009; Ubl et al., 2015). These underlying neurological mechanisms, impaired decision making, and/or comorbid mood disorders may help account for greater amotivation being associated with more negative drinking consequences, less use of protective behavioral strategies, and more impulsive drinking (Hofmann et al., 2009; Richards, Morera, et al., 2021; Richards, Pearson, et al., et al., 2021). Additional research is needed to investigate the mechanisms related to amotivation and drinking behaviors and consequences. Irrespective of the exact mechanism(s), we hypothesize that amotivation for drinking may be predictive of young adults maintaining high risk drinking behaviors or transitioning toward overt alcohol use disorders later in life, though future research is required to test this hypothesis (Richards, Morera, et al., 2021; Richards, Pearson, et al., et al., 2021).

Our findings have important implications for intervention development and clinical practice. For intervention, delivering interventions in community settings and using proven SDT-based strategies, such as supporting an individual's ability to succeed and identifying barriers to change, have the potential to reduce amotivation for drinking and its related consequences (Ntoumanis et al., 2021). For clinical practice, screening for amotivation and risk of comorbid mood disorders may help identify individuals who could benefit from coordinated clinical care targeting underlying mood disorders alongside harm reduction decision-making strategies (American Psychiatric Association, 2013; Calabrese et al., 2014; Hofmann et al., 2009; Richards, Morera, et al., 2021; Richards, Pearson, et al., et al., 2021).

Limitations

The study was limited to two convenience samples of adults were predominantly White, and non-Hispanic, undergraduate students. More diverse samples, including samples of people with alcohol use disorder, would strengthen the ability to generalize our findings about associations with drinking behaviors and consequences to clinical populations and to adults from other racial/ethnic groups or to adolescents, middle-aged, or older adults. Response options for the CRAI-Drinking were modified from the original survey to align with other SDT-based measures (Markland & Tobin, 2004), which may have affected findings. We used retrospective self-reported measures of drinking behaviors and consequences. Self-report measures are subject to recall and social desirability biases that may result in over- or under-reporting alcohol consumption and/or consequences, which would alter model estimates (Andreasson, 2016; Russell et al., 2022). Self-reports also fail to capture biological alcohol exposure, which is a more meaningful predictor of negative drinking consequences than self-reported number of drinks (Andreasson, 2016; Bond et al., 2014; Greenfield et al., 2014; Pearson et al., 2016; Russell et al., 2022). Future studies should use device-based measures of biological alcohol exposure, such as transdermal alcohol sensors, to overcome these limitations of self-report (Ariss et al., 2023; Ash et al., 2022; Courtney et al., 2023). Lastly, the CRAI-Drinking assessed contextual motivation for drinking, which represents an individual's average motivational orientation toward drinking (Vallerand, 1997). Future work should also investigate self-determined situational motivation for drinking, which represents an individual's motivation for drinking at a given

point in time (Vallerand, 1997). This would provide information about how self-determined motives for drinking vary across situations and their predictive value related to drinking behaviors and consequences. In general, future work evaluating the predictive value of CRAI-Drinking SDT-based drinking motives at both the contextual and situational levels is warranted to help inform researchers about the most useful motivational level at which to measure SDT-based drinking motives and to inform future intervention research.

Conclusions

The five SDT-based behavioral regulations for drinking assessed via the CRAI-Drinking were uniquely associated with drinking behaviors and consequences in adults, above and beyond the effects of sex, drinking intensity, and other drinking motives (i.e. the DMQ). Adults high in autonomous reasons for drinking reported low-risk, high-enjoyment drinking experiences. In contrast, adults with higher scores for amotivation for drinking reported riskier drinking experiences related to more negative consequences, even after accounting for drinking intensity, suggesting that high amotivation for drinking may be a novel variable that signals future alcohol-related risks. These findings support the idea that SDT provides a useful framework for understanding drinking motives, behaviors, and consequences. Future research exploring how SDT's individual behavioral regulations predict risk for alcohol use disorder or drinking transitions during young adulthood and later into life could inform clinical practice and interventions focused on reducing negative drinking consequences and promoting transitions toward lower risk drinking behaviors.

CRediT author statement

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ORCID

J. B. Courtney http://orcid.org/0000-0002-4609-4984
M. A. Russell http://orcid.org/0000-0002-3956-604X

Data availability statement

The data that support the findings of this study are available from the corresponding author, JBC, upon reasonable request.

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