Associations Between Behavioral Economic Constructs and Alcohol Use and Consequences among Young Adult Alcohol Users

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Abstract

Alcohol use among young adult college students is a significant public health concern. Behavioral economic (BE) research provides a framework for understanding maladaptive health behaviors, such as alcohol use/misuse. BE theory posits that problematic substance use is maintained through reinforcer pathology. Two key BE concepts used in examining reinforcer pathology are alcohol-related reinforcement and delay discounting (DD). DD refers to the reduction in reward value as a function of its delay. Individuals with higher rates of alcohol use/misuse typically: 1) derive more reinforcement from alcohol-related activities relative to alcohol-free activities and 2) exhibit higher rates of DD, seemingly demonstrating a general preference for immediate outcomes.

The current study examined the associations between measures of BE and alcohol use/consequences of young adult college students (N = 70) who self-reported engaging in hazardous drinking in the last 30-days. This study utilized a measure of alcohol-related reinforcement and a fully parametric combination of alcohol and money outcomes in single-commodity and cross-commodity DD tasks. This study hypothesized that alcohol-related and alcohol-free reinforcement would be positively and negatively associated with measures of alcohol/consequences, respectively, and that participants with greater alcohol use/consequences would prefer alcohol outcomes in DD tasks, independent of the delay. Results generally supported study hypotheses.

Measures of alcohol-related reinforcement were associated with alcohol use/misuse measures as expected. Moreover, greater levels of reinforcement derived from alcohol-related relative to alcohol-free activities were a significant predictor of alcohol use measures (all p's < 0.05).

In addition, alcohol use/misuse measures were positively associated with rate of DD in the alcohol now-money later task and negatively associated with rate of DD in the money now-alcohol later task. Further, when considering the predictive utility of the various DD tasks on alcohol use measures, the money now-alcohol later task provided unique explanatory power for individual alcohol use/consequences.

Overall, results from the current study support the use of BE constructs in the study of young adults who engage in problematic alcohol use. Findings indicate that individuals with hazardous drinking behaviors and alcohol-related problems receive greater reinforcement from alcohol use than other activities. Results also suggest that elevated alcohol use and related consequences are associated with a willingness to invest in future drinking and not with the inability to wait for delayed outcomes. Findings also highlight the utility of cross-commodity DD tasks when using BE constructs to assess for problematic alcohol use.

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Chapter 1: Introduction

Alcohol use and misuse is a substantial public health concern (White & Hingson, 2013). Young adult college students are considered a high-risk demographic for alcohol consumption due to their high levels of drinking (Acuff et al., 2018; Hingson et al., 2017; Morrell et al., 2021; White & Hingson, 2013). Several alcohol-related consequences may be experienced by college students who engage in hazardous drinking, including injury, cognitive impairments, and potential Alcohol Use Disorders (AUDs; Murphy & Dennhardt, 2016; White & Hingson, 2014). Thus, young adult alcohol users are a critical population to examine. Behavioral economic (BE) theory provides a framework for understanding factors contributing to maladaptive health behaviors such as alcohol use and misuse (Acuff et al., 2018; MacKillop, 2016; Murphy & Dennhardt, 2016).

Behavioral Economics

BE research combines psychological and economic concepts to understand human behavior, specifically decision-making and choice behavior (Acuff et al., 2018; Bickel et al., 2011, 2014; MacKillop, 2016). Consequently, BE approaches to understanding and reducing alcohol use, misuse, and addiction are well established (MacKillop, 2016; Murphy & Dennhardt, 2016). BE theory views alcohol and other substance misuses through the concept of reinforcer pathology, which results from: 1) the overvaluation of alcohol due to its reinforcing value compared to other environmental reinforcers, and 2) the undervaluation of the future in favor of the present (Bickel et al., 2011, 2014; MacKillop, 2016). The features of reinforcer pathology are evaluated through procedures that are derived from BE (Acuff et al., 2018; Bickel et al., 2011, 2014). Two key BE concepts highly relevant to understanding alcohol misuse are proportionate substance-related reinforcement and delay discounting (MacKillop, 2016).

Alcohol-Related and Alcohol-Free Reinforcement

Proportionate substance-related reinforcement is a key BE concept used in the study of addiction (Acuff et al., 2018; Bickel et al., 2011, 2014; MacKillop, 2016). BE research suggests that an individual's preference for alcohol and other drugs is related to the availability of alcohol or drug rewards compared to alternative rewards in their environment (Acuff et al., 2018, 2019; Correia et al., 1998, 2003; Murphy & Dennhardt, 2016; Murphy & Vuchinich, 2002). Standard measures of alcohol-related and alcohol-free reinforcement operationalize reinforcement as the product of the amount of time spent engaging in activities and the subjective enjoyment derived from the activities involving alcohol use relative to that of alcohol-free activities (Acuff et al., 2019; MacKillop, 2016; Murphy et al., 2005).

Research has shown that greater alcohol-related reinforcement is positively associated with alcohol use/ consequences (Correia et al., 1998, 2003; MacKillop, 2016; Murphy et al., 2005; Murphy & Dennhardt, 2016). Findings suggest that individuals who derive a large proportion of their reinforcement from alcohol-related activities may value alcohol-free activities less, therefore, increasing alcohol-related behaviors (Correia et al., 1998, 2003; MacKillop, 2016; Murphy et al., 2005; Murphy & Dennhardt, 2016). In addition, previous literature supports an inverse relationship between alcohol use and alcohol-free reinforcement, meaning individuals who derive greater reinforcement from alcohol-free activities use alcohol less (Acuff et al., 2019; Correia et al., 1998, 2003). Based on existing BE research, assessment of alcohol-related and alcohol-free reinforcement may predict alcohol use and related consequences among young adult alcohol users.

Delay Discounting

Delay discounting (DD) is a BE measure of impulsivity (MacKillop, 2016). DD is a useful BE construct for understanding human behavior as showing a preference for immediate outcomes while discounting delayed outcomes relates to behaviors with important implications for long-term health issues such as alcohol use and misuse (Bickel et al., 2014; MacKillop et al., 2011; Odum, 2011, 2020; Petry, 2001; Vuchinich & Simpson, 1998). DD refers to a decrease in the subjective value of an outcome or reward due to its delay (Odum, 2011). Various techniques can assess DD. A standard procedure for determining DD is a binary choice task where participants indicate their preference between different sums of hypothetical rewards of the same commodity: smaller rewards are typically available immediately (smaller sooner, SS), with larger rewards available after a delay (larger later, LL), also known as single-commodity delay discounting (SCDD) tasks. Hypothetical monetary rewards are commonly used in SCDD tasks, asking subjects to indicate their preference between immediate and delayed money, i.e., money now versus money later (Bickel et al., 2014).

SCDD tasks ask participants to indicate their preference for the SS or LL reward, for example, “Imagine that you have a choice between receiving $25 immediately or $50 in 3 weeks. Which one would you choose?” Each participant choice then adjusts the delay to the LL or the amount of the SS up or down. Participants are asked to indicate their preference for rewards until an indifference point is determined, i.e., the point at which two rewards have approximately the same value to a subject (Odum, 2011). From the indifference point, a discounting rate (the parameter *k*) is derived. An individual’s discounting rate describes how steeply delay reduces the value of a reward (Odum, 2011). High discounting rates – or high rates of DD – indicate a preference for immediate rewards, whereas low rates of DD indicate a preference for delayed rewards.

Delay Discounting and Alcohol Use

Early DD studies evaluated discounting behavior of individuals who (mis)use alcohol and other drugs compared to individuals who abstained from substances. These studies consistently observed higher rates of DD among individuals who engaged in alcohol or drug misuse, indicating a greater preference for immediate outcomes (Bickel et al., 1999; Kirby et al., 1999; Madden et al., 1997; Petry, 2001; Vuchinich & Simpson, 1998). Elevated rates of DD have been observed in participants who were opioid-dependent (Madden et al., 1997), smoked cigarettes (Bickel et al., 1999), addicted to heroin (Kirby et al., 1999), and misused alcohol (Field et al., 2007; Petry, 2001; Vuchinich & Simpson, 1998) compared to controls.

More recently, meta-analyses have been conducted to review literature that compared rates of DD in individuals who use alcohol and other drugs to controls (MacKillop et al., 2011) and literature that correlated individual rates of DD with measures of addictive behavior (Amlung et al., 2017). These studies supported the findings that individuals who use or misuse alcohol or other drugs discount delayed rewards more steeply than controls (MacKillop et al., 2011) and found that rate of DD is robustly associated with measures of addiction including alcohol misuse (Amlung et al., 2017). Though, many of these studies exclusively used SCDD tasks with hypothetical money.

A review of studies that used DD tasks of different commodities (e.g., alcohol) found that individuals who discount money at high rates also discount other outcomes at high rates (Odum, 2020). Early studies implementing DD tasks with consumable rewards asked participants to indicate their preference between immediate and delayed access to alcohol or their drug of choice, i.e., alcohol now vs. alcohol later (Bickel et al., 1999; Kirby et al., 1999; Lemley et al., 2016; Madden et al., 1997; Odum, 2020; Petry, 2001; Yankelevitz et al., 2012). Study results

consistently found that individuals who misuse substances exhibited higher rates of DD for the drug outcome than for the equivalent money outcome (Bickel et al., 1999; Kirby et al., 1999; Lemley et al., 2016; Madden et al., 1997; Odum, 2020; Petry, 2001; Yankelevitz et al., 2012). These findings are consistent with other research, suggesting that consumable rewards, such as alcohol, are discounted at a steeper rate than money, indicating a greater preference for immediate alcohol (Odum, 2011, 2020; Petry, 2001).

Overall, these results for money and alcohol or other drug outcomes have been interpreted as indicative of a generalized inability or unwillingness to wait for delayed outcomes, which is particularly exacerbated for alcohol or the drug of choice (Amlung et al., 2017; Bickel et al., 1999; Green & Myerson, 2019; Kirby et al., 1999; MacKillop et al., 2011; Madden et al., 1997; Petry, 2001). However, SCDD tasks may not be as ecologically valid as other tasks that measure individual preference, such as cross-commodity delay discounting (CCDD) tasks.

Cross-commodity Delay Discounting

While the SCDD tasks used in previous research are undoubtedly informative, they are incomplete. Discounting patterns observed in SCDD tasks with monetary rewards show an individual's preference for money rewards but reveal nothing about their alcohol preference and vice versa. Furthermore, asking individuals to make choices between a single commodity is not accurately reflective of the various circumstances surrounding real-life decision-making. In real life, decisions are often weighed on more than one commodity, each accompanied by unique consequences, making choices more complex than portrayed through SCDD tasks (Bickel et al., 2011; Mitchell, 2004; Moody et al., 2017; Odum, 2020). CCDD tasks attempt to address this shortcoming by assessing individual preference for comparably valued outcomes of different commodities: one commodity available immediately and a different commodity available after a

delay, e.g., money now vs. alcohol later, or alcohol now vs. money later. A question from this sort of task might ask a participant: “Imagine that you have a choice between receiving $25 immediately or ten standard alcoholic drinks in 2 months. Which one would you choose?”

Unlike DD rates from SCDD tasks, a high DD rate from CCDD tasks tells us different things for different tasks. For example, a high rate of DD on money now vs. alcohol later tasks would imply an individual’s preference for money now; a high rate of DD on alcohol now vs. money later tasks would indicate a preference for alcohol now. These tasks consider the delay and the reward in choice preference, which provide us with improved insight into real-life decision-making patterns and preferences of individuals who misuse alcohol (Bickel et al., 2011; Moody et al., 2017; Odum, 2020). Furthermore, the results from literature using CCDD tasks suggest that the previous interpretation of individuals who use drugs as being unable or unwilling to wait is inaccurate.

Specifically, findings from research using CCDD tasks suggest that individuals who (mis)use alcohol or other drugs prefer delayed money to immediate drug. In an online sample of alcohol users, Moody and colleagues (2017) implemented SCDD tasks with money and alcohol outcomes (i.e., money now vs. money later [money/money] and alcohol now vs. alcohol later [alcohol/alcohol]) and CCDD tasks (alcohol now vs. money later [alcohol /money] and money now vs. alcohol later [money/ alcohol]). The rank ordering of the rates of DD from these four tasks, from lowest to highest, was: alcohol/money, money/money, alcohol/alcohol, and money/alcohol. Of note is that the lowest rates of DD (indicating a preference for the delayed outcome) were observed in tasks with delayed money. In contrast, the highest rate of DD (indicating a preference for the immediate outcome) was observed in the task with immediate

money. Additionally, rate of DD in the money/alcohol task was significantly higher than that in the alcohol/money task.

A fair interpretation of this pattern of results is that alcohol users prefer money relative to a comparably valued amount of alcohol, regardless of whether the money is immediate or delayed (i.e., they exhibit an ability to wait for delayed money). This account is at odds with previous interpretations of DD that suggest individuals who misuse alcohol have a generalized inability to wait for delayed outcomes, particularly when presented with immediate access to alcohol.

Other studies have observed similar patterns among individuals who misuse other drugs (e.g., cocaine; Bickel et al., 2011; Wesley et al., 2014). While the exact rank ordering from Moody et al. (2017) is not replicated across all studies, the results show a similar pattern: the highest rate of DD in the money/drug task, and relatively low rates of DD in tasks with delayed money, particularly in the drug/money task (Bickel et al., 2011; Wesley et al., 2014; Pericot-Valverde et al., 2020). These findings suggest a general preference for money compared to drug outcomes regardless of its delay. Thus, the emerging interpretation is that individuals who misuse alcohol and other drugs continue to value money relative to a comparable amount of the drug of choice and specifically do decline immediate availability of the drug when the delayed outcome is money.

This improved interpretation partially informed the rationale for the current project, as it contradicts traditional understandings of rates of DD among individuals with misuse alcohol and other drugs. In addition, there is suggestive evidence from Moody et al. (2017) that scores on the Alcohol Use Disorders Identification Test (AUDIT) may be associated with rates of DD from CCDD tasks, but not SCDD tasks therefore, highlighting the unique utility of CCDD tasks. This

project aims to add to the literature using BE constructs to understand alcohol use/consequences of young adult college students who engage in hazardous drinking, focusing on examining differences in rates of DD in SCDD and CCDD tasks using money and alcohol.

The Current Study

The aims of the current project were to: (1) examine how alcohol-related and alcohol-free reinforcement relate to alcohol use/misuse in a sample of college drinkers who engage in hazardous drinking; (2) replicate the rank ordering of the rates of DD from Moody et al. (2017) in this sample; and (3) examine associations between rates of DD and alcohol use/misuse measures and, if associations are found, identify which DD task(s) provides the most explanatory power for measures of alcohol use/misuse.

The following hypotheses were made for each aim: (1a) alcohol-related reinforcement will be positively associated with measures of alcohol use/misuse; (1b) alcohol-free reinforcement will be negatively associated with measures of alcohol use/misuse; (2) the rank ordering of DD rates will be generally replicated across SCDD, and CCDD tasks, such that the lowest rates of DD will be found in DD tasks with delayed money, and the highest rates will be found in DD tasks with delayed alcohol; (3a) SCDD rates will be positively associated with measures of alcohol use/misuse, and in CCDD tasks, individuals with greater alcohol use /misuse will show a relative preference for alcohol outcomes, resulting in positive and negative associations with rates of DD in the delayed money and delayed alcohol tasks, respectively; (3b) assuming associations are found between DD tasks and alcohol use, CCDD tasks will have more explanatory power for alcohol use than SCDD tasks.

Chapter 2: Methods

Participants

Eighty-one participants were recruited from a large Midwestern university via posted flyers. Eligible participants were undergraduate students, aged 18-25 years, who engage in hazardous drinking by reporting either: 1) at least one episode of binge drinking within the past month, or 2) drinking above the recommended weekly drinking limits as defined by the NIAAA (4/5 or more standard drinks in about two hours for females/males, and weekly drinking limits as an average of 7/14 or more drinks per week for females/males). Nine participants were excluded for not meeting inclusion criteria or failing to complete study measures, resulting in 72 total participants.

Measures

Behavioral economic measures

Adolescent Reinforcement Schedule Survey – Alcohol Use Version (ARSS-AUV). The ARSS-AUV assessed alcohol-related and alcohol-free reinforcement from various activities (Murphy et al., 2005). The ARSS-AUV was adapted from the ARSS-SUV and is made up of 32-items, each representing one activity. The items fall within six different domains of activities: Dating, Leisure, Sex, Peer interactions, Home (family/ sibling) interactions, and Chores/ Studying (see Appendix B for full measure). Participants were asked to indicate their frequency and enjoyment ratings for each activity, both with and without alcohol – for a total of four scores per item. Frequency and enjoyment ratings each used a 5-point scale. Frequency ratings range from 0 (zero times) to 4 (more than once a day), and enjoyment ratings ranged from 0 (unpleasant or neutral) to 4 (extremely pleasant). Frequency and enjoyment scores (with and without alcohol) were multiplied to determine two cross-product scores (0 to 16) for each item, representing alcohol-related and alcohol-free reinforcement from that activity.

The average cross-products from the activities in each domain represent the average reinforcement obtained for that domain. The average alcohol-related and alcohol-free cross-products were computed for each domain. In addition, average reinforcement scores from all alcohol-related activities (total alcohol-related reinforcement) and alcohol-free activities (total alcohol-free reinforcement) were computed. The total reinforcement ratio (TRR) was calculated as total alcohol-related reinforcement/(total alcohol-related + alcohol-free reinforcement). The TRR measured the proportion of reinforcement obtained from alcohol-related activities relative to alcohol-free activities. TRR scores range from 0 to 1, with higher values indicating a greater proportion of reinforcement derived from alcohol-related activities (Correia et al., 1998).

Delay Discounting Task. DD was assessed using an adjusting DD task (Koffarnus & Bickel, 2014). This task presented participants with five trials of a hypothetical, binary choice between a smaller immediate reward (SS) and a larger later (LL) reward with 32 potential delays (1 hour – 25 years). For instance, in the first trial of the task with an LL reward of $200, participants chose between receiving half of the LL immediately (i.e., SS = $100) or the full LL ($200) in 3 weeks. Dependent on the selected choice, the next item adjusted the delay up or down as defined by Koffarnus and Bickel (2014). The fifth and final trial determined the Effective Delay 50% (ED50), representing the delay at which the delayed and immediate rewards were equally valued.

Participants completed two SCDD tasks (money/money, alcohol/alcohol) and two CCDD tasks (money/alcohol, alcohol/money). Each of the four tasks was completed for two magnitudes of the LL ($50, $200) or the alcohol equivalents – resulting in eight parametric combinations of DD tasks (see Table 1). Alcohol equivalences to monetary LL amounts were participant-dependent and determined using a procedure previously used by Stanger and colleagues (2012)

in which participants indicated the number of standard drinks (12 oz beer, 5 oz wine, 1.5 oz shot of hard liquor or in a mixed drink) that would be equally attractive to the money amounts.

Table 1

Eight discounting tasks

		Delayed outcome			
		Alcohol ($50)	**Money ($50)**	**Alcohol ($200)**	**Money ($200)**
Immediate outcome	**Alcohol**	AA50	AM50	AA200	AM200
	Money	MA50	MM50	MA200	MA200

Clinical alcohol use measures

Alcohol Use Disorder Identification Test (AUDIT). Participants reported their alcohol intake, potential symptoms of an AUD, and experience of alcohol-related harm in the past year using the 10-item AUDIT questionnaire (Saunders et al., 1993; see Appendix B for full measure). The AUDIT is a screening tool to identify individuals who may be at risk for developing alcohol problems. The AUDIT is widely utilized and validated across races and genders (Babor et al., 2001). Participants responded to questions regarding alcohol intake and AUD symptoms using a 5-point scale (from 0 to 4); questions about alcohol-related harm used a 3-point scale (0, 2, and 4) – scores on the AUDIT range from 0 to 40, with higher scores indicating greater individual risk. AUDIT scores of 8 or more indicate hazardous or harmful alcohol use (Babor et al., 2001).

Timeline Follow-back (TLFB). The TLFB methodology was adopted to assess alcohol consumption during the past 30 days (Sobell & Sobell, 1992). Participants were asked to self-report how many days they consumed alcohol in the past 30 days (TLFB Days) and how many standard drinks they consumed in the past 30 days (TLFB Drinks). Participants were given handouts with standard drink visuals, and TLFB calendars were created and marked with

relevant holidays and events to best assist participants with accurately recalling their drinking behaviors.

Exploratory measure

Consideration of Future Consequences Scale (CFC). The CFC is a 12-item scale that looked at the extent to which people considered distant versus immediate consequences of potential behaviors (Strathman et al., 1994; see Appendix B for full measure). The CFC is sometimes used along with other measures of behavioral economics such as DD and the ARSS-AUV (Acuff et al., 2018; Murphy et al., 2012; Voss et al., 2018); therefore, it was included as an exploratory measure in the current study. Participants were asked to indicate how characteristic the scale's statements are of them by responding to a 5-point scale (1 = extremely characteristic; 5 = extremely uncharacteristic) – scores on the CFC range from 12 to 60, with higher scores indicating greater individual consideration of future consequences.

Procedure

During initial contact with participants, a research assistant provided a brief study description and inclusion criteria. Individuals who self-identified as eligible to participate were scheduled for an in-person session. Following informed consent, participants completed a computerized survey that formally assessed inclusion criteria along with relevant demographic information. Participants who were deemed ineligible for the study immediately discontinued their session and were compensated $5 via prepaid ClinCards. Eligible participants completed all relevant study tasks, including the ARSS-AUV, the 5-trial Adjusting Delay Discounting Task, the AUDIT, the TLFB, and the CFC. All tasks were computerized except for the TLFB, which was done on paper. Participants were compensated $10 after completion of study procedures. While the DSM-5 AUD questionnaire was intended to be included, score accuracy was unable to

be confirmed due to written errors in some items of AUD criteria, and the AUD symptom count was excluded from analyses. Additional study procedures not relevant to this study are not reported here.

Data Analyses

All data cleaning and analysis were computed using SPSS (version 26). Bivariate correlations determined associations between alcohol use measures and ARSS-AUV scores of alcohol-related and alcohol-free reinforcement and TRR. Then, to determine the predictive utility of ARSS-AUV scores, AUDIT and TLFB scores were analyzed using separate linear regressions. Linear regression models were computed for the three total ARRS-AUV scores each predicting AUDIT and TLFB scores, for a total of nine linear regression models. Bivariate correlations and linear regressions were also used to explore associations between CFC scores and alcohol use measures.

Rates of DD (*k*) were determined from the ED50 values measured in the DD tasks, as ED50 is the inverse of *k* (Yoon & Higgins, 2008). Rates of DD were then log-transformed (ln *k*) to normalize distributions and allow for parametric analyses for all eight DD tasks (see Table 1). A one-way analysis of variance (ANOVA) was conducted for each DD magnitude ($50 and $200) to compare the four DD tasks, followed by Tukey's HSD pairwise comparisons. Bivariate correlations also determined associations between DD tasks and alcohol use measures.

To examine the predictive utility of DD tasks, AUDIT and TLFB scores (total days and total drinks) were analyzed in two ways utilizing multiple linear regression. First, an omnibus method including all four DD tasks was used in a single multiple regression model as has been previously done (Lemley et al., 2016). Second, to identify the incremental predictive power of each DD task, each parametric combination of the DD tasks alone and in combination was

compared using Akaike Information Criterion (AIC; Burnham et al., 2011). The purpose of the model comparisons was to a) compare the utility of CCDD as a class to SCDD in predicting alcohol use and b) determine whether all four DD tasks are necessary to achieve maximal predictive accuracy. When comparing between models, lower AIC values are better with an absolute ΔAIC of two or greater indicating a preferred model (see Burnham et al., 2011). In cases where ΔAICs are subthreshold, the more parsimonious model is preferred.

Chapter 3: Results

Outliers (i.e., more than 3 SDs from the mean) on a single assessment were excluded from relevant analyses. Three individuals had their data excluded for at least one measure, while two individuals were excluded from all analyses, resulting in a sample size of 70.

Participant characteristics

Participants included in analyses were 71.4% male and 80% self-identified as White, with a mean age of 20.63 years (*SD* = 1.43). Participants self-reported drinking (via TLFB), on average, 7.94 days (*SD* = 4.24) in the past 30 days and consuming an average of 33.92 drinks (*SD* = 23.64) total in the last month, with a mean of 7.69 (*SD* = 3.03) on a single occasion. The average participant AUDIT score was 10.21 (*SD* = 4.94); 68.6% of AUDIT scores fell within the hazardous or harmful range for individual risk of developing alcohol-related difficulties (score of 8 or more). All relevant participant characteristics are represented in Table 2.

Table 2

Sample Demographics

Sample demographics (*N* = 70)	Frequency (%)
Age	
Under 21	39 (55.7)
21 or older	31 (44.3)
Sex	

Female	20 (28.6)
Male	50 (71.4)
Race [a]	
White	56 (80.0)
Asian	10 (14.3)
Black	3 (4.3)
Other	6 (8.5)
Ethnicity	
Hispanic or Latino	10 (14.3)
Not Hispanic or Latino	60 (85.7)
Year in undergraduate school	
Freshman	28 (40.0)
Sophomore	16 (22.9)
Junior	15 (21.4)
Senior	11 (15.7)
Employment Status	
Employed part-time	31 (44.3)
Unemployed/Full-time	39 (55.7)
Annual Income	
Less than $10,000	62 (88.6)
$10,000 or above	8 (11.4)

[a] Participants were instructed to select all applicable races to include individuals of mixed race, therefore the total sample percentage exceeds 100%

Aim 1

On average, participants received greater total reinforcement from alcohol-free activities (M = 5.72, SD = 1.94) than alcohol-related activities (M = 2.75, SD = 1.38) on the ARSS-AUV. Reinforcement scores on each of the six domains were also higher for alcohol-free activities than alcohol-related activities (see Table 3). The average TRR, 0.32 (SD = 0.10), indicated a smaller proportion of reinforcement derived from alcohol-related activities relative to alcohol-free activities.

Table 3

Descriptive data on ARSS-AUV reinforcement scales

Reinforcement Scale	Alcohol-related reinforcement		Alcohol-free reinforcement	
	M	*SD*	*M*	*SD*
Dating	3.14	2.29	5.85	3.99
Leisure	0.07	0.43	5.63	3.90
Peer Interaction	4.08	2.11	7.08	2.73
Family	0.98	1.31	3.55	2.11
Sexual Activity	2.71	2.96	4.12	3.54
Chores/ studying	2.85	3.15	5.69	3.04
Total	*2.75*	*1.38*	*5.72*	*1.94*

Bivariate correlations

Bivariate correlations were computed to determine associations between participant ARSS-AUV reinforcement scores and alcohol use measures (see Table 4). The correlation matrix shows a pattern of strong positive correlations across ARSS-AUV reinforcement scores. One noteworthy pattern is that associations between alcohol-related reinforcement and TRR and all alcohol use measures were positive, and most met conventional levels of statistical significance ($p < 0.05$). The one exception was the relationship between alcohol-related reinforcement and TLFB Days ($p = 0.10$). Participant alcohol-free reinforcement did not appear to be associated with alcohol use (all p's > 0.05).

Table 4

Correlations among ARSS-AUV reinforcement scores and alcohol measures

Construct	1	2	3	4	5	6
1. ARSS-AUV Alcohol-related	–					
2. ARSS-AUV Alcohol-free	0.409**	–				
3. ARSS-AUV TRR	0.727**	-0.263*	–			
4. AUDIT	**0.249***	0.077	**0.291***	–		
5. TLFB Drinks	**0.264***	-0.042	**0.333****	0.549**	–	
6. TLFB Days	0.198	-0.009	**0.244***	0.239*	0.685**	–

Note: **$p < 0.01$, two-tailed; *$p < 0.05$, two-tailed; ARSS-AUV Alcohol-related = Total alcohol-related reinforcement; ARSS-AUV Alcohol-free = Total alcohol-free reinforcement; ARSS-AUV TRR = Total reinforcement ratio.

Regression analyses

In the regression analyses, alcohol-related reinforcement was a significant predictor of AUDIT (β = 0.893, $p = 0.038$) and TLFB Drinks (β = 4.534, $p = 0.027$). TRR was a significant predictor of AUDIT (β = 14.713, $p = 0.015$), TLFB Drinks (β = 80.661, $p = 0.005$) and Days (β = 10.583, $p = 0.042$). Alcohol-free reinforcement was not a significant predictor of any alcohol use measure (all p's > 0.05; see table 5).

Table 5

Regression analyses for ARSS-AUV reinforcement scores predicting alcohol use

Alcohol use measure	***t***	***p***	***β***	**Std. Error**	**95% CI**	
					LL	**UL**
AUDIT						
Alcohol-related	2.121	**0.038***	0.893	0.421	0.053	1.733
Alcohol-free	0.641	0.524	0.197	0.308	-0.417	0.811
TRR	2.505	**0.015***	14.713	5.873	2.994	26.432
TLFB Drinks						
Alcohol-related	2.261	**0.027***	4.534	2.005	0.532	8.536
Alcohol-free	-0.345	0.731	-0.508	1.475	-3.451	2.434
TRR	2.914	**0.005***	80.661	27.677	25.433	135.889
TLFB Days						
Alcohol-related	1.666	0.100	0.609	0.365	-0.121	1.338
Alcohol-free	-0.078	0.938	-0.021	0.265	-0.549	0.508
TRR	2.073	**0.042***	10.583	5.105	0.397	20.770

Note: *indicates significant at a $p < 0.05$ level. CI = Confidence Interval; LL = Lower Limit; UL = Upper Limit.

Aim 2

The omnibus ANOVA for the $50 magnitude was significant $F(3,276) = 43.79$, $p < 0.001$, indicating significant differences in discounting rates between the DD conditions (see Figure 1). Tukey's HSD pairwise comparisons indicate that nearly all DD tasks resulted in different rates of DD, with most pairs being significantly different (all p's ≤ 0.001). MM50 (M = -4.55, SD = 1.57) and AA50 (M = -2.97, SD = 3.08), AM50 (M = -4.65, SD = 1.79) and MA50

(*M* = -0.41, *SD* = 3.14), MM50 and MA50, AA50 and AM50, and AA50 and MA50 were all significantly different from each other. The only exception was between MM50 and AM50 (*p* = 0.995).

The omnibus ANOVA for the $200 magnitude was also significant *F*(3,268) = 104.41, *p* < 0.001 (see Figure 1). Tukey's HSD pairwise comparisons indicate that most DD tasks were significantly different (all *p*'s < 0.001). MM200 (*M* = -5.13, *SD* = 1.55) and AA200 (*M* = -2.82, *SD* = 3.14), AM200 (*M* = -5.53, *SD* = 1.53) and MA200 (*M* = 1.08, *SD* = 3.06), MM200 and MA200, AA200 and AM200, and AA200 and MA200 were all significantly different from each other. The only exception was between MM200 and AM200 (*p* = 0.771).

Finally, the four DD task's mean group rates, ranked from lowest to highest, were the same for each magnitude ($50 and $200): alcohol/money, money/money, alcohol/alcohol, and money/alcohol.

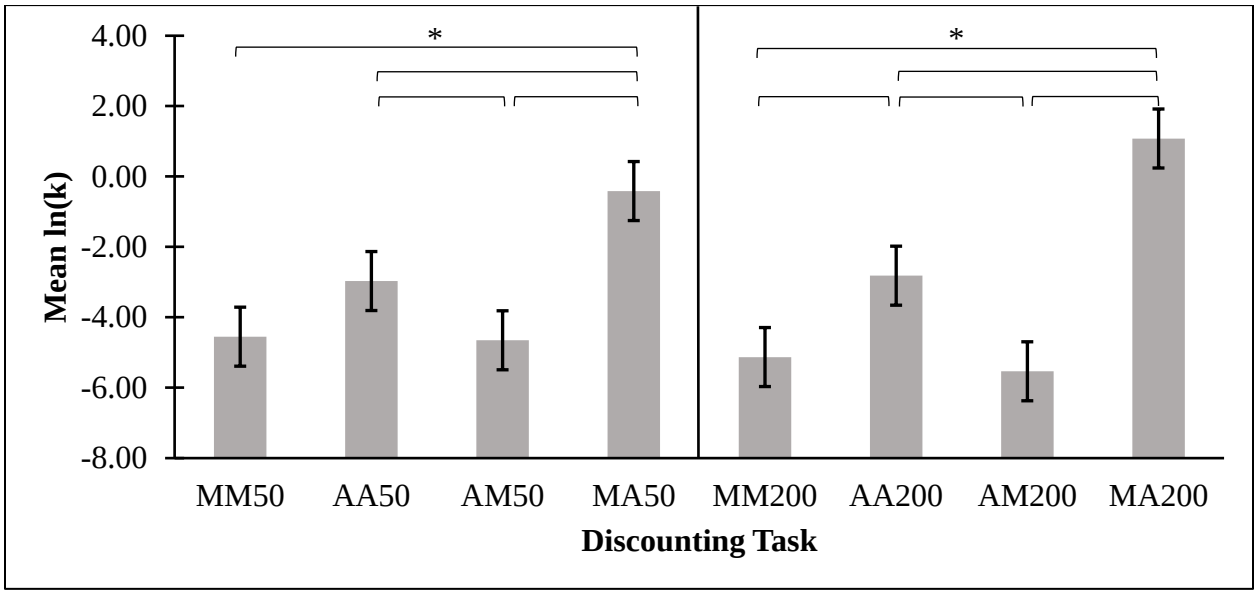

Figure 1

Mean DD rates with standard error.

Note: *indicates significant Tukey's HSD pairwise comparison at a *p* < 0.05 level.

Aim 3

Bivariate correlations

Bivariate correlations were computed to determine associations between participant rates of DD and alcohol use (see Table 6). The correlation matrix shows a pattern of strong positive correlations across magnitudes in the DD conditions. One noteworthy pattern is that associations between rate of DD in MA50 and alcohol use measures were negative and met conventional levels of statistical significance ($p < 0.05$).

Table 6

Correlations among DD tasks and alcohol measures

Construct	1	2	3	4	5	6	7	8	9	10	11
1. MM50	–										
2. MM200	0.845**	–									
3. AA50	0.522**	0.438**	–								
4. AA200	0.442**	0.457**	0.719**	–							
5. AM50	0.769**	0.712**	0.612**	0.401**	–						
6. AM200	0.776**	0.795**	0.329**	0.179	0.708**	–					
7. MA50	0.025	0.032	0.056	0.126	-0.022	-0.084	–				
8. MA200	-0.088	-0.018	0.195	0.253*	-0.012	-0.190	0.430**	–			
9. AUDIT	0.100	0.063	0.066	-0.144	0.209	0.179	-0.281*	-0.002	–		
10. TLFB Drinks	0.109	0.135	-0.020	0.070	0.144	0.164	-0.264*	0.013	0.549**	–	
11. TLFB Days	0.174	0.192	0.067	0.095	0.171	0.204	-0.303*	-0.083	0.239*	0.685**	–

Note: **$p < 0.01$, two-tailed; *$p < 0.05$, two-tailed; TLFB Drinks = Total standard alcoholic drinks consumed in the past 30 days (assessed via the TLFB); TLFB Days = Total days alcoholic drinks were consumed in the past 30 days (assessed via TLFB).

Regression analyses

When controlling for all other DD tasks in the omnibus $50 magnitude models, MA50 was the only significant predictor of AUDIT scores (β = -0.42, p = 0.025), TLFB Drinks (β = -1.90, p = 0.036), and TLFB Days (β = -0.41, p = 0.012). When controlling for all other DD tasks in the $200 magnitude models, no tasks were significant predictors of AUDIT or TLFB scores (all p's > 0.05; see table 7).

Because there were potential multicollinearity concerns in regression analyses due to the correlations between some pairs of DD tasks within the same magnitude, all DD tasks were separated into individual regression models for predicting AUDIT, TLFB Drinks, and TLFB Days. The 24 individual regression models showed no substantive changes in results (see Appendix A); therefore, the original multiple regression models are reported here.

Table 7

Results of multiple regression analyses for discounting rates predicting alcohol use

Magnitude	**Alcohol use measure**	***t***	***p***	***β***	**Std. Error**	**95% CI**	
						LL	**UL**
$50	AUDIT						
	MM50	-0.618	0.539	-0.354	0.573	-1.499	0.791
	AA50	-0.401	0.690	-0.095	0.237	-0.569	0.378
	AM50	1.650	0.104	0.899	0.545	-0.189	1.988
	MA50	-2.295	0.025*	-0.421	0.183	-0.787	-0.055
	TLFB Drinks						
	MM50	0.222	0.825	0.616	2.781	-4.937	6.170
	AA50	-0.984	0.329	-1.132	1.150	-3.430	1.165
	AM50	0.985	0.328	2.604	2.644	-2.676	7.884
	MA50	-2.138	0.036*	-1.902	0.889	-3.677	-0.126
	TLFB Days						
	MM50	0.770	0.444	0.379	0.492	-0.604	1.361
	AA50	-0.256	0.799	-0.052	0.203	-0.458	0.354
	AM50	0.401	0.690	0.187	0.468	-0.747	1.121
	MA50	-2.592	0.012*	-0.408	0.157	-0.722	-0.094

$200	AUDIT						
	MM200	-0.414	0.681	-0.306	0.740	-1.786	1.173
	AA200	-1.213	0.230	-0.278	0.229	-0.736	0.180
	AM200	1.417	0.161	0.979	0.690	-0.401	2.358
	MA200	0.771	0.444	0.159	0.206	-0.253	0.570
	TLFB Drinks						
	MM200	-0.156	0.876	-0.579	3.704	-7.980	6.822
	AA200	0.285	0.776	0.327	1.147	-1.965	2.619
	AM200	0.870	0.387	3.006	3.454	-3.896	9.908
	MA200	0.285	0.777	0.293	1.029	-1.764	2.350
	TLFB Days						
	MM200	0.224	0.823	0.147	0.655	-1.163	1.457
	AA200	0.427	0.671	0.087	0.203	-0.319	0.492
	AM200	0.616	0.540	0.377	0.611	-0.845	1.598
	MA200	-0.551	0.583	-0.100	0.182	-0.464	0.264

Note: *indicates significant at a $p < 0.05$ level. CI = Confidence Interval; LL = Lower Limit; UL = Upper Limit.

Model comparisons

A summary of model comparisons for all DD tasks is presented in Tables 8 and 9, separated by magnitude. In the $50 magnitude, MA50 was the single-model predictor with the best AIC score for AUDIT and TLFB Drinks and Days, though not sufficiently different from the AM50 model for AUDIT (ΔAIC = -1.44) or TLFB Drinks (ΔAIC = -0.37). When comparing the average AIC value for SCDD models to CCDD models, CCDD models consistently do better as a class of DD measures for predicting AUDIT scores (ΔAIC = -3.67), TLFB Drinks (ΔAIC = -3.61), and TLFB Days (ΔAIC = -2.92; see Table 8). In the $200 magnitude single-predictor models, AM200 has the best AIC score for AUDIT and TLFB Drinks and Days. However, when comparing the average AIC value for the SCDD models to the CCDD models, there is essentially no difference in AIC values for AUDIT (ΔAIC = -0.29), TLFB Drinks (ΔAIC = -0.17), or TLFB Days (ΔAIC = -0.12; see Table 9).

For multiple-predictor model comparisons in the $50 magnitude, the best AIC scores for double-predictor models were model 10 (AM50 and MA50) for AUDIT and TLFB Drinks and model 7 (MM50 and MA50) for TLFB Days. The best AIC scores for triple-predictor models was model 13 (MM50, AM50, and MA50). Across classes in the $50 magnitude, double-predictor models are best for AUDIT and TLFB Days, while the quadruple-predictor model is best for TLFB Drinks. For all alcohol use measures in the $200 magnitude, the best AIC scores for double, and triple-predictor were models 6 (MM200 and AM200) and 11 (MM200, AA200, and AM200). Across classes in the $200 magnitude, the single, double, and triple-predictor models do best for TLFB Days, AUDIT, and TLFB Drinks, respectively. The double-predictor models were best for predicting AUDIT across magnitudes, though with notably different tasks.

Table 8

AIC values for model comparisons – $50 magnitude

			AUDIT	TLFB Drinks	TLFB Days
Class	**Model**	**Predictors**	AIC	AIC	AIC
Single predictors	1	MM50	422.00	634.70	399.69
	2	AA50	423.72	636.83	402.82
	3	AM50	419.91	632.34	400.03
	4	**MA50**	**418.47**	**631.97**	**396.64**
Double predictors	5	MM50,AA50	423.10	632.14	401.09
	6	MM50,AM50	418.51	630.42	399.25
	7	MM50,MA50	417.80	628.02	**394.65**
	8	AA50,AM50	420.49	630.91	401.17
	9	AA50,MA50	419.49	630.33	397.94
	10	**AM50,MA50**	**415.85**	**627.86**	395.37
Triple predictors	11	MM50,AA50,AM50	419.17	626.98	400.32
	12	MM50,AA50,MA50	418.92	625.65	396.17
	13	**MM50,AM50,MA50**	**414.71**	**623.98**	**394.41**
	14	AA50,AM50,MA50	416.70	624.82	396.71
Quadruple predictors	**15**	**MM50,AA50,AM50,MA50**	**415.59**	**620.90**	**395.70**

Note*: For each alcohol use measure, the best inter-class AIC scores are in **bold and the best overall intra-class AIC scores are underlined.

Table 9

AIC values for model comparisons – $200 magnitude

			AUDIT	TLFB Drinks	TLFB Days
Class	**Model**	**Predictors**	AIC	AIC	AIC
Single predictors	1	MM200	407.78	616.22	387.70
	2	AA200	408.07	618.53	391.01
	3	**AM200**	**405.86**	**615.61**	**387.37**
	4	MA200	409.40	618.79	391.10
Double predictors	5	MM200,AA200	406.50	614.30	389.25
	6	**MM200,AM200**	**403.79**	**611.52**	**386.57**
	7	MM200,MA200	409.20	614.47	389.00
	8	AA200,AM200	405.14	613.79	388.88
	9	AA200,MA200	409.36	616.72	391.84
	10	AM200,MA200	407.20	613.71	388.93
Triple predictors	**11**	**MM200,AA200,AM200**	**403.79**	**609.34**	**387.88**
	12	MM200,AA200,MA200	407.62	612.45	390.38
	13	MM200,AM200,MA200	404.89	609.56	387.98
	14	AA200,AM200,MA200	405.93	611.85	390.19
Quadruple predictors	**15**	**MM200,AA200,AM200,MA200**	**404.52**	**607.37**	**389.15**

Note*: For each alcohol use measure, the best inter-class AIC scores are in **bold and the best overall intra-class AIC scores are underlined.

Exploratory analyses

The average participant CFC score was 45.60 (*SD* = 5.62), indicating high consideration of future consequences. Participant CFC did not appear to be associated with alcohol use measures (all *p*'s > 0.05; see Table 10) and was not a significant predictor of any alcohol use measures (all *p*'s > 0.05; see Table 11).

Table 10

Correlations among CFC and alcohol measures

Alcohol Use Measure	CFC Score
1. AUDIT	-0.097
2. TLFB Drinks	-0.106
3. TLFB Days	-0.109

Table 11

Regression analyses for CFC predicting alcohol use

Alcohol use measure	***t***	***p***	***β***	**Std. Error**	**95% CI**	
					LL	**UL**
AUDIT	-0.086	0.106	-0.086	0.106	-0.297	0.126
TLFB Drinks	-0.879	0.383	-0.445	0.507	-1.457	0.566
TLFB Days	-0.901	0.371	-0.082	0.091	-0.263	0.099

Chapter 4: Discussion

The primary purpose of the current study was to evaluate two constructs used in BE theory to understand alcohol use/misuse in a study of young adult college students who engage in hazardous drinking. The study tested a series of hypotheses to examine how these constructs – alcohol-related reinforcement and DD – are associated with, and predict, alcohol use and alcohol-related consequences among this high-risk sample. The findings partially supported the hypotheses.

Based on existing literature, alcohol-related and alcohol-free reinforcement measured by the ARSS-AUV were hypothesized to be positively and negatively associated with rates of alcohol use/misuse, respectively (Acuff et al., 2018, 2019; Correia et al., 1998, 2003; MacKillop, 2016; Murphy et al., 2005; Murphy & Dennhardt, 2016). Interestingly, when examining ARSS-AUV domain scores, reinforcement scores across all domains and the TRR were higher for alcohol-free activities than alcohol-related activities. However, when reinforcement scores were compared to alcohol use measures, alcohol-related reinforcement and the TRR were positively associated with all measures of alcohol use/consequences, with most associations reaching conventional levels of significance, consistent with previous literature. Findings also revealed that alcohol-related reinforcement and the TRR were significant predictors of alcohol use

measures. This indicates that individuals who derive high levels of reinforcement from activities related to alcohol use, in general, and relative to alcohol-free activities had higher rates of past 30-day alcohol consumption and more alcohol-related problems.

Moreover, associations between alcohol-free reinforcement and alcohol use measures did not reach conventional levels of significance; however, associations with two of the three alcohol use measures (TLFB Days and Drinks) were negative, consistent with previous literature. Overall, findings supported the ARSS-AUV hypothesis regarding alcohol-related reinforcement, but not alcohol-free reinforcement.

Study hypotheses related to DD were based on the limited literature using a combination of SCDD and CCDD tasks in the study of substance use (Bickel et al., 2011; Moody et al., 2017; Wesley et al., 2014). First, findings from the current study are consistent with recent studies in the general rank order of SCDD and CCDD tasks, with the low rates of DD rates in the alcohol/money task compared to the high rates of DD in the money/alcohol task (Bickel et al., 2011; Moody et al., 2017; Wesley et al., 2014). The rank ordering of the four DD task's mean group rates (from lowest to highest: alcohol/money, money/money, alcohol/alcohol, and money/alcohol) for each magnitude ($50 and $200) replicates Moody et al. (2017), supporting study hypotheses. This finding shows a general preference for money outcomes, regardless of temporal location, and suggests that individuals who misuse alcohol choose immediate money over delayed alcohol and are willing to wait for delayed money even if the immediate outcome is alcohol. This finding also affords greater confidence in the validity of the rest of this study's findings.

Next, study hypotheses regarding associations between rates of DD and alcohol use measures were based on existing literature. The association between high rates of alcohol

use/consequences and high rates of DD in SCDD tasks is well-established in existing literature (Lemley et al., 2016; MacKillop et al., 2011; Odum et al., 2020; Petry, 2001; Vuchinich & Simpson, 1998; Yankelevitz et al., 2012). Interestingly, findings did not support study hypotheses regarding associations between alcohol use measures and rates of DD in SCDD tasks, as results did not consistently show positive associations between the constructs and did not reach conventional levels of significance. Further, study results generally did not support hypotheses regarding CCDD tasks and alcohol use except in the MA50 DD task. High rates of alcohol use/consequences were significantly, negatively associated with rate of DD in the MA50 task, showing a preference for delayed alcohol relative to immediate money. Rate of MA50 DD exhibited the strongest predictive accuracy for both past 30-day alcohol consumption and alcohol-related problems. Moreover, this finding suggests that individuals who 1) consume alcohol at a higher frequency and 2) are at higher risk for developing alcohol-related problems prefer to wait to receive access to alcohol instead of receiving $25 immediately. This contradicts previous interpretations that higher alcohol use or related problems are associated with a generalized inability or unwillingness to wait for delayed outcomes, particularly alcohol.

Another interesting note is what the liquidity of money rewards versus the nonliquid alcohol rewards says about the DD findings. Monetary rewards have the characteristic of liquidity because it is exchangeable for many other rewards, whereas alcohol is a nonliquid reward, as alcohol is not exchangeable for other things the way money is (Estle et al., 2007; Stuppy-Sullivan et al., 2016). Therefore, money is often seen as a more desirable outcome in CCDD tasks, as seen in the existing literature using CCDD tasks discussed earlier (Bickel et al., 2011; Moody et al., 2017; Wesley et al., 2014) and in the current study's findings. However, in the present study, individuals with high rates of alcohol use/consequences chose delayed alcohol

over immediate money in the MA50 DD task despite alcohol being a nonliquid commodity and that money rewards could be used to buy alcohol. As such, individuals who choose delayed alcohol over immediate money are narrowing the potential outcomes that could result from choosing money by choosing nonliquid alcohol outcomes. The individuals who chose alcohol over money in the MA50 DD task may be unable to see the potential of maximizing a money outcome because alcohol may be the only outcome of interest due to a lack of alternative non-alcohol rewards in their environment – a hallmark of addiction (Bickel et al., 2011, 2014; MacKillop, 2016).

So far, study results support the potential for CCDD tasks to be more ecologically valid than SCDD tasks, enhancing the prediction of alcohol use/misuse. The model comparison findings further corroborate the importance of CCDD tasks in predicting alcohol use measures. The results from the single-predictor model comparisons in the $50 magnitude show that CCDD tasks, as a class, provide more explanatory power than SCDD, as the AIC values were sufficiently lower among the CCDD tasks for all alcohol use measures. Among the multiple-predictor models in the $50 magnitude, the best overall combination of models for AUDIT scores according to AIC values was a double-predictor model that included both CCDD tasks and no SCDD tasks. For past 30-day alcohol consumption (TLFB Drinks and Days), the results were less uniformly favoring CCDD tasks. Still, the preferred models within each model class (single, double, etc.) and the overall most predictive model included CCDD tasks. Overall, the $50 magnitude results suggest that implementing CCDD tasks may better predict alcohol use measures.

Conversely, model comparison findings from the $200 magnitude tasks were less conclusive. Although the overall results shared a similar pattern with the $50 magnitude tasks

(i.e., CCDD tasks were present in the best inter-class and overall preferred models), adding more DD tasks as predictors into the models tended not to improve AIC measures. As such, the general pattern is still suggestive of CCDD being ecologically valid predictors of alcohol use, therefore supporting study hypotheses. Still, further research is needed to verify the results quantitatively.

Finally, the CFC was included in the current study as an exploratory measure, as it is sometimes used in BE substance use research (Acuff et al., 2018; Murphy et al., 2012; Voss et al., 2018). Previous studies typically found negative associations between participant CFC and alcohol use, such that lower consideration of future outcomes is associated with greater alcohol use. Findings from the current study are somewhat consistent with previous literature as participant CFC scores were negatively associated with all alcohol use measures. However, these associations did not reach conventional significance levels, and participant CFC was not a significant predictor of alcohol use measures. Nonetheless, these findings are still interesting, as the current sample consists of heavy/hazardous drinkers with high consideration of future consequences, which is not typical. CFC findings and the DD analyses results from the current study show that hazardous drinkers think about the future when making decisions. Specifically, the average CFC score shows that hazardous drinkers in the present study consider the future consequences of their behavior. The MA50 DD results indicated that hazardous drinkers prefer delayed alcohol rewards, further suggesting that they consider the future and invest in their future when making choices.

Considerations

Some of the findings from the current study are inconsistent with other literature on this topic. For example, alcohol-free reinforcement was not associated with alcohol-related

reinforcement or measures of alcohol use/misuse. This unexpected result may be due to the demographic in the current study; all participants were college students, who very likely engage in a set of activities that are typical of the college experience and perhaps not activities that mirror those included in the ARSS-AUV measure.

Additionally, rates of DD in the SCDD tasks were not associated with alcohol use/consequences, despite an established association in previous research. One likely explanation is the current study's sample, which was largely homogenous in drinking behavior. Much of the extant literature has assessed samples with a larger range of alcohol use (MacKillop et al., 2011; Petry, 2001; Vuchinich & Simpson, 1998). This narrower sample range may have also affected the relatively small range of improvements in AIC values across model comparisons. Moreover, while rates of DD from the $50 magnitude predicted alcohol use/consequences consistently, we did not find rates of DD from the $200 magnitude to be significant predictors. The overall pattern found in the model comparisons among the $50 magnitude, which suggested CCDD tasks had more predictive utility than SCDD, was also not as strong in the $200 magnitude. It is plausible that $50 represents meaningful and likely decisions for college drinkers, particularly for DD tasks involving alcohol.

Limitations

There are some limitations to note from the current study. First, the generalizability of the findings is limited to the current sample’s demographics, which primarily consisted of college-aged White men. Still, findings from this study add valuable information to the small body of substance use literature that has used a combination of SCDD and CCDD tasks. Second, the DD tasks in the current used hypothetical money and alcohol outcomes. However, DD literature has

established that rates of DD from DD tasks that use hypothetical rewards are the same as tasks that use real rewards (Matusiewicz et al., 2013).

Chapter 5: Conclusion and Implications

This study expanded on BE research on alcohol use/misuse using alcohol-related reinforcement and DD to understand the drinking behaviors of young adult college students who engage in hazardous drinking. The study found that high rates of alcohol use/misuse are associated with high alcohol-related reinforcement levels, suggesting that individuals with increasingly severe alcohol problems devote a considerable amount of time and resources to alcohol use relative to other activities. Further, the current study extended recent work by comparing SCDD and CCDD rates to young adult drinkers. Conventional interpretations of alcohol users' discounting behavior suggest a generalized inability or unwillingness to wait for delayed rewards of money and alcohol. However, this study counters the previous narrative, revealing that young adult college students with more alcohol use/consequences have the ability to consider the future and wait for delayed rewards, specifically when alcohol is the delayed outcome, suggesting a willingness to invest in future alcohol access. An intriguing and underexplored phenomenon might be that an individual's willingness to invest in future drinking, rather than an inability to wait, may better characterize negative drinking trajectories and outcomes. Finally, results highlight the potential utility of CCDD tasks as individual rates of alcohol use/consequences regularly related to CCDD and results frequently showed CCDD tasks to have more explanatory power than SCDD tasks. Consequently, this study's findings emphasize the necessity of including CCDD tasks in BE research assessing alcohol use/misuse.

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Appendix A

Table 12

Results of 24 individual regression analyses for discounting rates predicting alcohol use

Magnitude	Alcohol use measure	*t*	*p*	*β*	Std. Error	95% CI	
						LL	UL
$50	AUDIT						
	MM50	0.827	0.411	0.314	0.379	-0.443	1.070
	AA50	0.546	0.587	0.106	0.194	-0.282	0.494
	AM50	1.758	0.083	0.576	0.328	-0.078	1.231
	MA50	-2.413	0.019*	-0.442	0.183	-0.807	-0.076
	TLFB Drinks						
	MM50	0.904	0.369	1.638	1.811	-1.977	5.253
	AA50	-0.163	0.871	-0.151	0.931	-2.009	1.706
	AM50	1.199	0.235	1.902	1.586	-1.263	5.068
	MA50	-2.260	0.027*	-1.989	0.880	-3.745	-0.233
	TLFB Days						
	MM50	1.455	0.150	0.468	0.322	-0.174	1.110
	AA50	0.553	0.582	0.092	0.167	-0.240	0.425
	AM50	1.428	0.158	0.404	0.283	-0.161	0.970
	MA50	-2.617	0.011*	-0.408	0.156	-0.719	-0.097
$200	AUDIT						
	MM200	0.515	0.608	0.199	0.385	-0.571	0.968
	AA200	-1.185	0.240	-0.223	0.188	-0.598	0.153
	AM200	1.482	0.143	0.570	0.384	-0.198	1.337
	MA200	-0.020	0.984	-0.004	0.195	-0.394	0.386
	TLFB Drinks						
	MM200	1.111	0.271	2.076	1.869	-1.655	5.807
	AA200	0.573	0.569	0.530	0.926	-1.318	2.379
	AM200	1.354	0.180	2.549	1.883	-1.211	6.309
	MA200	0.103	0.918	0.098	0.954	-1.807	2.003
	TLFB Days						
	MM200	1.593	0.116	0.527	0.331	-0.134	1.188
	AA200	0.773	0.442	0.128	0.165	-0.202	0.458
	AM200	1.691	0.096	0.565	0.334	-0.102	1.232
	MA200	-0.676	0.501	-0.115	0.170	-0.454	0.224

Note: *indicates significant at a $p < 0.05$ level. CI = Confidence Interval; LL = Lower Limit; UL = Upper Limit.

Appendix B

Alcohol Use Disorder Identification Test (AUDIT)

The following questions will ask about your use of alcoholic beverages during the past year. Your answers will remain confidential so please be honest. Select the option that best describes your answer to each question.

	Never	Monthly or less	2-4 times a month	2-3 times a week	4+ times a week
1. How often do you have a drink containing alcohol?	0	1	2	3	4
	1 to 2	3 to 4	5 to 6	7 to 9	10+
2. How many units of alcohol do you drink on a typical day when you are drinking?	0	1	2	3	4
	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
3. How often have you had 6 or more units if female, or 8 or more if male, on a single occasion in the last year?	0	1	2	3	4
4. How often during the last year have you found that you were not able to stop drinking once you had started?	0	1	2	3	4
5. How often during the last year have you failed to do what was normally expected from you because of your drinking?	0	1	2	3	4
6. How often during the last year have you needed an alcoholic drink in the morning to get yourself going after a heavy drinking session?	0	1	2	3	4
7. How often during the last year have you had a feeling of guilt or remorse after drinking?	0	1	2	3	4
8. How often during the last year have you been unable to remember what happened the night before because you had been drinking?	0	1	2	3	4
9. Have you or somebody else been injured as a result of your drinking?	0	1	2	3	4
	No		Yes, but not in the last year		Yes, during the last year
10. Has a relative or friend, doctor or other health worker been concerned about your drinking or suggested that you cut down?	0		2		4

Consideration of Future Consequences (CFC)

For each of the statements below, please indicate whether the statement is characteristic of you.

1 = Extremely uncharacteristic
2 = Somewhat uncharacteristic
3 = Uncertain
4 = Somewhat characteristic
5 = Extremely characteristic

1. I consider how things might be in the future and try to influence those things with my day to day behavior.	1	2	3	4	5
2. Often, I engage in a particular behavior in order to achieve outcomes that may not result for many years.	1	2	3	4	5
3. I only act to satisfy immediate concerns, figuring out the future will take care of itself.	1	2	3	4	5
4. My behavior is only influenced by the immediate (i.e., a matter of days or weeks) outcomes of my actions.	1	2	3	4	5
5. My convenience is a big factor in the decisions I make or the actions I take.	1	2	3	4	5
6. I am willing to sacrifice my immediate happiness or well-being in order to achieve future outcomes.	1	2	3	4	5
7. I think it is important to take warnings about negative outcomes seriously even if the negative outcome will not occur for many years.	1	2	3	4	5
8. I think it is more important to perform a behavior with important distant consequences than a behavior with less important immediate consequences.	1	2	3	4	5
9. I generally ignore warnings about possible future problems because I think the problems will be resolved before they reach crisis level.	1	2	3	4	5
10. I think that sacrificing now is usually unnecessary since future outcomes can be dealt with at a later time.	1	2	3	4	5
11. I only act to satisfy immediate concerns, figuring I will take care of future problems that may occur at a later date.	1	2	3	4	5
12. Since my day-to-day work has specific outcomes, it is more important to me than behavior that has distant outcomes.	1	2	3	4	5

Adolescent Reinforcement Survey Schedule (ARSS)

The following is a list of activities, events, and experiences. Please indicate how often you have engaged in each activity and how much you enjoyed each activity, in the last 30 days:

1. **When you were not using alcohol:** indicate score in both *Frequency without alcohol* and *Enjoyment without alcohol* columns.
2. **When you were using alcohol**: indicate score in both *Frequency with alcohol* and *Enjoyment with alcohol* columns.

If you have experienced an activity more than once in the past month, try to rate how enjoyable it was on average.

Frequency	Enjoyment
0 = 0 times	0 = unpleasant or neutral
1 = once a week or less	1 = mildly pleasant
2 = 2-4 times per week	2 = moderately pleasant
3 = about once a day	3 = very pleasant
4 = more than once a day	4 = extremely pleasant

	Frequency without alcohol	Enjoyment without alcohol	Enjoyment with alcohol	Frequency with alcohol
1. Go places with dates or potential romantic partners.	0 – 4	0 – 4	0 – 4	0 – 4
2. Talk with dates or potential romantic partners.	0 – 4	0 – 4	0 – 4	0 – 4
3. Go out to eat with dates or potential romantic partners.	0 – 4	0 – 4	0 – 4	0 – 4
4. Flirt with dates or potential romantic partners.	0 – 4	0 – 4	0 – 4	0 – 4
5. Get compliments from dates or potential romantic partners.	0 – 4	0 – 4	0 – 4	0 – 4
6. Go on dates.	0 – 4	0 – 4	0 – 4	0 – 4
7. Kiss dates or potential romantic partners.	0 – 4	0 – 4	0 – 4	0 – 4
8. Exercise or participate in sports.	0 – 4	0 – 4	0 – 4	0 – 4
9. Go out to eat with friends.	0 – 4	0 – 4	0 – 4	0 – 4
10. Talk with same sex friends.	0 – 4	0 – 4	0 – 4	0 – 4

11. Go places with friends.	0 – 4	0 – 4	0 – 4	0 – 4
12. Go for a walk with friends.	0 – 4	0 – 4	0 – 4	0 – 4
13. Talk on phone with friends.	0 – 4	0 – 4	0 – 4	0 – 4
14. Go to parties with friends.	0 – 4	0 – 4	0 – 4	0 – 4
15. Talk with friends about day's activities.	0 – 4	0 – 4	0 – 4	0 – 4
16. Get compliments from friends.	0 – 4	0 – 4	0 – 4	0 – 4
17. Meet people my age.	0 – 4	0 – 4	0 – 4	0 – 4
18. Go hang out where friends meet.	0 – 4	0 – 4	0 – 4	0 – 4
19. Interact with people of own age and sex.	0 – 4	0 – 4	0 – 4	0 – 4
20. Write email, text messages, or letters to friends.	0 – 4	0 – 4	0 – 4	0 – 4
21. Go places with siblings or family members.	0 – 4	0 – 4	0 – 4	0 – 4
22. Talk with siblings or family members.	0 – 4	0 – 4	0 – 4	0 – 4
23. Go out to eat with siblings or family members.	0 – 4	0 – 4	0 – 4	0 – 4
24. Tell secrets to siblings or family members.	0 – 4	0 – 4	0 – 4	0 – 4
25. Spend weekends or vacations with siblings or family members.	0 – 4	0 – 4	0 – 4	0 – 4
26. Caressing with a date or romantic partner.	0 – 4	0 – 4	0 – 4	0 – 4
27. Oral sex with a date or romantic partner.	0 – 4	0 – 4	0 – 4	0 – 4
28. Sexual intercourse with a date or romantic partner.	0 – 4	0 – 4	0 – 4	0 – 4
29. Spend weekends or vacations with romantic partner.	0 – 4	0 – 4	0 – 4	0 – 4
30. Going to school.	0 – 4	0 – 4	0 – 4	0 – 4
31. Studying.	0 – 4	0 – 4	0 – 4	0 – 4
32. Doing chores at home.	0 – 4	0 – 4	0 – 4	0 – 4