

THE RELATIONSHIP BETWEEN REWARD SENSITIVITY AND THE
MOTIVATION TO DRINK ALCOHOL BEFORE GOING TO EVENTS WHERE
ALCOHOL IS SERVED (PRE-DRINK)

by

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ABSTRACT

The term “pre-drinking” refers to the purposeful act of drinking alcohol before attending an event where alcohol is served. This practice is associated with higher overall alcohol consumption per drinking episode and a greater number of adverse alcohol-related events. Some studies suggest that young women may be particularly vulnerable to this practice. To improve prevention efforts, it is important to understand the factors that may contribute to pre-drinking. To this end, the current study focused on the interrelationships between reward sensitivity (both behavioral indices and self-reported levels), drinking motives, and quantity/frequency of pre-drinking among female college students. Based on previous studies, it was hypothesized that enhancement drinking motives would mediate the relationship between reward sensitivity and pre-drinking. Results indicated that, while enhancement motives were related to both reward sensitivity and pre-drinking (either significantly, or at the trend level), correlations between reward sensitivity and pre-drinking were not significant in this participant sample. Taken together, the results of this study suggest that female college students who drink for enhancement reasons may be at greater risk of engaging in pre-drinking behaviors. Ultimately, this information could contribute to the improvement of prevention efforts on college campuses.

I. OVERVIEW

In recent years, the practice of pre-drinking (also known as pre-partying or pre-gaming) has received an increased amount of attention in the alcohol research field. Pre-drinking refers to the purposeful act of drinking alcohol before attending an event where alcohol is served (Pedersen & LaBrie, 2007). Studies have shown that pre-drinking leads to higher overall consumption on a given occasion and a greater number of adverse alcohol-related events (Kuntsche & Labhart, 2013), including blackouts (LaBrie, Hummer, Kenney, Lac, & Pedersen, 2011).

Relatively few studies have examined motives that lead to pre-drinking. Among participants in the United States, social and enhancement drinking motives are most frequently endorsed by pre-drinkers (Borsari, Mastroleo, Hustad, & Zamboanga, 2012). In contrast, Kuntsche and Labhart (2013) surveyed young adults in Switzerland and found women may be more likely to endorse coping motives for pre-drinking behavior.

To date, studies of pre-drinking have primarily focused on survey data. The current thesis project offers a more comprehensive view, exploring associations between drinking motives, pre-drinking, and both behavioral, and self-reported measures of reward sensitivity. The results of this study will contribute to improved characterization of populations that are more likely to engage in pre-drinking and may be at risk for alcohol abuse. Ultimately, this information may be applied to the improvement of prevention and intervention efforts.

II. INTRODUCTION: ALCOHOL-DRINKING MOTIVES, PATTERNS, AND PSYCHOLOGICAL CHARACTERISTICS

Drinking patterns and the conscious and unconscious reasons for drinking vary among individuals. Reasons for drinking are often referred to as “drinking motives.” Alcohol researchers have defined four common drinking motives (Cooper, Frone, Russell, & Mudar, 1995; Mazaridis, Vieno, Kuntsche, & Santinello, 2010; Kuntsche, Stewart, & Cooper, 2008). These motives include drinking to increase positive emotion (i.e., enhancement motive), drinking to reduce negative emotions (i.e., coping motive), drinking to fit in with the behavior of others (i.e., conformity motive) and drinking to increase sociability (i.e., social motive). Research validates these motives, as most participants identify with at least one of these as their primary motivation to drink (O’Connor & Colder, 2005; Kuntsche & Cooper, 2010; Willem, Bijttebier, Claes, & Uytterhaegen, 2012; Colder & O’Connor, 2002).

Individual motivations to drink have been shown to vary in relation to certain psychological characteristics (Willem et al., 2012). In particular, the trait of “reward sensitivity” has a strong relationship with drinking for enhancement purposes (Rose & Mossler, 2013; Colder & O’Connor, 2002; O’Connor & Colder, 2005). Reward sensitivity refers to the degree of appetitive motivation that an individual experiences when he or she is presented with a reward. This trait varies among individuals as does the opposing characteristic, punishment sensitivity (Gray, 1970). Variability in the presence of these two characteristics arises as a result of individual differences in the strength of two internal systems: the Behavioral Inhibition System (BIS) and the Behavioral Activation System (BAS) (Carver & White, 1994). As proposed by Gray (1981), the BAS

is responsive to rewarding stimuli and promotes approach behavior (behavior oriented towards a stimulus of interest). In contrast, the BIS is responsive to signals of punishment and non-reward, promoting avoidance behavior (behavior oriented away from an undesired stimulus) (1994). According to Gray's theory, individuals with a more prominent BAS are more sensitive to rewards relative to those with a more active BIS.

The increase in appetitive motivation associated with reward sensitivity is likely to lead to a lot of time spent seeking activities that stimulate neural reward. This type of behavior is often referred to as sensation seeking and has been shown to be related to reward sensitivity (Castellanos-Ryan, Rubia, & Conrod, 2011). For reward sensitive individuals, alcohol intoxication may satisfy the sensation seeking urge, as alcohol stimulates neural reward through the release of dopamine and serotonin (Yoshimoto, McBride, Lumeng, & Li, 1992). Research consistently shows higher levels of reward sensitivity to be significantly related to stronger cravings for alcohol (Franken, 2002; Zisseron & Palfai 2007; & Kambouropoulos & Staiger, 2001).

In further support of the relationship between reward sensitivity and appetitive motivation to drink alcohol, research has shown that increased reward sensitivity is correlated with a higher heart rate while intoxicated compared to individuals with less reward sensitivity (Brunelle et al., 2004). This suggests that inherent reward sensitivity may predispose drinkers to be more sensitive to the intoxicating effects of alcohol.

Research suggests that, in general, alcohol is consumed in an effort to regulate affect (Wills and Shiffman, 1985, Lang et al., 1999). That is, alcohol may serve the purpose of reducing a negative emotion, e.g., anxiety, or increasing a positive emotion, e.g., euphoria. These two forms of motivation for consuming alcohol have been coined

“relief drinking” and “reward drinking”, respectively (Ooteman, Koeter, Verheul, schippers, & van den Brink, 2006).

In consideration of the relationship between reward sensitivity, sensation seeking, and increased physiological response to alcohol, it stands to reason that reward sensitive individuals may participate in reward drinking more often than relief drinking. That is, alcohol is likely to be more appealing to reward sensitive individuals for its rewarding, enhancing properties (i.e., the previously defined drinking for enhancement motive), rather than its potential to alleviate negative feelings, for example, (which would correlate with the coping motive) (Colder & O’Connor, 2002; Willem et al., 2012; Rose & Mossler, 2013).

It is well established that specific psychological differences are related to differences in drinking motives. Research has also revealed a relation to frequency and quantity of alcohol consumption (Willem et al., 2012; Rose & Mossler, 2013; Kuntsche & Kuendig, 2012). Specifically, several studies have shown reward sensitive individuals tend to drink alcohol more frequently as compared to the drinking behavior of individuals with less reward sensitivity (Rose & Mossler, 2013; Colder & O’Connor, 2002; O’Connor & Colder, 2005; Pardo, Aguilar, Molinuevo, & Torrubia, 2007). Pardo et al. (2007) also found heightened reward sensitivity to be predictive of quantity of alcohol consumed per occasion and positively correlated with the age at which participants began drinking alcohol. Lyvers, Duff, Basch, and Edwards (2012) found that higher scores on self-report measures of reward sensitivity was correlated with higher scores on the Alcohol Use Disorders Identification Test (AUDIT; Babor, Higgens-Biddle, Saunders, & Montiero, 2001).

The cumulative findings from these studies suggest that heightened reward sensitivity may be a risk factor for alcohol misuse. Other studies have shown that drinking for enhancement is associated with increased alcohol consumption relative to other drinking motives (Kuntsche & Kuendig, 2012; Chalder, Elgar, & Bennett, 2006). The same pattern of results is found when assessing alcohol consumption in participants with increased reward sensitivity who drink for enhancement (Willem et al., 2012).

Individuals with increased motivation to drink alcohol may exhibit risky behavioral patterns associated with increased alcohol consumption. Pre-drinking is one such pattern. In contrast to the relationship between drinking motives and general drinking behavior, research on the motives that contribute to pre-drinking, specifically, has shown mixed results.

According to Sheehan, Lau-Barraco, and Linden (2013), pre-drinking has a stronger relationship with drinking for enhancement than with any of the other drinking motives. The authors interpret these results as an indicator that, in general, individuals who frequently pre-drink do so to experience the positive reinforcement effects of alcohol. Pedersen and LaBrie also found a significant relationship between drinking for enhancement and pre-drinking (2007). In contrast, Kuntshce and Labhart found no drinking motive to be predictive of pre-drinking frequency (2013).

Knowledge Gaps

The aforementioned mixed results reveal gaps in the knowledge regarding the factors that motivate individuals to pre-drink. In addition to these inconsistencies, the relationship between reward sensitivity and pre-drinking has not been investigated thoroughly, particularly with regard to behavioral measures of reward sensitivity. The

relatively new field of pre-drinking research could benefit from continued investigation of the psychological characteristics of individuals who engage in this behavior.

The current research aims to fill these knowledge gaps by exploring the drinking motives that lead to pre-drinking while also addressing potential differences in reward sensitivity. A novel aspect of this study is the use of a behavioral measure of reward sensitivity in addition to self-report.

Research Questions and Hypotheses

This project assessed three research questions. Question 1 asked, how does reward sensitivity relate to drinking motives? It was hypothesized that reward sensitivity would be positively related to the enhancement motive for drinking and unrelated to (or show weaker correlation to) the social, conformity, and coping motives. Question 2 asked, how do drinking motives relate to pre-drinking? It was hypothesized that the quantity/frequency index for pre-drinking would be related to the enhancement motive for drinking and unrelated to (or show weaker correlation to) the social, conformity, and coping motives. Question 3 asked, what associations exist between reward sensitivity, drinking for enhancement, and pre-drinking? It was hypothesized that the enhancement motive would mediate the relationship between reward sensitivity and quantity/frequency of pre-drinking.

III. METHODS

Participants and Procedures

Participants were recruited through the Texas State University Department of Psychology's human participant pool (the SONA system). Students who completed all aspects of the study were granted 2 course credits. Students who did not wish to participate completed an alternate, research-related assignment. Participants were required to be at least 18 years old and social drinkers. Individuals were excluded from participation if they have been diagnosed with a substance use disorder or any medical issue that would interfere with the behavioral task (e.g., an attention deficit disorder). Use of medication that would interfere with the task also excluded participation.

After determining eligibility to participate, participants were provided with a link to the consent form, online survey, and a mobile version of the computerized behavioral task. In the consent document, participants reviewed the purpose, procedures, risks and benefits and either agreed to or declined participate. Participants who decided to continue with the study were redirected to the first stage of the study: the behavioral task. After completing the task, participants were redirected to complete the survey. Four questionnaires (detailed below) were presented using Qualtrics.

Behavioral Task

Probabilistic Reward Task (PRT). The PRT was administered via the internet using the Inquisit program (Millisecond Software, Seattle, Washington); however, participants were instructed to complete the task on a desktop computer. The PRT is an assessment of reward responsiveness, operationalized by measurement of tendency to develop a reward bias (Pizzagalli, Jahn, & O'Shea, 2005).

The task used in this study was adapted from Frank, Seeberger and O'Reilly (2004). The task involves presentation of one of three symbol pairs. The instructions explain that in each trial, the two symbols are competing to “win.” Participants are instructed to choose which symbol they believe will win. Gradually, participants learn that one symbol wins, and is rewarded, more often than the others. In this task, the richly rewarded symbol is symbol A. There is also a symbol that wins the least often, symbol B. The purpose of this design is to elicit a reward bias towards choosing the more richly rewarded stimulus.

In the learning phase, participants are shown 3 symbol pairs (AB, CD, EF) (see Figure 1). They are instructed to choose which symbol will win in each pair. A wins over B in 80% of trials, C wins over D in 70% of trials, and E over F in 60% of trials. Participants must stay in the learning phase until they choose the winning symbol at a pre-determined frequency (when symbol A is chosen in at least 65% of trials, symbol C is selected in at least 60% of trials, and symbol E in at least 50% of trials). The learning phase consists of 60 trials, 20 per symbol pair. If the criteria are not met in a given learning block, a new block of 60 trials will begin.

In the learning phase, if participants choose the correct symbol, they will be awarded virtual money. Choices are made by either pressing the left arrow or right arrow key, corresponding to the symbol on the left or the right side of the screen. Selection of the correct symbol for a given trial is followed by “Correct, you win 5 cents” and an incorrect choice is followed by “wrong” with no reward. The symbols remain on the screen until the participant makes a selection.

In the test phase, novel pairs are presented: AC, AD, AE, and AF and BC, BD, BE, and BF. Note that the symbols that win the most (A) and the least (B) are paired with all

other symbols. The test phase consists of 160 trials, 20 per pair. Participants are not given any feedback in the test phase. The task is scored based on the percentage of trials in which A is correctly chosen. Possible scores range from 0 to 100 with a higher score indicating greater reward sensitivity.

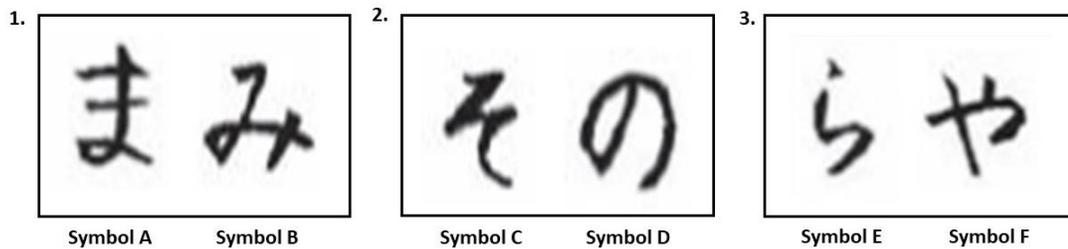


Figure 1. Probabilistic Reward Task Stimuli. Images were adapted from Frank, Seeberger, and O'Reilly, 2004. Panel 1 shows symbols A and B; Panel 2 shows symbols C and D, and Panel 3 shows symbol E and F.

Pizzagalli and colleagues (2005) assessed the test-retest reliability of the PRT and found a significant correlation ($r = 0.57, p < .004$) between participants' response biases at baseline and at a follow-up session approximately 38 days later. The validity of the PRT as a measure of individual differences in reward learning was demonstrated by de Boer and colleagues (2017). They found that activity in the ventromedial prefrontal cortex, an area associated with reward learning, predicted performance on the probabilistic reward task ($r(55) = .47, p < .001$) (de Boer et al., 2017).

Survey

Demographics. Participants reported their age, ethnicity (National Institutes of Health, NIH, 2015), and race (NIH, 2015).

Sensitivity to Reward Questionnaire (SRQ). Self-reported reward sensitivity was also assessed using the Sensitivity to Reward Questionnaire (SRQ) (Torrubia, Avila, Moltó, & Caseras, 2001). This scale contains 24 questions that address sensitivity to reward (e.g., “Do you like to take some drugs because of the pleasure you get from them?”). Participants answer questions on a scale of 1 (never) to 5 (always). The structural validity and reliability of this scale have been tested and confirmed (Beck, Smits, Claes, Vandereycken, & Bijttebier, 2009). Beck and colleagues (2009) reported acceptable internal consistency ($\alpha = .62$). Construct validity of the SRQ was demonstrated by Sava and Sperneac (2006), who found correlations between the SRQ and the Behavioral Activation Scale ($r(343) = .43, p < .01$).

Drinking Motives. The Modified Drinking Motives Questionnaire-Revised (Modified DMQ-R, Grant, Stewart, O’Connor, Blackwell, & Conrod, 2007) assessed individuals’ motives to drink alcohol. This scale contains 28 items that address the degree to which participants endorse social, coping, enhancement, and conformity motives (Blackwell & Conrod, 2003). Sample statements for social, coping, enhancement and conformity motives, respectively, are as follows: “Because it makes a social gathering more enjoyable”, “To forget my worries”, “To get a high”, “Because my friends pressure me to use”. Participants indicated how often they consumed alcohol for the stated reason using a 5-point Likert scale ranging from 1 (never) to 5 (always).

The Modified DMQ-R is a reliable and valid measure of undergraduates’ drinking motives. In terms of validity, the DMQ-R significantly predicted concurrent drinking frequency ($R^2 = .18, p < .001$) and quantity ($R^2 = .17, p < .001$), even after accounting for demographic variables (Grant et al., 2007). For reliability, Cronbach’s alpha for the factors

at time 1 ranged from .58 to .89, and after a mean interval of 95 days the intraclass correlation coefficient between corresponding subscales at time 1 and time 2 ranged from .61 to .78 (Grant et al., 2007).

Alcohol Consumption and Pre-Drinking. The Quantity-Frequency Index (QFI, Cahalan, Cisin, & Crossley, 1969) was administered in two ways, 1) specifically to assess pre-drinking (P-QFI), and 2) to assess total drinking (T-QFI; i.e., all drinking that occurred during typical drinking episodes, including any pre-drinking). The QFI survey asks participants to indicate the quantity and frequency of their use of wine, beer, and liquor in the prior six-month period, ultimately providing an index of absolute ounces of ethanol consumed per day over the prior six-month period. The QFI has good convergent validity with retrospective diary measures, with $r = .86$ agreement between the two methods (Webb, Redman, Gibberd, & Sanson-Fisher, 1991). The QFI tends to be the more conservative of the two approaches (Webb et al., 1991; however, see also Wyllie, Zhang, & Casswell, 1994). The QFI measures alcohol consumption reliably ($r=.86$) and with a high degree of stability, particularly at lighter average drinking levels below the level of alcohol use disorder (Webb et al., 1991).

Prior to completing the QFI questions, participants were presented with a schematic illustrating the size of a standard drink of various types of alcohol (i.e., wine, beer, liquor, mixed drinks, etc.). The QFI questions were presented first to collect the *total* quantity and frequency of alcohol that participants consumed (T-QFI). Next, the QFI questions were presented a second time to ask about quantity and frequency of pre-drinking (P-QFI). Pre-drinking was defined in the instructions as “drinking alcohol before going to an event where you planned to continue drinking” (Pedersen & LaBrie, 2007). Participants were

asked to complete the QFI items with a focus on the quantity and frequency of the pre-drinking episodes only.

IV. STATISTICAL ANALYSES

Research Question 1

How does reward sensitivity relate to drinking motives? Pearson correlations were used to examine the relationship between the continuous variables of reward sensitivity (obtained from both survey and behavioral measures) and the four observed drinking motives.

Research Question 2

How do drinking motives relate to pre-drinking behavior? Pearson correlations were also used to examine the relationship between drinking behavior (T-QFI and P-QFI scores) and drinking motives. Before analysis, QFI scores were square-root transformed to correct to skewness and kurtosis (Osborne, 2002).

Research Question 3

What associations exist between reward sensitivity, drinking for enhancement, and pre-drinking? To examine enhancement motives as a possible mediator of the relationship between reward sensitivity (as measured via the SRQ) and pre-drinking (P-QFI), the relationships between these variables were considered using the methods of Baron and Kenny (1986). Four steps were conducted. In step 1, P-QFI was used as the criterion variable in a regression equation with SRQ as the predictor. In step 2, enhancement motives were used as the criterion variable in the regression equation with SRQ as the predictor. In steps 3 and 4, P-QFI, and T-QFI were used as the criterion variable in a regression equation with enhancement motives as the predictor, and this analysis was conducted both with and without controlling for SRQ.

V. RESULTS

Final Participant Sample

Fifty-seven participants enrolled in the study, ten of whom were men. Given known gender differences in male and female pre-drinking behaviors and motives (Napper et al., 2015), the decision was made to focus statistical analyses on female participants only. Further, two female participants were excluded from further analyses because they lacked the required drinking history. Finally, five participants with mean reaction times of less than 100ms on the PRT were excluded from further analyses as suggested by Whelan and colleagues (2008). Thus, the final participant sample was composed of 40 women.

Participant Characteristics

Demographics. Participants ($N = 40$) were female with a mean age of 20.3 years ($SD = 2.7$). In terms of the National Institutes of Health ethnic categories (NIH, 2015), 48% of participants identified themselves as Hispanic. For the NIH (2015) racial categories, 60% were White, 5% were Black or African-American, 7% endorsed more than one racial category, and 28% declined to answer.

Alcohol Consumption. All participants reported that they had consumed alcohol at some point in their lives. The mean *typical* quantity/frequency index of alcohol consumption (T-QFI) for the six-month period prior to the study was 0.66 ($SD = .82$), corresponding to an average of approximately seven alcoholic beverages per week. The mean *pre-drinking* quantity/frequency index of alcohol consumption (P-QFI) for the same time period was 0.31 ($SD = .51$), or an average of approximately four alcoholic beverages per week. When considering the participant sample is considered as a whole,

this statistic suggests that approximately half of participants' weekly alcohol consumption may have occurred during pre-drinking episodes.

Drinking Motives. In response to the Modified Drinking Motives Questionnaire – Revised (Grant et al., 2007), participants indicate how often they typically consumed alcohol for social, coping, enhancement, and conformity reasons. These data are shown in Table 1. Overall, drinking for social reasons received the strongest participant endorsement, followed by enhancement motives, coping motives, and conformity.

Table 1

Participants' Endorsements of Drinking Motives

<u>Motive</u>	<u>Mean (Standard Deviation)</u>
Social	3.00 (1.68)
Coping	1.80 (0.95)
Enhancement	2.73 (0.97)
Conformity	1.35 (0.49)

Note. Modified Drinking Motives Questionnaire – Revised (Grant et al., 2007). Data were collected using a 5-point, Likert-type scale (1 = never, 5 = always).

Reward Sensitivity. Participants provided a self-report measure of their sensitivity to reward using the Sensitivity to Reward Questionnaire (SRQ; Torrubia et al., 2001), which measured their responses on a 5-point, Likert-type scale (1 = never, 5 = always). The mean SRQ score for this participant sample was 2.41 (SD = 0.42).

Behavioral reward responsiveness was measured using a mobile version of the computerized probabilistic reward task (PRT; Pizzagalli et al., 2005). Possible scores on the PRT range from 0 to 100 with a higher score indicating greater reward sensitivity.

The mean PRT score for the current participant sample was 57 (SD = 22).

Research Question 1

How does reward sensitivity relate to drinking motives? It was hypothesized that both questionnaire and behavioral measures of reward sensitivity would be positively related to the enhancement motive and unrelated (or show weaker correlations) to the other drinking motives (i.e., social, coping, and conformity). Results suggested that these predictions were somewhat true for questionnaire measures of reward sensitivity, but not for behavioral measures.

Correlations are shown in Table 2. The participants' responses to the reward sensitivity questionnaire (i.e., the SRQ), were significantly and positively related to their endorsement of drinking for enhancement purposes and drinking to conform. Responses to the reward sensitivity questionnaire were not significantly related to drinking for social reasons or drinking to cope.

However, performance on the probabilistic reward task was not significantly correlated with social, coping, or enhancement motives. The strongest (albeit non-significant) correlation between task performance and drinking motive occurred for conformity, which was negatively related to PRT performance.

It should be noted that the correlation between responses to the reward sensitivity questionnaire and performance on the probabilistic reward task did not reach statistical significance in this participant sample ($r(38) = -.08, p = .64$).

Table 2

Correlations between Reward Sensitivity and Drinking Motives

<u>Drinking Motives</u>			
Social	Coping	Enhancement	Conformity
<i>r (df)</i>	<i>r (df)</i>	<i>r (df)</i>	<i>r (df)</i>

Table 2. Continued

Correlations between Reward Sensitivity and Drinking Motives

SRQ	.10 (38)	-.11 (38)	.34 (38)*	.33 (38)*
PRT	-.19 (38)	.09 (38)	-.06 (38)	-.20 (38)

Note. Modified Drinking Motives Questionnaire – Revised (Grant et al., 2007), Data were collected using a 5-point, Likert-type scale (1 = never, 5 = always). SRQ = Sensitivity to Reward Questionnaire (Torrubia et al., 2001); Probabilistic Reward Task (PRT; Pizzagalli et al., 2005). * $p < .05$

Research Question 2

How do drinking motives relate to pre-drinking behavior? Correlations are shown in Table 3. Participants’ quantity/frequency indices of alcohol consumption during *pre-drinking* episodes (P-QFIs) were positively, though not significantly ($p = .08$, trend), related to drinking for enhancement. P-QFIs were not significantly related to social, coping, or conformity motives.

Further, as expected, P-QFI was strongly, positively correlated with participants’ *total* quantity/frequency index of alcohol consumption (T-QFI; i.e., not focused solely on pre-drinking) ($r(38) = .76, p < .001$). As shown in Table 3, T-QFI was significantly and positively related to social motives and enhancement motives, but correlations with coping motives and conformity motives failed to reach statistical significance.

Table 3

Correlations between Alcohol Use and Drinking Motives

	<u>Drinking Motives</u>			
	Social	Coping	Enhancement	Conformity
	<i>r (df)</i>	<i>r (df)</i>	<i>r (df)</i>	<i>r (df)</i>
P-QFI	.16 (38)	.06 (38)	.28 (38)	-.02 (38)

Table 3. Continued

Correlations between Alcohol Use and Drinking Motives

	<u>Drinking Motives</u>			
T-QFI	.37 (38)*	.16 (40)	.51 (38)**	.14 (38)

Note. Modified Drinking Motives Questionnaire – Revised (Grant et al., 2007), data were collected using a 5-point, Likert-type scale (1 = never, 5 = always). The Quantity / Frequency Index of Alcohol Consumption (Cahalan et al., 1969) measured consumption during pre-drinking (P-QFI) and total drinking (T-QFI) episodes. * $p < .05$, ** $p = .001$

Research Question 3

What associations exist between reward sensitivity, drinking for enhancement, and pre-drinking? It was predicted that the enhancement drinking motive would mediate the relationship between reward sensitivity and pre-drinking. To examine this possibility, the correlations between the three variables of interest were considered. Figure 2 shows relationships between the causal variable (Reward Sensitivity, SRQ), the outcome variable (Pre-Drinking Index, P-QFI), and the proposed mediator (Enhancement Motives). Reward sensitivity was not related to pre-drinking, and while reward sensitivity was correlated with enhancement motives, the influence of enhancement motives on pre-drinking was not significant, even after controlling for reward sensitivity. Thus, a mediator role for enhancement motives was determined to be unlikely in the current participant sample.

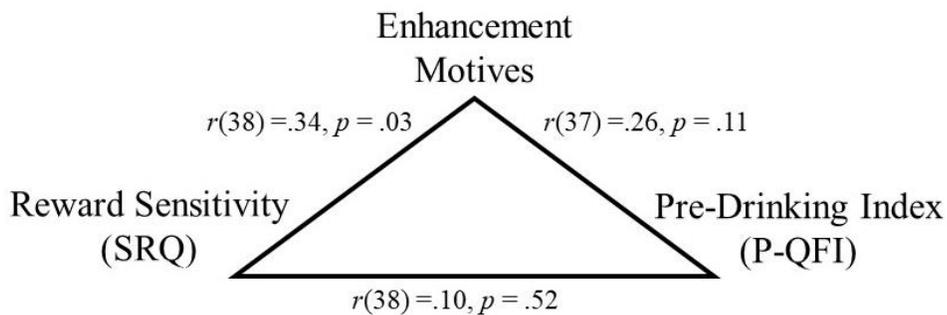


Figure 2. Relationships between Reward Sensitivity, Enhancement Motives, and Pre-

drinking. Variables derived from the Sensitivity to Reward Questionnaire (SRQ; Torrubia et al., 2001), the Modified Drinking Motives Questionnaire – Revised (Enhancement subscale; Grant et al., 2007), and the Quantity / Frequency Index of Alcohol Consumption (Cahalan et al., 1969) for pre-drinking (P-QFI). Relationship between enhancement and P-QFI controlled for SRQ.

The potential mediator role of enhancement motives was also examined for total drinking (T-QFI). Figure 3 shows relationships between the causal variable (Reward Sensitivity, SRQ), the outcome variable (Total Drinking Index, T-QFI), and the proposed mediator (Enhancement Motives). Reward sensitivity was not related to total drinking, thus, a mediator role for enhancement motives was determined to be unlikely in the current participant sample. Reward sensitivity was correlated with enhancement motives, and the influence of enhancement motives on total drinking (controlling for reward sensitivity) was also significant.

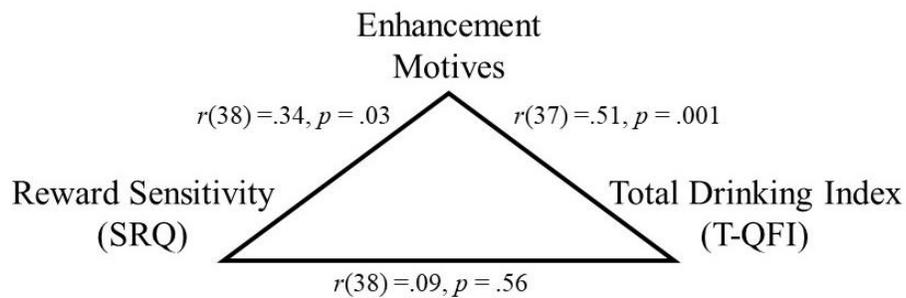


Figure 3. Relationships between reward sensitivity, enhancement motives and typical drinking. Variables derived from the Sensitivity to Reward Questionnaire (SRQ; Torrubia et al., 2001), the Modified Drinking Motives Questionnaire – Revised (Enhancement subscale; Grant et al., 2007), and the Quantity / Frequency Index of Alcohol Consumption (Cahalan et al., 1969) for total drinking (T-QFI). Relationship between enhancement and T-QFI controlled for SRQ.

VI. DISCUSSION

People drink alcohol for many reasons, which generally fall into one of two categories: drinking to alleviate negative affect (negative reinforcement) or to enhance positive affect (positive reinforcement). The current study aimed to assess whether the different motives for drinking relate to a psychological trait, reward sensitivity, and whether these variables are predictive of risky drinking patterns.

The current study focused on college students. Drinking alcohol is very common among this population. Pre-drinking is a relatively new trend, common on and around college campuses, in which students drink alcohol before going to an event where they plan to continue drinking (Labrie, Hummer, Pedersen, Lac, & Chithambo, 2012). Students may do this alone, but it commonly occurs in groups. One danger of pre-drinking is that it may increase the total amount of alcohol consumed during a drinking episode and may lead to more severe negative, alcohol-related consequences (Kuntsche & Labhart, 2013; LaBrie et al., 2011).

Historically, the majority of studies on factors predicting pre-drinking have focused on overall drinking motives. When considering reasons for their total alcohol consumption (i.e., not specifically pre-drinking) participants in the current study typically endorsed drinking for positively reinforcing reasons, such as social and/or enhancement motives, rather than drinking for negatively reinforcing reasons, such as coping with negative affect or conforming to cultural norms. Further, while previous studies have found that enhancement motives tend to predict pre-drinking behaviors (Pedersen & Labrie, 2007; Read, Merrill, & Bytschkow, 2010; Sheehan et al., 2013; Tomaso et al., 2015), data also suggest that enhancement may not be as strongly related to typical

drinking (i.e., alcohol consumption at a typical drinking event; that is, following pre-drinking) (Pedersen & Labrie, 2007; Tomaso et al., 2015). In the current study, while both pre-drinking and typical drinking were most strongly related to the enhancement and social drinking motives, only typical drinking showed a *significant* relationship. This distinction may be related to the fact that the current participant sample was composed of female college students recruited on the basis of having consumed alcohol at some point in their lives. A more focused examination of heavier collegiate drinkers, particularly those who strongly endorse pre-drinking, may have yielded more significant results. Despite the broad recruitment scheme used for the current study, the results do suggest that drinking for enhancement was more strongly related to pre-drinking than any other drinking motive, which is line with the original study hypothesis (i.e., Research Question 2).

However, as noted in the Introduction, participants' trait levels of reward sensitivity were also expected to influence both their drinking motives, and their drinking behaviors. For self-reported measures, the results of the current study supported a significant relationship between reward sensitivity and the motives of drinking for enhancement, a finding that aligned with study hypotheses (see Research Question 1). This finding was also congruent with previous work by Beaton (2014), who reported that individuals with higher levels of reward sensitivity more frequently endorsed the enhancement motive, compared to their less reward sensitive counterparts. Similarly, Colder and O'Connor (2002) found that drinking for enhancement was significantly related to biased attention towards reward (a behavioral measure of reward sensitivity).

However, behavioral measures of reward sensitivity were not correlated with drinking motives in the current study.

Given that drinking for enhancement is related to both pre-drinking and reward sensitivity, it would seem logical for pre-drinking and reward sensitivity to be related, as well. However, the results of the current study did not support a significant correlation between these two variables; analyses revealed that reward sensitivity did not predict pre-drinking behavior. Therefore, it was determined to unlikely that enhancement acted as a mediator as predicted in the study hypotheses (see Research Question 3). A review of the literature on this topic failed to uncover any previous studies that examined these relationships in the context of pre-drinking. However, other researchers have reported a relationship between reward sensitivity and *typical drinking* (i.e., total alcohol use, including any pre-drinking episodes). For example, Willem and colleagues (2012) found that, in a participant population that ranged in age from adolescents to adults, reward sensitivity did have a significant, positive relationship with total alcohol consumption on a typical drinking day, and this relationship was mediated by drinking for enhancement. Lyvers, Coundouris, Edwards, & Thorber (2017) found the same mediating relationship in a participant sample ranging from young adults to older adults. In contrast, the results of the current study did not support a significant correlation between reward sensitivity and typical drinking either; thus, it was determined to be unlikely that enhancement acted as a mediator for typical alcohol consumption in the current study.

There are several potential reasons why reward sensitivity was not correlated with either typical or pre-drinking alcohol consumption in the current study. Since reward sensitivity was the only psychological trait assessed in this study, there may be other

potentially confounding variables that were not assessed. For example, in addition to reward sensitivity, Lyvers and colleagues (2017) also measured alexithymia, a relative difficulty in understanding and expressing feelings and a tendency to be externally-oriented, rather than introspective. The presence of psychological traits that may interfere with reward sensitivity may affect observed results. To speculate, perhaps there is another, unexplored personality trait that correlates with avoidance of certain negative aspects of alcohol consumption. For example, a reward sensitive individual who believes that excessive drinking may lead to socially embarrassing behavior might avoid alcohol and search for enhancement via other stimuli. In another study, Willem and colleagues (2012) excluded participants who did not consider alcohol as their preferred mood-altering substance, while in the current study, drug use other than alcohol was not addressed. Assessment of these or similar variables may have produced different results in the current study.

In addition, the inclusion of a broader assessment of drinking context might provide additional clarity to the results. For example, Beaton (2014) found that reward sensitivity predicted alcohol use in a party setting, but not in a home or multi-generational setting, particularly one that was relatively formal with a wide range of age groups present. Participants in the current study were not asked whether their pre-drinking and typical drinking primarily occurred at home, at parties, or in the presence of familiar or unfamiliar peers.

Overall, results suggest that reward sensitive individuals drink alcohol to feel enhanced, and that drinking for enhancement may increase risk for pre-drinking. This study does not suggest that reward sensitivity alone is a risk factor for excessive or risky

drinking patterns, but does suggest that the desire to feel enhanced may lead to alcohol abuse. The correlation between reward sensitivity and drinking for enhancement supports that reward sensitive individuals tend to pursue stimuli that have potential to induce positive affect (e.g., euphoria produced by alcohol consumption). Whether this reward seeking behavior can directly lead to negative consequences is not clearly supported by the current study.

Limitations and Future Directions

The lack of a significant relationships between the behavioral measure of reward sensitivity (i.e., the PRT) and self-reported reward sensitivity, as well as drinking motives, was unexpected. In particular, the failure of the PRT data to correlate with self-reported reward sensitivity suggests that the PRT may not have adequately measured reward sensitivity in this participant sample. Though previous studies have shown the PRT to be a reliable measure of reward sensitivity (Pizzagalli et al., 2005), those studies have been conducted in the laboratory setting, whereas, the current study used a version of the task presented via mobile device. However, Schubert and colleagues (2013) provide evidence that completing behavioral tasks online should not affect performance for tasks of this nature. Further, using the guidelines of Whelan and colleagues (2008), latency data were closely examined and any participants suspected of inattention were excluded from further analyses as noted in the Results section. A more likely explanation for the current findings is that the PRT offered no tangible reward for correct responses. When participants made the correct choice, they were rewarded with a very low amount of *virtual* money. They were informed of these conditions prior to the task. With no anticipation of tangible reward, reward responsiveness may have been affected.

Another potential limitation to this study is that the final participant sample was small and did not include males. Different results might have been obtained with a proportional distribution of gender, and a larger participant sample would have provided greater statistical power. Further, a more detailed assessment of participants' drinking habits, including age at first drink and first intoxication, as well as family history of alcohol-related problems could potentially strengthen future studies.

Finally, it would be interesting to examine the relationships between the variables in the current study while using neural imaging techniques to provide a deeper analysis of reward sensitivity. Perhaps observed differences in reward sensitivity would be correlated with differential activity of dopaminergic systems.

Conclusions

Taken together, the results of the current study suggest that reward sensitive individuals may be more likely to drink for enhancement purposes, and that enhancement-related drinking may, in turn, increase risk for pre-drinking. Because pre-drinking has been associated with higher overall alcohol consumption per drinking episode and a greater number of adverse alcohol-related events, it is important to develop prevention approaches that might reduce this behavior. This study takes a step in that direction by identifying factors that may be linked with pre-drinking in female college students. Ultimately, this information could contribute to the prevention of alcohol misuse on college campuses.

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