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Development and preliminary validation of a behavioral task of negative reinforcement underlying risk taking and its relation to problem alcohol use in college freshmen

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Abstract

Background—A long line of theoretical and empirical evidence implicates negative reinforcement as a process underlying the etiology and maintenance of risky alcohol use behaviors from adolescence through emerging adulthood. However, the bulk of this literature has relied on self-report measures and there is a notable absence of behavioral modes of assessments of negative reinforcement-based alcohol-related risk-taking. To address this clear gap in the literature, the current study presents the first published data on the reliability and validity of the Maryland Resource for the Behavioral Utilization of the Reinforcement of Negative Stimuli (MRBURNS), which is a modified version of the positive reinforcement-based Balloon Analogue Risk Task (BART).

Methods—Participants included a convenience sample of 116 college freshmen ever regular drinkers (aged 18–19) who completed both behavioral tasks; self-report measures of negative reinforcement/avoidance constructs and of positive reinforcement/appetitive constructs to examine convergent validity and discriminant validity, respectively; and self-report measures of alcohol use, problems, and motives to examine criterion validity.

Results—The MRBURNS evidenced sound experimental properties and reliability across task trials. In support of convergent validity, risk taking on the MRBURNS correlated significantly with negative urgency, difficulties in emotion regulation and depressive and anxiety-related symptoms. In support of discriminant validity, performance on the MRBURNS was unrelated to risk taking on the BART, sensation seeking, and trait impulsivity. Finally, pertaining to criterion validity, risk taking on the MRBURNS was related to alcohol-related problems but not heavy episodic alcohol use. Notably, risk taking on the MRBURNS was associated with negative reinforcement-based but not with positive reinforcement-based drinking motives.

Conclusions—Data from this initial investigation suggest the utility of the MRBURNS as a behavioral measure of negative-reinforcement based risk-taking that can provide a useful complement to existing self-report measures to improve our understanding of the relationship between avoidant reinforcement processes and risky alcohol use.

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Keywords

Adolescence; problem alcohol use; negative reinforcement; risk taking propensity

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Research consistently indicates that alcohol use escalates rapidly during late adolescence and emerging adulthood; a pattern particularly notable among college youth (SAMHSA, 2006). Moreover, risky alcohol use during this developmental period is associated with a wide range of potentially negative consequences, from diminished academic and occupational performance (Wood, Read, Palfai, & Stevenson, 2001) to alcohol-related injury and death (e.g., Hingson et al., 2005). Clearly, identification of psychological and behavioral processes underlying alcohol use and related problems among this developmental group is crucial for informing prevention and intervention efforts.

Avoidant Models and Alcohol Use Behaviors

When considering mechanisms underlying risky alcohol use in late adolescence, a long line of theoretical and empirical evidence implicates negative reinforcement. Negative reinforcement models emphasize that substance use is largely motivated by escape or avoidance of negative external stimuli and corresponding internal affective states (Baker et al. 2004; Solomon and Corbit 1974). Additional support for the role of negative reinforcement is provided within the motivational model of alcohol use developed by Cox and Klinger (1988) and advanced by Cooper (1994; 1995). This model proposes that individuals drink to obtain certain outcomes within a two by two matrix considering source (internal vs. external) and valence (positive vs. negative reinforcement) of motives, with social and enhancement motives mapping onto positive reinforcement, and coping and conformity motives operating through negative reinforcement. Of particular theoretical relevance to understanding the relationship between negative reinforcement and alcohol, drinking to cope with negative emotional states may serve as a proximal link between more distal personality factors, such as neuroticism and traits rooted in the BIS/BAS system (Gray 1975), and problematic alcohol use behaviors among older adolescents (e.g., Cooper et al., 2000; MacPherson, Richards, Collado, & Lejuez, 2011; O'Connor & Colder, 2005). Similarly, research examining negative urgency, defined as the tendency to act rashly in response to extreme negative affect or distress (Cyders & Smith, 2008), indicates that youth high in negative urgency who tend to rely on rash, avoidant coping styles in the face of negative emotions, are less able to effectively regulate their negative mood states, becoming vulnerable to the immediate relief promised by risky behavioral coping strategies (e.g., problem drinking; Fischer & Smith, 2008).

Despite ample theory linking negative reinforcement and adolescent alcohol use, there are currently no validated behavioral instruments that assess this process. Existing laboratory-based behavioral measures of risk-taking provide a starting point for developing a behavioral measure of negative reinforcement to understand problematic alcohol use among youth.

Risk-Taking and Alcohol Use Behaviors

One commonly used behavioral task shown to be a reliable and valid measure of the positive reinforcement aspects of risk-taking is the Balloon Analogue Risk Task (BART; Lejuez et al., 2002). Studies indicate adolescents engaging in excessive, versus little, substance use are more risky on the BART (e.g., Aklin et al., 2005; Fernie et al., 2010; Lejuez et al., 2005;

Williams et al., 2010), suggesting the tendency to engage in risk-taking to obtain a rewarding outcome may be a risk factor for real-world risk behavior. However, the BART is limited by its exclusive focus on the positive reinforcement aspects of risk-taking, thereby excluding the assessment of negative reinforcement processes. As a first step to address this clear methodological need, we developed the Maryland Resource for the Behavioral Utilization of the Reinforcement of Negative Stimuli (MRBURNS), which is a modified version of the BART, designed to measure negative reinforcement-driven risk-taking.

The aim of the current paper was to assess the initial reliability and validity of the MRBURNS and to examine the relationship between task performance and alcohol use variables among a sample of freshmen college students. Based on extant literature, we assessed college students with a history of regular alcohol use to test three main hypotheses. First, the MRBURNS would show evidence of reliability comparable to the original BART. Second, the MRBURNS would show convergent validity evidenced by positive correlations with self-report measures of negative emotionality and negative reinforcement-based responding in the face of negative affect, and discriminant validity evidenced by an absence of significant correlations with self-report measures of positive affect-based disinhibition. Third, the MRBURNS would show criterion validity evidenced by positive correlations with heavy episodic alcohol use and alcohol-related problems. We expected a strong relationship between performance on the MRBURNS and alcohol-related problems due to extant research suggesting that alcohol use behavior driven by negative reinforcement manifests as alcohol-related problems and heavy episodic alcohol use, rather than alcohol use frequency (e.g., Cooper, 1994; Kutsche et al., 2005). Finally, as additional evidence of criterion validity, we hypothesized the MRBURNS would show a relationship with self-reported negative reinforcement-based drinking motives and no relationship with positive reinforcement-based drinking motives.

Materials and Method

Subjects

The sample was drawn from students enrolled in a large public university. To reduce developmental heterogeneity, eligibility criteria included being a college freshman, 18–19 years of age. Given the focus on the consequences of alcohol, it was necessary to have a sample with a period of regular alcohol use from which problems could arise. Therefore, consistent with previous studies (e.g., Kahler, Strong & Read, 2005), the sample was limited to those ever having a period during which alcohol was consumed at least once per week. Additional inclusion criteria included having no hearing impairment due to the nature of the MRBURNS task and proficiency in English. Recruitment included flyers posted around campus and lasted for three months starting one month after classes began. Interested participants meeting inclusion criteria were invited to the laboratory on the university campus. Upon arrival, a more detailed description of the study was provided and participants provided informed consent.

The sample ($n=116$) was on average 18.1 years of age ($SD = 0.4$), 44.8% female, 73.3% non-Hispanic White, 10.3% African-American, 7.8% Asian-American, 4.3% mixed ethnicity, and 4.3% other ethnicity.

Measures

Demographics—Participants completed a basic demographics form, assessing their age, gender, parent education, familial income, and current housing situation.

Behavioral Risk Assessments

Positive Reinforcement Risk-Propensity Behavioral Measure: Balloon Analogue Risk

Task – Auto Pump (BART-AP): BART-AP involves a computer generated balloon that can be inflated to earn money, with greater inflation increasing earnings at the rate of one cent per pump. At any point, accrued earnings could be deposited into a permanent bank, but if a deposit did not occur before the balloon exploded, all earnings on that balloon would be lost. The inflation point ranged between 0–128 pumps, with a mean explosion point of 64 ($SD = 32$). The above characteristics are consistent with the original BART, except for the method of balloon inflation. Specifically, the BART-AP has participants select the number of pumps they want to make at the start of the balloon, as opposed to manually pumping the balloon in real time as in the original BART. Once the participant provides the number, the inflation point cannot be changed. The primary dependent measure was average number of pumps, (see Pleskac, Wallsten, Wang, & Lejuez, 2007).

Negative Reinforcement Risk-Propensity Behavioral Measure: Maryland Resource for the Behavioral Understanding of Reinforcement from Negative Stimuli (MRBURNS):

The MRBURNS was developed to measure negative reinforcement mechanisms underlying risk taking. In contrast to the BART where a participant inflates a balloon to earn money, the MRBURNS involved a participant inflating a balloon to limit the duration of exposure to an aversive event. The MRBURNS uses pre-selection of the inflation value at the start of a balloon as was used for the BART-AP described above. The aversive event used for the MRBURNS was 19.2 seconds of 85 decibels (dB) white noise with an intermittent boat horn effect to limit habituation¹. Based on the number selected at the start of the balloon, the aversive noise duration was reduced 0.15 seconds for each pump.

As with the BART, each balloon had an explosion point. Our initial intention was to have an explosion remove any reduction in duration, setting the sound duration back to 19.2 seconds. However, this does not fit well with how consequences of negative reinforcement responses occur in the real-world. For example, an adolescent receiving peer pressure to drink may ultimately agree to drink, resulting in immediate removal of the pressure (akin to selecting higher pump values on the balloon), but that may also result in some future negative consequence such as being arrested for driving while intoxicated (akin to the balloon exploding). Having the explosion reset the full duration of the noise would be analogous to having peers come to the scene of the arrest and immediately re-initiate the same level of pressure to drink. Consequences of a negative reinforcement response are almost never reinstatement of the aversive stimulus (at least not immediately), but instead some opportunity cost in the future as the drunk driving arrest might result in loss of license, or freedom if incarcerated. Thus, the consequence we chose for a balloon exploding was the loss of an opportunity to win a lottery at the end of the session. Specifically, we started the participant off with a guaranteed lottery win, but with the likelihood of winning reduced with each exploded balloon. This choice in the design of the task was made to ensure a focus on explosions (and therefore the negative reinforcement response) as having an opportunity cost. Details of the MRBURNS are provided below, broken down into pretask and three sequential steps of the task.

Pretask: Before starting the task, participants were provided rules for the task via written text and verbal instructions. Given the complexity of the task, participants were quizzed on the instructions and had to correctly answer 5 of 7 questions before completing the task (otherwise the instructions were repeated). Following the successful completion of the quiz,

¹This dB level was chosen because it was shown to be aversive in our pilot testing, but also safely below 90–95 dBs where sustained exposure can lead to hearing damage.

participants listened to the aversive noise used for the experiment for a full trial duration of 19.2 seconds to provide a context for what the noise would be like if he or she made no pumps to reduce its duration. The participant then watched the computer perform 5 trials displaying a range of possible selections.

As with the BART there were 30 trials (i.e., 30 separate balloons). For each trial, a balloon would appear on the screen and participants completed the following three steps: 1) select a number of pumps at the start of the balloon, 2) experience aversive noise for a duration of time based on the number of pumps, 3) watch the balloon inflate, see if it explodes, and if it does then lose one chance to win a lottery later in the session (Figure 1).

Step One (Automatic Pump Selection): The screen displayed a dial of numbers on the left side, a grid in the top left, and an uninflated balloon on the right side. Using the dial on the left, participants selected the inflation level. The range of pumps and characteristics of the explosion point were the same as in the original BART. It is important to note that in this phase, the number of pumps was selected but the balloon did not yet inflate and no noise was played. We considered having the noise play while participants made their decisions but we were concerned about the speed at which they made their responses affecting the duration of exposure; therefore, we decided to use a more straightforward aversive noise period after their pump selection.

Step Two (Aversive Noise): The second screen was displayed for a total of 19.2 seconds. On this screen there was a black and green bar across the center of the screen with a red indicator crossing vertically over it. As time passed, the indicator moved left to right over the bar, indicating the progression of time. While the indicator was over the green section of the bar, participants listened to the aversive noise through headphones. Once the indicator reached the black section of the bar, participants did not listen to any more noise for the remainder of that trial. As noted above, the relative size of the green and black sections on the bar was entirely dependent on number of pumps selected for that balloon.

Step Three (Consequence and Lottery): Next, the screen showed the balloon from Step 1 and it began to inflate according to the number of pumps in Step 1. At the end of inflation, the balloon either stopped safely with the word “SAFE” written across it or it exploded with the word “POP” written over the shattered balloon. The explosion point for each lottery group had a mean of 64 pumps with a standard deviation of 32. Regardless of the consequence, no noise was produced.

With regard to the lottery introduced above, the screen indicated a green “winning” lottery ball associated with each balloon. If that particular balloon did not explode the ball stayed green, but if the balloon exploded the ball changed to a red “losing” lottery ball. The lottery using the resultant green and red balls was divided into 6 separate lottery drawings for sequential clusters of five balloons each. The value for the lottery was \$1 for two drawings, \$3 for two drawings, and \$9 for two drawings. The lottery drawings occurred in the same order of presentation for each participant: 1, \$9, \$3, \$9, \$1, and \$3. This was identical to the order the groups were presented during the task. This sequence was used for all participants to limit any possible impact of different orders across participants. Although a lottery drawing was linked to each sequential cluster of 5 balloons, all drawings occurred at the conclusion of the task to keep the results of each individual lottery from influencing participant behavior in future balloons. For the drawings, a ball was selected from the green and red balls for that cluster of balloons and the value was won if a green ball was selected.

Alcohol-Related Measures to Test Criterion Validity—The Timeline Followback (TLFB) method (Sobell & Sobell, 1992) was used to assess number of heavy drinking

episodes during the 30 days preceding the interview, with a heavy drinking episode defined as four or more drinks on one occasion for women and five or more drinks on one occasion for men (Wechsler et al., 1995). Lifetime alcohol use was assessed using the *Customary Drinking and Drug Use Record* (CDDR; Brown et al., 1998), including age of first alcohol use and ever having been a regular drinker (defined as consuming alcohol at least once per week). The 24-item self-administered *Brief Young Adult Alcohol Consequences Questionnaire* (B-YAACQ; Kahler, Strong, & Read, 2005) was used to provide a total score indicating drinking-related problems experienced in the past. Finally, the 20-item *Drinking Motives Questionnaire – Revised* (DMQ-R; Cooper, 1994) included the coping and conformity motives subscales (negative reinforcement), and the social and enhancement subscales (positive reinforcement).

Measures of negative reinforcement- and avoidance-related constructs

We used the 12-item negative urgency subscale of the *UPPS-P Impulsive Behavior Scale* (c.f., Lynam, Smith, Cyders, Fisher, and Whiteside, 2007) to measure negative urgency, or the tendency to engage in rash action in response to extreme distress. We used the 36-item *Difficulties in Emotion Regulation Scale* (DERS; Gratz & Roemer, 2004) to measure individuals' typical levels of emotion dysregulation across six domains: nonacceptance of negative emotions, difficulties engaging in goal-directed behaviors when distressed, difficulties controlling impulsive behaviors when distressed, limited access to effective ER strategies, lack of emotional awareness, and lack of emotional clarity. Current depressive symptoms were measured using the 20-item *Center for Epidemiologic Studies - Depression Scale* (CES-D; Radloff, 1977) and state and trait anxiety were measured using the 40-item *State-Trait Anxiety Inventory* (STAI; Spielberger, Gorsuch, & Lushene, 1970).

Measures of positive reinforcement- and appetitive-related constructs

We used the 14-item *Positive Urgency subscale of the UPPS-P* (Cyders et al., 2007; Lynam et al., 2007) to measure positive urgency, or the tendency to act rashly when experiencing positive emotions. The 12-item sensation seeking subscale of the *UPPS-P Impulsive Behavior Scale* (c.f., Lynam et al., 2007) was used to measure preference for novel and arousing experiences. Finally, the 30-item *Barratt Impulsiveness Scale, version 11* (BIS-11; Patton, Stanford, & Barratt, 1995) was used to measure impulsive behavior across domains of inattention, nonplanning, and motor impulsiveness.

Results

Sample Description

On average, lifetime regular drinkers ($n = 116$) were 15.09 ($SD = 1.70$) years old at first alcohol use and consumed 8.96 ($SD = 7.86$) drinks per week and 5.18 ($SD = 5.09$) drinks per drinking day during the past 90 days, with 92.2% reporting ever having engaged in heavy episodic alcohol use. In the past 30 days, 87.9% reported engaging in heavy episodic alcohol use with no significant gender difference. Participants reported $M = 7.58$ ($SD = 4.58$) alcohol-related problems in the past on the BYAAQ.

Experimental Properties and Reliability of the MRBURNS

The primary index of risk taking on the MRBURNS was average number of pumps; this variable was examined as both a composite and separately across the three possible monetary values, \$1, \$3, and \$9, as well as the first and second half of the task. We also included number of explosions as descriptive data2

Sample means and standard deviations for average pumps and explosions are presented in Table 1. As a manipulation check on the differing monetary values as well as the change in

responding over time on the task, we conducted a monetary value (\$1, \$3, and \$9) $\times$ time (first or second half of the task) ANOVA. There was no interaction, but two main effects. As expected and supporting the utility of the task, average pumps on the MRBURNS decreased systematically across the progressively larger monetary values ($F_{(2, 230)} = 41.51, p = .0001$). Specifically, there was a significant decrease in the number of pumps from the \$1 to the \$3 monetary value ($t(115) = 2.29, p = .02$, and from the \$3 to the \$9 monetary value ($t(115) = 9.39, p = .0001$, indicating that participants engaged in less negative reinforcement-driven risk-taking in balloon groups with higher potential earnings. Additionally, there was a main effect for time ($F_{(1, 115)} = 45.56, p = .0001$). Although pumps decreased across monetary value and from the first to second half of the task, there were robust correlations for both variables ranging from $r = .69-.88$ across the different monetary values, as well as a correlation of $r = .90$ ($p = .0001$) across the first and second half of the task. These correlations provide strong evidence of reliability and support the decision to conduct all analyses examining validity with a single MRBURNS composite score.

Average number of pumps was not associated with age or ethnicity (p 's $> .10$); however, the average number of pumps on the MRBURNS was higher for women than for men ($F_{(1, 115)} = 10.41, p = .002$ (Table 1). Based on this difference we explored gender as a moderator of the relationship between performance on the MRBURNS and the convergent, divergent, and criterion validity measures. In each case, no moderation was found (p 's $> .15$) indicating a relatively similar relationship for males and females between the MRBURNS and the outcomes variables.

Relationship of the MRBURNS with measures of negative reinforcement- and avoidance-related constructs

Average pumps on the MRBURNS demonstrated significant positive correlations with all negative reinforcement-based constructs (ranging from $r = .22$ to $r = .33$), including negative urgency (UPPS-Neg), difficulties with emotion regulation (DERS), current depressive symptoms (CES-D), and state and trait anxiety (STAI-S, STAI-T) (see Table 2).

Relationship of the MRBURNS with measures of positive reinforcement- and appetitive-related constructs

Consistent with expectations, MRBURNS average pumps were not significantly related to the positive reinforcement-related constructs, including the original BART, sensation seeking (UPPS-SS), and trait impulsivity (BIS), with the exception of positive urgency ($r = .19$) (see Table 2). Correlations were of small magnitude and relatively consistent across the discriminant validity variables.

Relationship of the MRBURNS with alcohol use behaviors, problems, and motives

Average pumps on the MRBURNS was not significantly related to heavy episodic alcohol use in the past 30 days ($r = -.09$), but it was significantly associated with alcohol-related problems ever experienced ($r = .21$) indicating that greater negative reinforcement-based risk taking was associated with a greater number of alcohol-related problems. As hypothesized, average pumps on the MRBURNS was positively related to the negative reinforcement-based coping and conformity motives (DMQ-Coping, $r = .29$; DMQ-Conformity, $r = .28$), and showed no significant relationship with the positive reinforcement-based social and enhancement motives (DMQ-Social, $r = .11$; DMQ-Enhancement, $r = .14$) (see Table 2).

²Although we considered number of explosions, this measure is dependent at least in part on pumps and therefore not surprisingly produced almost identical results; thus analyses with explosions are not included here.

Discussion

Existing behavioral measures of risk-taking utilized in the alcohol literature focus primarily on appetitive and positive reinforcement-based processes (Harrison, Young, Butow, Salkeld, & Solomon, 2005). The current study presents the MRBURNS as the first behavioral measure of negative reinforcement-based risk-taking. Data reported herein support the reliability and validity of the MRBURNS among a sample of college freshmen with a history of regular alcohol use.

Regarding reliability of the MRBURNS, data indicated that participants decreased in risk-taking over time and across increasing monetary values, but there were notably robust correlations across monetary value and from the first to second half of the task. These correlations suggested that despite decreased responding both when the value of the lottery was higher and in the second half of the balloons, the relative ordering of individuals in their number of pumps changed little as a function of these two variables. Based on these findings, we concluded the MRBURNS was highly reliable and could be used to examine validity with a single composite score. Nevertheless, future studies will need to examine other dimensions of reliability including test-retest across shorter and longer-term durations.

Results also revealed convergent validity of the MRBURNS. The correlations of the MRBURNS average pumps with several theoretically relevant constructs, albeit relatively modest, were notable given the relationships between behavioral measures of positive-reinforcement risk-taking and self-report measures of appetitive traits are typically low or nonexistent (e.g. Meda et al., 2009). We found that the average number of pumps on the MRBURNS was related to negative urgency, difficulties with emotion regulation, and depressive and anxiety-related symptoms. Moreover, the magnitude of the convergent validity correlations were relatively consistent across these constructs, suggesting that the MRBURNS may be effectively capturing a basic negative reinforcement process as it is relevant to each domain.

As hypothesized, discriminant validity of the MRBURNS was also supported by the nonsignificant correlations between risk-taking on the task and appetitive constructs. The relationship with positive urgency was unexpected but may have been related to the emotion-based aspects of the construct. Collectively these findings provide support for the distinction between appetitive traits and the negative reinforcement process underlying performance on the MRBURNS. Future research should consider expanding the range of convergent and divergent validity measures to include physiological and neurobehavioral assessments.

As expected, negative reinforcement-based risk-taking was associated with past alcohol-related problems. The significant association between greater risk taking on the MRBURNS and higher number of past alcohol-related problems is consistent with extant empirical literature indicating that with increased alcohol experience, adolescents have more opportunities through their learning history to develop stronger associations between alcohol consumption and removal of aversive stimuli (negative reinforcement), even if problematic alcohol use also continues to be maintained in part through positive reinforcement processes. It has been argued that drinking driven by negative reinforcement effectively removes aversive stimuli in the short term but likely contributes to greater alcohol-related problems in the long-term as more adaptive coping strategies are not learned or employed (e.g., Cooper et al., 1995; Kuntsche et al., 2005).

Consistent with Cox and Klinger's motivational model and as further evidence for convergent and discriminant validity, it is theoretically noteworthy that risk-taking on the MRBURNS was positively correlated with self-reported negative reinforcement-based

motives for alcohol use, but unrelated to self-reported positive reinforcement-based motives. Such novel findings indicate that MRBURNS discriminates among the individuals' perceived motivational drives for alcohol use, further highlighting the value of a complimentary set of behavioral measurement tools to assess both positive and negative reinforcement related to risky alcohol use. Future work can examine the possibility that negative reinforcement processes as measured with MRBURNS represents one mechanism through which certain genetic polymorphisms might result in problem alcohol use via learning history (Agrawal et al., 2008; Prescott et al., 2004) and may serve as an endophenotype (e.g., Anokhin, Golosheykin, Grant & Heath, 2009) linking genetic factors and cognitive-based motives for alcohol use.

Notably, women evidenced a greater average number of pumps compared to men. This finding is consistent with literature suggesting that women are less tolerant of aversive physical sensations than men. In general, women exhibit lower pain thresholds and diminished pain tolerance as compared to men in both clinical (Daughters et al., 2005) and non-clinical samples (e.g., Fillingim & Maixner, 1995). Although gender moderated the relationship between physical pain tolerance and smoking outcomes in previous studies (MacPherson, Stipleman, Duplinsky, Brown, & Lejuez, 2008), no moderating effect was found in the current study, suggesting that despite a gender difference on the MRBURNS, performance on the task for males and females was not differentially related to the key outcome variables. Future work should pursue the nature of this gender difference on the MRBURNS, in relation to findings with other tasks as noted above.

The present study has several important limitations. First, the sociodemographic homogeneity of our sample limits generalizability of the present findings. Although we purposely limited our sample to a restricted age range and college class, the findings may not generalize to young adults with more drinking experience or to non-college attending youth. Second, it would be useful in the future to have a measure of pain or aversiveness tolerance to provide evidence that the MRBURNS is not simply a measure of aversive stimulus tolerability. Third, we did not collect data regarding the functional contexts in which alcohol use occurred, and thus we cannot differentiate drinking episodes that were driven by negative reinforcement-based motives as opposed to other motives. Fourth, as this study was a first step in examining the psychometric properties of the MRBURNS, we examined univariate associations. Future research would benefit from incorporating performance on the MRBURNS with other theoretically important characteristics into predictive models of alcohol use and related problems. Finally, although we believe the findings here are meaningful and set the stage for further investigation of the utility of the MRBURNS, the modest effects should be acknowledged.

Despite these limitations, data from this initial investigation suggest the utility of the MRBURNS as a behavioral measure of negative reinforcement-based risk taking for understanding problematic alcohol use. The availability of the MRBURNS may open new directions, providing the ability to demonstrate contextual effects on negative reinforcement in real time, and to use neuroimaging to examine neural correlates of negative reinforcement. In light of Koob and LeMoal's (2008) allostatic model of how drug use becomes increasingly negatively reinforced over time at a biological level, future research should examine performance of the MRBURNS in clinical samples characterized by diagnostic threshold alcohol use disorders. It will also be necessary to examine the utility of the MRBURNS with younger adolescents before alcohol use has initiated or progressed, allowing insight into key developmental changes in negative reinforcement motives and their link to their positive counterpart and problem alcohol use.

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Screen 1 **Screen 2** **Screen 3**

Figure 1.

Table 1

Explosions and Average Number of Pumps for Total Sample and by Gender (n=116)

DV	Average Pumps									
	Total		\$1		\$3		\$9		\$9	
	M	SD	M	SD	M	SD	M	SD	M	SD
Total Sample	16.80	17.50	21.56	22.47	18.34	19.19	10.12	14.95		
Men	12.23	14.94	17.28	21.27	12.77	15.65	6.49	11.44		
Women	22.45	18.89	26.83	22.98	25.20	20.99	14.60	17.47		

DV	Explosions									
	Total		\$1		\$3		\$9		\$9	
	M	SD	M	SD	M	SD	M	SD	M	SD
Total Sample	.58	.62	.82	.81	.66	.74	.27	.67		
Men	.41	.49	.69	.78	.42	.56	.11	.44		
Women	.79	.70	.97	.81	.94	.83	.47	.83		

Table 2

Means, Standard Deviations, and Intercorrelations Among MRBURNS and Validity Variables in Ever Regular Drinkers (n=116)

Variable	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Task																		
1. MRBURNS Tot	16.8	17.5	---															
Convergent Validity																		
2. UPPS-Neg	26.2	6.7	.26**	---														
3. DERS	76.8	18.4	.24**	.55**	---													
4. CES-D	12.7	8.2	.33**	.48**	.66**	---												
5. STAI-S	37.5	11.3	.26**	.43**	.57**	.66**	---											
6. STAI-T	38.2	10.0	.22*	.44**	.70**	.73**	.82**	---										
Discriminant Validity																		
7. BART	51.3	12.9	-.06	.10	.14	.02	-.07	-.02	---									
8. UPPS-Pos	26.8	8.5	.19*	.64**	.32**	.25**	.09	.22*	.07	---								
9. UPPS-SS	34.8	5.8	.05	.20*	-.04	-.01	-.10	-.10	.21*	.26**	---							
10. BIS	70.3	9.6	.15	.53	.37**	.34**	.17	.27**	.12	.43**	.33**	---						
Criterion Validity																		
11. Binge Alc (30)	5.1	4.1	-.09	-.05	-.07	-.02	-.03	.0001	-.08	-.06	.09	.14	---					
12. BYAAQ	7.6	4.6	.21*	.47**	.29**	.33**	.20*	.21*	-.04	.22*	.05	.30**	.34**	---				
13. DMQ Cop	10.8	4.2	.29**	.38**	.37**	.39**	.24*	.30**	-.11	.33**	.02	.25**	-.04	.51**	---			
14. DMQ Conf	9.5	4.2	.28**	.28**	.34**	.26**	.12	.15	.08	.27**	.07	.21*	-.09	.34**	.45**	---		
15. DMQ Soc	19.8	3.6	.11	.21*	.11	.08	.001	.07	-.10	.24**	.08	.24**	.14	.35**	.47**	.28**	---	
16. DMQ Enh	17.4	14.5	.14	.25**	.12	.08	-.05	-.02	-.11	.19*	.13	.27**	.24**	.43**	.43**	.20*	.68**	---
17. Age First Alc	15.1	1.7	.16	.16	.14	.21*	.04	.02	-.10	.09	.09	-.01	-.17	.04	.02	.11	-.004	.05

Note:

* indicates $p < .05$;** indicates $p < .01$