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One-Year Test-Retest Reliability of the Maryland Resource for the Behavioral Utilization of the Reinforcement of Negative Stimuli (MRBURNS)

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Abstract

The Maryland Resource for the Behavioral Utilization of the Reinforcement of Negative Stimuli (MRBURNS) is a novel behavioral task designed to measure individual differences in negative reinforcement-based risk taking propensity. Performance on the MRBURNS has been linked with alcohol-related problems and negative reinforcement-based drinking motives, as well as symptoms of anxiety and depression; however, it is unclear if performance on the task represents a stable measure of negative reinforcement-based risk taking over time. As such, the current study aimed to examine the test-retest reliability of the MRBURNS over a period of one year. Results indicate that the correlation between year 1 and year 2 risk behavior (average number of pumps) on the MRBURNS was .43 across all trials. With the one year test-retest reliability of the MRBURNS established, the MRBURNS may be a useful approach to measuring the relative contribution of negative reinforcement-based risk taking in the development of risky behaviors over time, and may be used to monitor the effects of novel interventions that aim to reduce negative reinforcement based risk taking in the real world.

Keywords

risk taking; negative reinforcement; alcohol-related problems; behavioral measure; test-retest reliability

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1. INTRODUCTION

Risk taking can be broadly conceptualized as engagement in behaviors that possess the potential for both harm or negative consequences, as well as rewards or positive outcomes (Byrnes, Miller, & Schafer, 1999; Leigh, 1999), and is frequently related to issues with great public health significance, such as problematic alcohol use, illicit drug use, risky sex, gambling, and aggression (Dahne, Richards, Ernst, MacPherson, & Lejuez, 2012). Towards understanding mechanisms that contribute to risk behavior, both positive and negative reinforcement models have found support (MacPherson, Richards, Collado, & Lejuez, 2011). From a positive reinforcement or appetitive framework, an individual would take risks due to a desire to pursue or enhance positive rewards, whereas from a negative reinforcement framework, an individual would engage in risky behavior in order to alleviate or cope with negative affective states (Cooper, Agocha, & Sheldon, 2000). In order to assess the relative contributions of negative and positive reinforcement processes in risk behavior, it is essential to have sound measurement approaches. Further, there is reason to believe that behavioral measures of risk taking may be superior to self- or observer-report measures as issues related to response bias can be effectively eliminated (Meyer et al., 2001).

Although a number of behavioral measures exist for assessing the positive reinforcement component of risk taking, considerably fewer measures exist that offer a behavioral assessment of negative reinforcement-based risk taking. One newly developed behavioral analogue task specifically designed to assess negative reinforcement processes that contribute to risk taking is The Maryland Resource for the Behavioral Utilization of the Reinforcement of Negative Stimuli (MRBURNS; MacPherson et al., 2012). The MRBURNS was designed as a complement to the Balloon Analogue Risk Task (BART; Lejuez et al., 2002), one of the most widely used behavioral measures of appetitive risk taking.

The MRBURNS is a computerized measure of negative-reinforcement based risk taking that was initially developed in order to understand the role of negative reinforcement-based processes in the development of risky alcohol use (MacPherson et al., 2012) and is, to our knowledge, the only behavioral measure of negative reinforcement-based risk taking currently available. Preliminary work to validate the MRBURNS within a sample of college students found that the MRBURNS evidenced sound experimental properties including convergent and discriminant validity with theoretically-related and distinct constructs of interest (MacPherson et al., 2012). Specifically, risk taking on the MRBURNS was significantly positively related to negative urgency, emotion regulation difficulties, symptoms of depression, and symptoms of anxiety, and was unrelated to performance on the BART and self-reported sensation seeking and impulsivity. In regards to alcohol-related processes specifically, risk taking behavior on the MRBURNS was significantly positively related to alcohol-related problems and negative-reinforcement based drinking motives, supporting the utility of the MRBURNS for understanding the development of risky alcohol use.

Based on existing psychometric data, the MRBURNS appears to be a valid measure of negative-reinforcement based risk taking, and may be useful more specifically for enhancing

our understanding of the relative role of negative reinforcement based processes in the emergence of risky alcohol use among college students. It remains to be seen, however, whether the MRBURNS can serve as a reliable means of assessing the relative role of negative reinforcement processes in risk taking behavior over time. Examining the reliability of the MRBURNS as a behavioral measure of negative reinforcement-based risk taking is crucial as it would provide the means for researchers to better understand the natural trajectory of negative reinforcement-based risk taking during normative development and at critical developmental periods such as adolescence and young adulthood. Further, with reliability of the MRBURNS determined, researchers can examine the task as a clinical assessment to evaluate the effectiveness of interventions designed to target negative reinforcement-based risk taking behaviors including risky behaviors such as alcohol use, tobacco use, illicit drug use, and risky sex.

Importantly, utilization of the MRBURNS for these purposes is predicated on its test-retest reliability. However, test-retest periods typically employed throughout the literature of several days or weeks may be limited if the MRBURNS is to be used in the future for treatment evaluation research. In treatment evaluation research, interventions often occur over several months with follow-ups up to one year following treatment completion. Accordingly, the present study evaluated (1) the one-year test-retest reliability of the MRBURNS and (2) the stability of each participants' ranked riskiness on the MRBURNS over time.

2. METHOD

2.1 Participants

163 participants were recruited as a part of a larger study that aimed to develop and test a novel behavioral task designed to measure negative reinforcement-based risk taking. The entire study involved two visits: an initial testing session in the Fall of 2009, and a one-year follow-up session in Fall of 2010. In order to reduce developmental heterogeneity, inclusion criteria included: college freshman standing, 18–19 years of age, as well as English proficiency. As the task involved listening to aversive noise through headphones, participants were excluded if they had any auditory impairment. Following participants' initial testing session, reminder phone calls and e-mails were made to all participants during Summer, 2010 to inform participants that they would be contacted during Fall, 2010 to schedule their follow-up appointment. Participants were then contacted two to three weeks prior to the one-year anniversary of their first assessment in order to schedule their follow-up appointment. Of the 163 college students initially assessed, 113 (69.33%) were re-assessed one year later (see Table 1 for demographic characteristics of the full sample and of the sample that was re-assessed at year 2). The analyses for the current study are all based on this smaller sub-sample of 113 participants that completed both study visits. Participants who returned for the year 2 assessment (returners) did not significantly differ from those individuals who did not return for the year 2 assessment (non-returners) on demographic variables including age, gender, and race/ethnicity (see Table 1). Additionally, a one-way ANOVA comparing returners to non-returners on risk behavior on the MRBURNS task at

year 1 revealed that the groups did not significantly differ on average risk behavior across all trials ($F(1,160)=1.45$, $p=.23$).

2.2 Measures

Demographic information—Participants completed a survey of age, gender, race/ethnicity, and annual family income.

The Maryland Resource for the Behavioral Utilization of the Reinforcement of Negative Stimuli (MRBURNS; MacPherson et al., 2012)—Briefly, the MRBURNS is comprised of 30 trials, each with three distinct phases. In phase 1, the automatic pump selection phase, participants were informed of the lottery amount they would be risking on the upcoming trial and selected the number of pumps they would like to apply to an uninflated balloon for the trial (0–128 pumps). In phase 2, the aversive noise phase, participants were exposed to aversive noise (85 decibels white noise delivered through headphones with an intermittent boat horn sound to limit habituation). The number of pumps chosen at the outset of the trial determined the duration of exposure; each pump reduced the duration by 0.15 seconds. Throughout the 19.2 s exposure phase, a visual display indicated the remaining amount of time the participant would be exposed to the aversive noise. In phase 3, the consequence and lottery phase, an animated balloon was displayed. The balloon was incrementally inflated according to the number of pumps selected at trial outset. During this phase, the balloon was either safe or popped at the end of inflation. On each trial, the participant received a winning lottery ball if the balloon was safe and a losing lottery ball if the balloon popped. Following the completion of all 30 trials, the participants used their accumulated lottery balls in a lottery. The task began with a guaranteed lottery win and each subsequent explosion reduced the likelihood of winning the lottery. The lottery was divided into six drawings with each successive five trials constituting one drawing. Lottery values were \$1, \$3, or \$9. The lottery order was: \$1, \$9, \$3, \$9, \$1, \$3 for the six drawings. The primary index of risk taking on the MRBURNS was average number of pumps. This variable was examined as both a composite across all trials and separately across the three possible monetary values (see MacPherson et al., 2012). For a schematic of the phases of the MRBURNS, see Figure 1. For task instructions provided to participants, see Appendix A.

2.3 Procedure

Permission to conduct research was obtained from the University of Maryland Institutional Review Board. As detailed in MacPherson et al (2012), after providing informed consent, participants completed self-report questionnaires and the MRBURNS task. One year later, participants returned to the laboratory and completed the MRBURNS a second time.

2.4 Analytic Strategy

Preliminary analyses were conducted to assess internal consistency in order to determine whether a composite score of average pumps across monetary amounts could be used to examine test-retest reliability as a supplement to average pumps within each reward level. Specifically, Pearson correlations of risk behavior between each lottery amount within each year were used to determine if risk taking remained consistent across lottery amounts. Subsequently, to address the first study aim, test-retest characteristics of the MRBURNS

were assessed using: (1) paired t-tests across years to assess whether risk behavior at each lottery level and on the composite score across lottery levels changed from year 1 to year 2 and (2) Pearson correlations of risk behavior at each lottery amount during year 1 with risk behavior at each lottery amount during year 2 as well as average risk behavior at year 1 with average risk behavior at year 2 to determine the stability of risk behavior on the MRBURNS across repeated administrations. To address the second study aim, the stability of each participant's ranked riskiness on the MRBURNS over time was assessed using Spearman rank-order correlations. We selected this analytic plan both to address our primary study aims as well as to remain consistent with previous literature examining the test-retest reliability of the BART (White et al., 2008).

3. RESULTS

3.1 Lottery Amount and Risk Taking Behavior at Years 1 and 2

In order to determine whether a composite score of average pumps on the MRBURNS could be used in addition to average pumps across each monetary value, we examined correlations between average risk taking values within and across lottery amounts within each year as an assessment of internal consistency. To calculate average risk taking, the number of pumps on each trial within each lottery were averaged within each year. Within years, correlations within and across lottery amounts were high ranging from .60 to .89 (all p 's < .001). Considering these high correlations, for subsequent test-retest analyses, the average pumps across all lottery amounts within each year was used in addition to average pumps within each reward level (Table 2).

3.2 Mean Risk Behavior

Average number of pumps for each reward level and for the composite score during each year are presented in Table 3. A paired-samples t-test revealed that mean risk behavior across all monetary values and the composite score significantly decreased from year 1 to year 2 (Table 3).

3.3 Test-Retest Reliability

Pearson correlations for MRBURNS risk behavior between administrations ranged from .37 to .43 (p < .001; Table 3). Correlations did not differ between the three MRBURNS reward levels (\$1, \$3, \$9; Z < |0.09|, ns).

3.4 Stability of Individual Differences in Ranked Order

Spearman rank-order correlations for MRBURNS risk behavior between administrations ranged between .37 and .42 (p 's < .001; Table 3). Correlations did not significantly differ between the three MRBURNS reward levels (\$1, \$3, \$9; Z < |0.26|, ns).

4. CONCLUSION

Results from the present study suggest that: 1) across monetary amounts, individuals tended to decrease in risk taking behavior on the MRBURNS from year 1 to year 2, 2) across trials, the correlation between MRBURNS year 1 and year 2 risk taking was .43, and 3) across

monetary amounts, individuals who were more risky at year 1 tended to remain more risky at year 2. Results and their implications are discussed below.

First, participants who returned for year 2 tended to be less risky at year 2 than at year 1. This was observed across all monetary values and potentially could be due to the effects of novelty, learning, or habituation. Similar effects have occasionally been found with repeated administrations of the BART (Weafer, Baggott, & de Wit, 2013) as well as with other behavioral analogue measures such as the Iowa Gambling Task (IGT; Verdejo-García & Pérez-García, 2007). Another possibility is that age differences in the present sample from year 1 to year 2 could be related to a decrease in risk taking over the developmental period, as risk taking on both self-report and behavioral measures tends to decrease with age (Gardner & Steinberg, 2005). It will be important for future studies to tease apart whether the observed decreases in risk taking over time are due to practice effects or normative development.

Second, the correlation between year 1 and year 2 risk taking on the MRBURNS was .43 across all trials. Test-retest of the MRBURNS can be compared to that of other behavioral analogue measures that assess constructs similar to negative reinforcement-based risk taking. Regarding other behavioral analogue measures, delay discounting and probability discounting measures have test-retest reliabilities ranging from .52 to .94 over two to five day retest periods (Richards, Zhang, Mitchell, & De Wit, 1999; Weafer et al., 2013). In terms of the positive-reinforcement-based risk taking BART, when administered three times during a single day, test-retest reliability for the original BART ranges from .62 to .82 (Lejuez, Aklin, Jones, et al., 2003), over a one-week retest period, test-retest reliability for the BART is .79 (Weafer et al., 2013), and over a two-week retest period test-retest reliability for the BART is .77 (White et al., 2008). Finally, over a similar one year period, test-retest reliability of a youth version of the BART (BART-Y) is 0.49 and over a two year period, test-retest reliability of the BART-Y is 0.39 (MacPherson et al., 2010). Thus, test-retest reliability of the MRBURNS is similar to that of the BART-Y when observed across similar periods of time.

Third, Spearman rank-order correlations highlighted that individuals who were more risky compared to other participants at year 1 tended to remain more risky compared to other participants at year 2. This finding is important considering that risk behavior on the MRBURNS has predictive utility for other stable constructs such as negative urgency, emotion regulation difficulties, symptoms of depression and anxiety, and negative health behaviors such as alcohol-related problems and negative-reinforcement based drinking motives (MacPherson et al., 2012). In order to further examine the stability of negative reinforcement based risk taking, future studies would benefit from the examination of individual trajectories of behavior on this task over time.

Results from this study have important practical implications for substance use research. A large body of both theoretical and empirical research supports the role of negative reinforcement processes in the development and maintenance of problematic alcohol use (e.g., Cox & Klinger, 1988), tobacco use (Eissenberg, 2004), illicit drug use (Higgins, Heil, & Lussier, 2004), and other risky behaviors (Cooper, Shapiro, & Powers, 1998). Taken

together in conjunction with the results of MacPherson et al. (2012), the MRBURNS could be used as a supplement to existing self-report measures of negative reinforcement processes in order to better understand processes contributing to risky behaviors such as substance use. Additionally, the MRBURNS may be used in the future to better understand the developmental trajectories of both normative and problematic substance use and other risky behaviors as well as changes in underlying negative reinforcement processes as a result of intervention for problematic risk taking behaviors.

Strengths of the present study include the relatively large sample size and the duration of time between administrations. Because the majority of previous test-retest studies of behavioral analogue tasks utilize relatively short test-retest periods, it is difficult to interpret results of longer duration studies such as longitudinal developmental studies and treatment studies. With these strengths in mind, limitations must also be noted. Although our follow-up rates were high, a substantive portion of the sample did not return for the year 2 assessment and thus results should be interpreted with this in mind. Additionally, the restricted age range for the parent study on which the present study is based may limit the generalizability of present findings.

There are a number of important future directions from this line of research. First, there are a number of candidate moderators such as age, gender, and personality constructs including impulsivity and sensation seeking that will be important to investigate in order to determine for whom the MRBURNS may be more or less reliable. Second, it will be important to utilize the task in order to assess ways in which contextual factors influence risk behavior. Finally, future studies might use the MRBURNS, in conjunction with positive reinforcement-based behavioral risk taking tasks like the BART, to track the relative contributions of negative vs. positive reinforcement processes in the development of risky behaviors, such as substance use, over the course of development, and track the relative contributions of these processes over the course of disease progression and treatment among clinical samples.

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Appendix A: MRBURNS Task Instructions

In this game you will be inflating 30 balloons and listening to annoying noises. You will be selecting a number of pumps to inflate each balloon. The more you inflate the balloon the less time you will listen to the annoying noise; however, pumping the balloon also increases your chance of popping the balloon. If the balloon pops, your chance of winning money at the end of the game will decrease.

Each balloon is paired with a lottery ball. If you pop the balloon, your lottery ball for that balloon will become a red (losing) ball, but if it does not, it will remain a green (opportunity) ball. Every group of 5 balls is worth a certain amount. At the end of the game a lottery ball is randomly chosen from each group. You will not know if you will win a group until you have inflated all 30 balloons. If the ball is a green (opportunity) ball you will receive the full amount for that group, but if it is a red (losing) ball you will not receive any money for that group. Click the 'Next' button to see a demonstration of the lottery.

[Participant is shown a demonstration of the lottery being performed.]

The maximum number of pumps you can inflate the balloon by is 128 and the minimum number is 0. Pumping the balloon 64 pumps will balance the annoying sound and your winnings. On the left side of the screen there will be some yellow buttons which you can use to select the number of pumps you would like to make. After selecting the number of pumps you will hear the annoying sound. Remember how long you listen to the noise depends on the number of pumps you make. After listening to the noise the balloon will inflate. If the balloon does not pop you still have the lottery ball, but if the balloon does pop you have lost the lottery ball.

It is very important that you do NOT remove your headphones during the task. If you remove your headphones during the task you will not receive any money for this task and the task will end.

Do you have any questions?

[Participant then completes a short quiz to ensure task instruction knowledge.]

- The MRBURNS measures negative reinforcement-based risk taking.
- The current study examined the one-year test-retest reliability of the MRBURNS.
- The correlation between year 1 and year 2 MRBURNS risk taking was .43.
- The MRBURNS can be used to examine the development of risky behaviors over time.

- 30 trials total with 3 task phases: Automatic Pump Selection, Aversive Noise, and Consequence and Lottery
- Automatic Pump Selection: Selection of number of balloon pumps

Aversive Noise: Aversive noise plays while a red indicator is over the green portion of a green and black bar. Each pump reduces the duration of aversive noise by 0.15 seconds. This screen lasts a total of 19.2 seconds.

Consequence and Lottery: Balloon inflates according to the number of pumps selected during Automatic Pump Selection and is either safe or pops at the end of inflation. Participant receives a winning lottery ball if balloon is safe and a losing lottery ball if balloon pops.

- The task begins with a guaranteed lottery win. Each explosion reduces the likelihood of winning.
- If the balloon explodes, the participant receives a red (losing) lottery ball. If the balloon is safe, the participant receives a green (winning) lottery ball.
- Lottery: Occurs after completion of all 30 trials. Divided into 6 drawings with each successive 5 balloons constituting one drawing. Lottery values are \$1, \$3, or \$9. The lottery order is \$1, \$9, \$3, \$9, \$1, \$3 for the 6 drawings.

Figure 1.
The MRBURNS

Table 1

Sample demographics

	Full Sample	Returned	Did not Return
<i>n</i>	163	113	50
Age (<i>M</i> (<i>SD</i>))	18.13 (.38)	18.13 (.39)	18.14 (.35)
Female (%)	49.7%	50.4%	48.0%
Ethnicity (%) [*]			
Non-Hispanic White	71.2%	69.0%	76.0%
African American	12.9%	13.3%	12.0%
Asian American	15.3%	16.8%	12.0%
Other Ethnicity	7.3%	9.8%	2.0%

^{*} Participants were given the option to select more than one ethnicity.

Note. There were no significant group differences between returners and non-returners on any of the above demographic factors.

Table 2

Within-year correlations between each lottery amount and across lottery amounts for years 1 and 2

	Year 1		Year 2
	Non-Returners	Returners	
First \$1 x Second \$1	.72**	.89**	.86**
First \$3 x Second \$3	.64**	.78**	.88**
First \$9 x Second \$9	.86**	.82**	.87**
Avg \$1 x Avg \$3	.71**	.82**	.81**
Avg \$3 x Avg \$9	.90**	.86**	.86**
Avg \$1 x Avg \$9	.60**	.69**	.71**

**
 $p < .001$

Table 3

Test-retest reliability of the MRBURNS

	Year 1	Year 2	t	r	rho
MRBURNS					
Risk Behavior					
Total Score	17.02(17.62)	11.00(15.42)	3.51**	.43**	.42**
Reward Levels					
\$1	21.12(22.80)	15.51(22.57)	2.34*	.37**	.40**
\$3	18.72(19.41)	11.50(16.28)	3.83**	.38**	.39**
\$9	10.02(14.19)	6.02(10.61)	3.00**	.38**	.37**

* p<.05;
** p<.01

Note: All data above refers to participants who returned for the Year 2 assessment.