Influence of Alcohol Reinforcement on Choice in the Moment

by

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Abstract

Behavioral economic theory suggests that individuals choose to perform certain activities (e.g. drug use) based on constraints of obtaining access to the activity (e.g. cost of obtaining drugs) and the available alternative activities (Tucker, Vuchinich, Black, & Rippens, 2006). The Adolescent Reinforcement Survey Schedule – Substance Use Version (ARSS-SUV; Murphy, Correia, Colby, & Vuchinich, 2005) uses a substance-related to substance-free ratio to assess the relative reinforcing value of alcohol in the natural environment and found that individuals with more access to substance-free activities consumed less alcohol compared to those with more substance-related activities. A multiple choice procedure (MCP; Little & Correia, 2006; Benson, Little, Henslee, & Correia, 2008) has also been used to assess the relative reinforcing value of alcohol asking individuals to make discreet choices between alcohol and alternative reinforcers. All previous studies collected data with paper-and-pencil surveys but online research assessing reinforcement and alcohol use is lacking. The current study compared the MCP and ARSS-SUV in an online format to determine if the relative reinforcing value of alcohol in the natural environment predicts the value of alcohol on a given choice point. Results suggested that the ARSS-SUV correlated with alcohol consumption, alcohol-related problems, and binge drinking but not the MCP survey. Inconsistent with previous studies, the MCP survey wasn't correlated with any drinking variable other than binge drinking, suggesting that the MCP survey didn't translate to an online format. Future studies should consider using the paper-and-pencil and online formats in conjunction to determine if the two methods are comparable.

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According to the National Center for Education Statistics (2008), there were over 15 million undergraduates' enrolled in colleges and universities in the United States during 2006; this number was projected to reach 17 million by 2017. The Substance Abuse and Mental Health Services Administration (SAMHSA; 2008) found that young adults between the ages of 18 to 22 enrolled full-time in college were more likely than young adults not enrolled full-time to use alcohol, binge drink, and drink heavily in the past month. Specifically, 63.7% of full-time students reported alcohol use in the last month compared to 53.5% of non-full-time students; 43.6% of full-time students reported binge drinking compared to 38.4% of non-full-time students; and 17.2% of full-time students reported heavy drinking compared to 12.9% of non-full-time students. The SAMHSA reported that these rates have remained consistent since 2002 and the trend appears likely to continue.

Wechsler, Davenport, Dowdall, Moeykens, and Castillo (1994) reported that students who binge drink are 7-10 times more likely than students who do not binge drink to engage in behaviors with negative consequences (e.g., having unprotected sex and driving while intoxicated). Students who reported drinking alcohol were also more likely to have academic difficulties, engage in physical and sexual aggressive behaviors, and die in traffic-related accidents (Hingson, Heeren, Zakocs, Kopstein, & Wechsler, 2002). Given the potential for these negative, sometimes fatal consequences, it is important to understand why students continue to make the risky decisions regarding alcohol consumption.

Behavioral theories of substance use find evidence that various drugs (e.g., nicotine, alcohol, and cocaine) have positive reinforcing properties. In particular, both humans and animals who are not alcohol dependent will engage in a variety of behaviors in exchange for access to psychoactive drugs (Brady & Lukas, 1984; Griffiths, Bigelow, & Henningfield, 1980; Johanson, 1978). Laboratory studies also find that monkeys would continue to press a lever in exchange for cocaine instead of eating food (Aigner & Balster, 1978) and would voluntarily self-administer lethal amounts of cocaine (Deneau, Yanagita, & Seevers, 1969). Wise (1998) suggested that the reinforcement attained from substance use is similar to reinforcement attained from satiating biological needs. In a review of dopamine's role in reward, Berridge (2007) found that the dopamine systems are activated when pleasant rewards such as food, sex, and drugs are attained. Similarly, research has also found that blocking dopamine activity using a dopamine antagonist decreased behaviors used to attain food, water, and sexual contact (Wise, 2004). Taken together, research suggests that dopamine plays a vital role in how animals and humans experience reward. Specifically, humans are biologically prewired to experience pleasure when dopamine is activated. Similar to the suggestion made by Chilcoat and Johanson (1998), if all humans have the ability to attain reward from activating the dopamine system with drugs, then why aren't all humans abusing drugs?

Behavioral economic theory suggests that individuals choose to perform certain activities (e.g. drug use) based on the constraints on obtaining access to the activity (e.g. cost of obtaining drugs), as well as the alternative activities that are available (Tucker, Vuchinich, Black, & Rippens, 2006). Herrnstein (1970) proposed the *matching law*, which posited that an individual's preference for an activity depends on both the reinforcement derived from the activity and the reinforcement derived from competing activities. Specifically, Herrnstein's

(1961) theory produced an equation that predicted the proportion of responding to two alternative choice behaviors equaled the proportion of reinforcement derived from those alternative choice behaviors:

$$\frac{R_1}{R_1 + R_2} = \frac{r_1}{r_1 + r_2}$$

where R_1 and R_2 represent responses to the first and second alternative choice behaviors and r_1 and r_2 represent reinforcement derived from the first and second alternative choice behaviors, respectively. Thus, reinforcement from one source is not enough to determine the choice an individual will make; reinforcement from competing sources must also be taken into account. Similar to the matching law, Vuchinich and Tucker (1988) suggested that as constraints on an activity increased, individuals would choose to perform that activity less often and begin allocating behavior towards alternative options. Taken together, it appears that the choice to use psychoactive substances depends on three factors: (1) constraints on substance use, (2) reinforcement derived from substance-free alternatives, and (3) the reinforcement derived from substance use.

Constraints on Substance Use

Constraints refer to anything that restricts individuals from pursuing certain activities; for example, the cost and availability of the activity. When applied to substance use, Vuchinich and Tucker (1983) suggested that constraining the availability of alternate activities may lead to an increase in alcohol consumption while constraining the availability of alcohol may decrease its consumption; various methods have been used to study this theory. In a review of previous research related to alcohol use and cost, Chaloupka, Grossman, and Saffer (2002) found decreases in individuals driving while intoxicated and alcohol-related crimes when the cost of alcohol was increased. Wagenaar, Salois, and Komro (2009) conducted meta-analyses

examining the relationship between alcohol tax/price and alcohol sales/self-reported drinking. The authors concluded that the cost of alcohol significantly impacted the consumption of alcoholic beverages (e.g. beer, wine, and spirits) by various populations of drinkers (i.e. from light to heavy drinkers). The authors suggested that the literature on alcohol prices/taxes has had more published studies and consistent effects than any other preventative intervention on decreasing alcohol consumption. Thus, these findings suggest that increasing the constraints to obtaining alcohol (e.g. higher costs) can help decrease its consumption.

Using a more controlled approach, Liebson, Cohen, Faillace, and Ward (1971) conducted a study using a token economy in an inpatient treatment facility for alcoholics. The authors found that alcohol consumption decreased when patients were required to increase their workload (e.g., laundry, tutoring, and providing other services) in order to earn enough credits to exchange them for alcohol. In another study using a token economy, Bigelow, Griffiths, and Liebson (1976) found that sedative abusers decreased their drug use when they were required spend more time (e.g., ride 2 minutes for 1 token) riding a stationary bicycle to earn enough credits (e.g., number of tokens required varied across days) for a single dose of sedatives. Taken together, these studies suggest that as the constraints for obtaining the drug of choice increase, drug consumption decreases.

Reinforcement Derived from Substance-Free Alternatives

Researchers have looked at substance-free behaviors by utilizing self-report measures such as the Pleasant Events Schedule (PES; MacPhillamy & Lewinsohn, 1982) in order to measure a variety of substance-free behaviors retrospectively. The PES is a widely used reinforcement survey designed to measure the frequency and subjective pleasure of 320 events and activities. Correia, Carey, Simons, and Borsari (2003) modified the PES by having

participants provide two ratings of frequency and pleasure for each event or activity, one when the event or activity was performed substance-free and another when it was performed under the influence of some psychoactive substance. The authors found that participants who reported binge drinking two or more times during the past month derived less reinforcement from nonsocial, passive outdoor, and introverted activities compared to the control group. Other survey studies using the PES have found that frequency, quantity, and negative consequences of alcohol use are related to the amount of reinforcement derived from the ratio of drug-related to drug-free reinforcement (Correia et al., 1998, 2002).

Although naturalistic studies provide a wealth of knowledge, Carroll (1996) suggested that substance-free alternative activities must also be accounted for in experimental studies. Experimental studies can mimic some of the environmental contexts surrounding substance use while controlling for extraneous variables. Correia, Benson, and Carey (2005) conducted a study in which participants reporting recent substance use were encouraged to engage in specific substance-free activities (e.g. exercise and creative behaviors). The authors found that participants with increases in exercise and creative behaviors reported decreased substance use at the 28 day follow-up session. This result was obtained even though students were told that they would receive extra course credit regardless of whether or not they engaged in the substance-free activities. Both time constraints (e.g., more time engaging in exercise/creative behaviors meant less time for substance use) and shift in relative reinforcing value (e.g., increased engagement in exercise/creative behaviors lead to increased reinforcement derived from these behaviors) may have contributed to the findings.

Laboratory based experiments also find that increases in substance-free activities correspond to decreases in substance-use activities. Vuchinich and Tucker (1983) conducted a

study where moderate to heavy drinking participants were given a choice to press 2 buttons; one increased the amount of alcohol they could receive later in the session while the other increased the amount of money (by 2 or 10 cents per button press) they could receive at the end of the session or in 2 or 8 weeks. The participants were able to increase the amount of alcohol or money when the green light above the button was illuminated; otherwise, pressing the buttons yielded no returns. The green lights were illuminated on a 20 second variable interval schedule. Vuchinich and Tucker (1983) found that participants pressed the button for money more frequently when each button press yielded 10 cents and when the money was received at the end of the session. The authors suggested that the preference for the substance-free reinforcer increased as the reinforcer amount increased and the delay period was decreased.

Taken together, these survey, experimental, and laboratory studies suggest an inverse relationship between substance use and substance-free activities. In other words, as substance-free activities increase, substance use decreases (Correia, Simons, Carey, & Borsari, 1998).

Reinforcement Derived from Substance Use

Relative reinforcement value (RRV) is a term used by behavior economic researchers to describe the amount of reinforcement derived from an activity such as drug use (Bickel, Marsch, & Carroll, 2000). Higher RRV indices indicate higher reinforcement derived from substance use relative to the total pool of all available activities. RRV has been operationalized in a variety of ways. For example, in a study of natural resolutions to drinking problems, Tucker, Foushee, and Black (2008) found that problem drinkers who allocated more money to immediate drinking versus a savings account had a higher preference for drinking. As predicted by the RRV index, individuals who were spending their money on drinking derived more reinforcement from drinking compared to saving the money for delayed reinforcement.

The modified version of the Adolescent Reinforcement Survey Schedule (ARSS; Holmes, Sakano, Cautela, & Holmes, 1991), the ARSS-Substance Use Version (ARSS-SUV; Murphy, Correia, Colby, & Vuchinich, 2005), is a 45-item survey measuring the frequency and enjoyment derived from substance-related and substance-free activities in the past month. Murphy et al. (2005) used data from the ARSS-SUV to calculate an RRV based on the matching law, such that:

$$\frac{\text{Mean Cross Product for Substance-Related Activities}}{(\text{Mean Cross Product for Substance-Related Activities}) + (\text{Mean Cross Product for Substance-Free Activities})}$$

Using the ARSS-SUV, Murphy et al. (2005) found that participants with lower RRV index scores at baseline reported lower levels of alcohol consumption at the 6-month follow-up after completing a brief motivational intervention. The authors concluded that individuals with more access to substance-free activities were more likely to reduce alcohol consumption after the intervention. Similar to what other researchers have found (Correia, Carey, Simons, & Borsari, 2003; Correia, Benson, and Carey, 2005), increasing the access to substance-free activities may help to decrease alcohol consumption, as well as substance use in general, while increasing access to substance-related activities may increase alcohol consumption.

The Multiple Choice Procedure (MCP)

Laboratory studies have also used the Multiple Choice Procedure (MCP) to compare the RRV of substance-related and substance-free activities (Griffiths, Troisi, Silverman, & Mumford, 1993). The MCP is a structured questionnaire in which participants choose between receiving a dose of drug (e.g. alcohol) or an alternative reinforcer (e.g. money). The MCP is interested in the *crossover point*, the point where the participant chooses the alternative reinforcer over the dose of drug (Griffiths, Rush, & Puhala, 1996). The crossover point is considered the RRV of the drug. While survey studies (e.g. PES) have used a similar format, in

vivo MCP studies have actually given participants the item they chose; thus, participants were making a choice between receiving a dose of drug or an alternative reinforcer in the moment. In an in vivo study of caffeine RRV and physical dependence, Garrett and Griffiths (1998) used the MCP to assess whether induced physical dependence on caffeine (i.e. showing physical withdrawal in the absence of caffeine) affected the crossover point. The authors found that participants who were physically dependent on caffeine chose to receive caffeine at higher crossover points compared to those who were not physically dependent.

The MCP has also been used as part of survey research. For example, Schmitz, Sayre, Hokanson, and Spiga (2003) used the MCP as a survey to measure hypothetical drug preference on individuals seeking treatment for tobacco and alcohol dependence. As the authors expected, participants had a higher self-reported preference for the combination of tobacco and alcohol compared to either one alone. The results of the MCP confirmed the self-reported preferences as the crossover points were higher for the combination of the drugs versus either one by itself. The study by Schmitz et al. (2003) provided evidence that the MCP is also effective as a survey.

Previous research on the MCP has primarily used participants seeking treatment for substance use, and research using college student participants is limited. In an initial study evaluating RRV with college student drinkers, Little and Correia (2006) compared the survey and in vivo versions of the MCP. Although the authors did not find a significant correlation between the two methods, they suggested that both methods appeared to be valid measures of RRV but may have been measuring different aspects of the decision making process, as both versions were correlated with self-reported substance use and sensitive to parameters known to influence choice behavior (e.g. reinforcer magnitude, delays associated with alternative reinforcer). In a systematic replication of this initial study, Benson, Little, Henslee, and Correia

(2008) found stronger magnitudes of the correlation between MCP and RRV when using a restricted range of college students (i.e. 21 year old males who self-reported at least 3 episodes of binge drinking in the past month) and a wider range of alcohol doses (12, 24, or 36 ounces of beer compared to 6 or 12 ounces of beer). The studies by Little and Correia (2006) and Benson et al. (2008) provide evidence that both the survey and in vivo versions of the MCP can be used to assess alcohol preference in college students.

Present Study

Using various methods (e.g. population studies, naturalistic studies, surveys), previous research on behavioral choice has focused primarily on how individuals chose substance-related versus substance-free activities in the past. More recently, laboratory studies have used the MCP to examine behavioral choice in the moment. However, survey research assessing how participants make decisions in the present appeared to be lacking. As suggested by Little and Correia (2006), participants may be using a different decision making process when choosing between reinforcers in the here and now. The present study was designed to investigate the influence of reinforcement from substance-related and substance-free activities on choice in the moment by assessing the relationships between the ARSS-SUV and the MCP. It was hypothesized that the ARSS-SUV could be used to predict the crossover point on the MCP. Specifically, it was hypothesized that participants who reported greater reinforcement from substance-related activities, relative to total reinforcement obtained from substance-related and substance-free activities, would have higher crossover points on the MCP. It was also hypothesized that the MCP would be related to the Daily Drinking Questionnaire (DDQ; Collins, Parks, & Marlatt, 1985) and the Rutgers Alcohol Problem Inventory (RAPI; White & Labouvie, 1989), which measured alcohol use and behaviors associated with alcohol use problems.

Methods

Participants

A total of 340 undergraduates from a large Southeastern public university participated in the online study. However, students who appeared to have difficulty following the MCP instructions (i.e., provided multiple crossover points; n = 9) and those who completed the survey quicker than two standard deviations below the mean duration (n = 34) were removed. In addition, only participants who reported at least one occasion of alcohol use over the past 28 days were used in the analyses, resulting in a sample of 237. The average age of the sample was 20.46 years (*SD* = 1.71). The sample was composed of 73% women and 42% were affiliated with a Greek organization. The majority of participants were Caucasian (93%), but other racial ethnicities were also represented in the same (African American/Black = 5.9%, Asian = 3.4%, American Indian/Native American = 3%, Native Hawaiian/Pacific Islander = 0.8%, and other = 5.1%; percentages sum to greater than 100% because participants could endorse multiple categories). Participants were compensated for their participation with extra credit in their psychology courses.

Procedure

All procedures were approved by the university's Institutional Review Board (IRB). All study materials were administered online via the SONA system. Participants read an informed consent letter that indicated that completion of the measures implied that they were giving their informed consent. Participants then completed the measures described in the next section.

Measures

Daily Drinking Questionnaire (DDQ): The DDQ (Collins, Parks, & Marlatt, 1985) is a self-report questionnaire that asks participants to report their drinking rates during the past 28 days. Participants report the "number of drinks" and "number of hours drinking" during each day of a *typical week* and *heaviest drinking week* in the previous 28 days. The DDQ is a widely used measure of drinking behavior and has been shown to have good psychometric properties, with correlations ranging from .65 and .72 when compared to other substance use self-monitoring reports (Kivlahan, Marlatt, Fromme, Coppel, & Williams, 1990).

Rutgers Alcohol Problem Inventory (RAPI): The RAPI (White & Labouvie, 1989) is a measure assessing behaviors that are associated with alcohol-related problems over a 3 year period. The measure consisted of 23 items rated on a 5-point Likert scale ranging from 0 (*never*) to 4 (*more than 10 times*). The measure included items such as "missed out on other things because you spent too much money on alcohol" and "went to work or school high or drunk." The measure was developed with adolescents between ages 12 to 21 so it is an appropriate measure to use with a college student sample. The modified version of the RAPI (assessing alcohol-related problems over a 28 day period) showed adequate psychometric properties when used with a college student sample (internal consistency = .84; Correia, Carey, & Borsari, 2002). While measuring alcohol-related problems was not a goal of this study, the RAPI was used to describe the sample and provide support for the other measures of substance use.

Adolescent Reinforcement Survey Schedule – Substance Use Version (ARSS-SUV): Murphy, Correia, Colby, and Vuchinich (2005) modified the Adolescent Reinforcement Survey Schedule (ARSS; Holmes, Sakano, Cautela, & Holmes, 1991) to measure reinforcement derived from substance-related and substance-free activities in the past month among college students.

The measure consists of 45-items rated on 5-point Likert scales; frequency ratings ranged from 0 (*0 times over the past 30 days*) to 4 (*more than once per day*); enjoyment ratings ranged from 0 (*unpleasant or neutral*) to 4 (*extremely pleasant*). The frequency and enjoyment ratings are multiplied together to obtain the reinforcement derived from the activity, which ranges from 0-16. A total of 5 subscales were derived: 1) Dating Activity (9-items; internal consistency = .86-.90), 2) Peer Interaction (14-items; internal consistency = .87-.90), 3) Sibling/Family Interaction (7-items; internal consistency = .81-.83), 4) Sexual Activity (4-items; internal consistency = .84-.87), and 5) School Activity (3-items; internal consistency = .81-.82). The mean cross product of each subscale represents the mean reinforcement derived from that domain. Both the substance-related and substance-free cross products will be computed for each subscale. Total scores from all substance-related items (substance-related total) and all substance-free items (substance-free total) will also be computed. The total reinforcement ratio will be computed from the equation: (substance-related total) / (substance-related total + substance-free total). The ratio will range from 0 to 1, with higher ratios indicating more reinforcement derived from substance-related activities. In previous research both total scores have shown high internal consistency (substance-free cross product = .90, substance-related cross product = .92).

Survey version of the Multiple-Choice Procedure (MCP): The MCP has been adapted from Griffiths, Troisi, Silverman, and Mumford (1993) to measure the RRV of substance use. Participants will be asked to make hypothetical choices between a set amount of alcohol (12 ounces of beer, 5 ounces of wine, or a mixed drink with 1 ounce of liquor) and 40 escalating monetary values ranging from $0.50 to $20; the monetary values will escalate at $0.50 increments. The value of interest will be the crossover point, or the point where the participant

chooses the monetary reward over the set amount of alcohol. The crossover point is considered the RRV of the alcohol; higher crossover points indicate higher RRV.

Results

Data Analyses Plan

Correlation and regression analyses were conducted to analyze the main hypothesis (i.e. ARSS-SUV predicts MCP). As previously noted, the MCP should also be related to the DDQ and RAPI. Higher reinforcement scores for substance-related activities on the ARSS-SUV should predict higher crossover points on the MCP. Likewise, higher reinforcement scores for substance-free activities on the ARSS-SUV should predict lower crossover points on the MCP. Finally, higher scores on the ARSS-SUV reinforcement ratio should predict higher crossover points. As a first step, bivariate correlations were examined to assess the relationship between the ARSS-SUV scores and the MCP crossover point. Next, a step-wise regression was conducted to assess the contribution of each ARSS-SUV variable in the prediction of the MCP crossover point. Gender was entered as the first step. Alcohol use was entered as the second step. Substance-related and substance-free reinforcement was entered as the third step. The reinforcement ratio was entered as the fourth and final step. It was hypothesized that variables from the ARSS-SUV would account for unique variance in MCP crossover points above the contributions of gender and alcohol use.

Correlation Analyses

A series of correlations were conducted to determine the relationship between MCP crossover point, DDQ, RAPI, and ARSS-SUV scores (see Table 1). The MCP crossover point was positively correlated with only binge drinking ($r = .136$, $p < .05$), which suggested that

participants who drank more heavily had higher RRV for alcohol. Evidence for the main hypothesis (i.e., higher MCP crossover point predicts higher ARSS-SUV ratio) was not found, ($r = 0$, $p > .05$), which suggested that participants who had higher MCP crossover points did not also enjoy substance-related activities more or participate in them more frequently than substance-free activities. However, the ARSS-SUV ratio was significantly correlated positively with DDQ ($r = .274$, $p < .01$), RAPI ($r = .198$, $p < .01$), and binge drinking ($r = .324$, $p < .01$). These significant correlations suggested that participants who drank more, had more negative consequences as a result of alcohol use, and drank more heavily during each occasion perceived substance-related activities as more reinforcing compared to substance-free activities.

Regression Analyses

Step-wise regression analyses were conducted to determine if the ARSS-SUV contributed unique variance in MCP crossover points above the contributions of gender and alcohol use. Results of the step-wise regression are presented in Table 2. In the first step, gender was entered as the predictor of MCP crossover point. Gender was not significant, accounting for 1.5% of the variance [$F(1, 235) = 3.552$, $p = .06$]. The second step included gender and added DDQ (i.e., total drinks in the last 28 days) and binge drinking. With the addition of these variables, the model accounted for 5.2% of the variance in MCP crossover point [$F(2, 233) = 4.27$, $p = .01$], with only binge drinking serving as a significant independent predictor. The third step included the aforementioned variables and added substance-related and substance-free reinforcement variables from the ARSS-SUV. With the addition of these variables, the model accounted for 5.9% of the variance in MCP crossover point [$F(2, 231) = 2.92$, $p > .05$], with only binge drinking serving as a significant independent predictor. The final step added the ARSS-SUV substance reinforcement ratio. The final model accounted for 7% of the variance [$F(1, 230) =$

2.88, $p > .05$], with only binge drinking serving as a significant independent predictor. The regression analyses suggested that the ARSS-SUV did not account for unique variance in MCP crossover points as predicted; only binge drinking accounted for unique variance.

Discussion

The MCP has been used in previous studies to measure the relative reinforcing value of different drugs. The current study was designed to assess the predictability of MCP crossover points using the substance-related reinforcement ratio of the ARSS-SUV. It was hypothesized that participants who displayed a stronger preference for alcohol over money on the MCP would also show a stronger preference towards alcohol-related activities in their natural environment. The results indicated that the ARSS-SUV did not correlate with the MCP nor did it account for unique variance in the MCP above the contribution of gender, alcohol use, and consequences of alcohol use. In other words, participants who reported more frequently engaging in and enjoying alcohol-related activities compared to alcohol-free activities did not report correspondingly high crossover points on the MCP.

Inconsistent with previous behavioral economic studies, the MCP crossover point was only correlated with binge drinking and not with the other measures of substance use (Little & Correia, 2006). Specifically, Little and Corriea (2006) found significant correlations between the laboratory (*r*'s ranged from .44 to .59, all *p*'s < .05) and survey (*r*'s ranged from .21 to .42, all *p*'s < .001) versions of the MCP with other measures of alcohol use (i.e., DDQ, RAPI, and binge drinking). While this appeared to suggest a problem with the data, the substance-related ratio of the ARSS-SUV was significantly correlated with number of drinks consumed in the last 28 days (i.e., DDQ), alcohol-related problems (i.e., RAPI), and binge drinking. This suggested that there

wasn't a problem with the data, but perhaps the MCP just didn't translate well to an online format.

The current study was the first to use a survey version of the MCP in an online format. Previous studies on the relative reinforcing value of alcohol have relied on paper-and-pencil surveys or laboratory-based measures (Benson, Little, Henslee, & Correia, 2008; Little & Correia, 2006; Murphy, Correia, Colby, & Vuchinich, 2005). Online studies have become increasingly popular among researchers because they generally attract more participants, are more cost effective, and are available around the clock. Disadvantages include variable environments, biased samples, and unmonitored participants (Dandurand, Shultz, & Onishi, 2008; Riva, Teruzzi, & Anolli, 2003). Perhaps the survey version of the MCP did not translate into an online format because the instructions were more complex relative to the instructions for the other alcohol measures. Dandurand, Shultz, & Onishi (2008) suggested that laboratory participants have the benefit of receiving extra information and/or instructions should they require them. The participants of the current study weren't given the opportunity to ask questions before completing the measures so perhaps clearer instructions for the survey version of the MCP would benefit future online studies.

A limitation of the current study was that it didn't follow some of the specific guidelines for online research provided by Michalak and Szabo (1998). For example, pilot testing for the study should have been conducted with students who weren't already familiar with the measures so the instructions could be more thoroughly evaluated for clarity. Also, answer-reliability techniques (e.g., reverse coding of items, consistency in responding) should have been used to ensure students had understood and were following the instructions. Future studies should consult Michalak and Szabo's (1998) guidelines for conducting online research as the author's

suggestions may provide some assistance in bridging the gap between laboratory and online formats.

Another limitation of the current study was that the measures were only administered in an online format. Given that this was the first study to use the survey version of the MCP online, it would have been useful to have a laboratory-based format as well so that the results could be compared. Measurement invariance (Millsap, 1995; Byrne & Watkins, 2003) could be a potential confounding variable because the measures originated in laboratory and paper-and-pencil based formats so the use of an online format may change the construct being measured. LaBrie, Earleywine, Lamb, and Sheleky (2006) compared paper-and-pencil questionnaires with electronic-keypad responses in group assessments of alcohol consumption and found the formats to be highly correlated (r's ranged from .19 to .79, all p's < .05). Similarly, Khadjesari et al. (2009) compared face-to-face interviews with online measures of alcohol consumption and found a high correlation (r = .97, p < .05) between the two formats. Future studies should test both formats concurrently to determine if any differences exist between laboratory-based and online versions of the MCP. Finally, the sample consisted of primarily Caucasian female participants from a large Southeastern university. Future studies should recruit more diverse samples of college and non-college students to determine the validity of the MCP measure with different populations.

While previous studies have used traditional paper-and-pencil measures to assess alcohol-free and alcohol-related reinforcement, the current study attempted to use an online format to predict choice in the moment. However, the main hypothesis (i.e., ARSS-SUV substance-related ratio contributes unique variance in predicting MCP crossover points above that contributed by gender and substance use) was not supported, presumably because the survey version of the

MCP was not successfully transitioned into an online format. Online studies can be more cost- and labor-effective than traditional assessment methods but special attention must be paid to ensuring relative similarity between the different presentation formats. The results do offer additional support for the behavioral economic model of substance use. Consistent with previous studies, these findings indicate that participants who reported more reinforcement from alcohol-related activities relative to alcohol-free activities consumed more alcohol and had more negative consequences. These findings can guide substance abuse treatment, where clients are encouraged to increase their participation in reinforcing substance-free activities (Murphy, Correia, & Vuchinich, 2009).

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Table 1
Correlations of Alcohol Related Variables

	MCP	DDQ	RAPI	Binge	Substance-Free Cross Product	Substance-Related Cross Product	ARSS-SUV Ratio
MCP	1	0.002	0.103	0.136*	-0.005	-0.035	0.000
DDQ		1	.530**	.739**	-0.061	.224**	.274**
RAPI			1	.525**	-0.066	.136*	.198**
Binge				1	-0.052	.279**	.324**
Substance-Free Cross Product					1	.388**	-0.111
Substance-Related Cross Product						1	.815**
ARSS-SUV Ratio							1

N = 237
* $p < .05$
** $p < .01$

Table 2

Step-wise Regression Analyses of MCP Crossover Point

Predictor	B	SEβ	β	T	R^2 Change	Model Sig.
Step 1					0.015	0.06
Gender	1.48	0.785	0.122	1.89		
Step 2					0.037*	0.006**
Gender	1.48	0.858	0.123	1.73		
DDQ	-0.069	0.047	-0.15	-1.47		
Binge	0.368	0.118	0.275	2.88**		
Step 3					0.007	0.014*
Gender	1.73	0.883	0.132	1.81		
DDQ	-0.065	0.047	-0.141	-1.38		
Binge	0.368	0.121	0.279	3.05**		
Substance-Related	-0.005	0.004	-0.092	-1.26		
Substance-Free	0	0.005	0.007	0.097		
Step 4					0.01	0.010*
Gender	1.73	0.884	0.143	1.96		
DDQ	-0.064	0.047	-0.14	-1.37		
Binge	0.362	0.12	0.293	3.01**		
Substance-Related	-0.022	0.011	-0.391	-1.96		
Substance-Free	0.011	0.008	0.153	1.32		
ARSS-SUV Ratio	10.55	6.55	0.297	1.61		

* $p < .05$

** $p < .01$