

# Using Behavioral Theories of Choice to Predict Drinking Outcomes Following a Brief Intervention

James G. Murphy  
Auburn University

Christopher J. Correia  
Johns Hopkins University

Suzanne M. Colby  
Brown University

Rudy E. Vuchinich  
Auburn University

Behavioral theories of choice predict that substance use is partly a function of the relative value of drugs in relation to other available reinforcers. This study evaluated this hypothesis in the context of predicting drinking outcomes following an alcohol abuse intervention. Participants ( $N = 54$ , 69% female, 31% male) were college student heavy drinkers who completed a single-session motivational intervention. Students completed a baseline measure of substance-related and substance-free activity participation and enjoyment. Only women showed a significant reduction in drinking at the 6-month follow-up, and the ratio of substance-related to substance-free reinforcement accounted for unique variance in their drinking outcomes. Women who at baseline derived a smaller proportion of their total reinforcement from substance use showed lower levels of follow-up drinking, even after the authors controlled for baseline drinking level. Male and female participants who reduced their drinking showed increased proportional reinforcement from substance-free activities.

*Keywords:* college students, alcohol, intervention, behavioral economics, behavioral theories of choice

National surveys indicate that approximately 40% of U.S. college students report at least one heavy drinking episode during a given 2-week period (O'Malley & Johnston, 2002). Every year, large numbers of college students also experience alcohol-related health and social problems, including risky sexual behavior, physical or sexual assault, and serious accidents or fatalities (Hingson, Heeren, Zakocs, Kopstein, & Wechsler, 2002). Accordingly, prevention and treatment of young adult alcohol abuse has become a significant research and public health priority (Ham & Hope, 2003; National Institute on Alcohol Abuse and Alcoholism, 2002).

A number of studies have found that brief motivational interventions are well received by young adult drinkers and result in reductions in alcohol consumption and related

harm that exceed various control conditions (Baer, Kivlahan, Blume, McKnight, & Marlatt, 2001; Monti et al., 1999; Murphy et al., 2001). However, mean levels of consumption remain relatively high at follow-up, and a substantial percentage of students do not show clinically significant improvement (Larimer & Cronce, 2002; Roberts, Neal, Kivlahan, Baer, & Marlatt, 2000). A potential limitation of existing brief interventions is that they focus exclusively on increasing intrinsic motivation to decrease substance use but neglect more global environmental and behavioral variables that might influence drinking patterns. The present study uses a behavioral theories of choice (BTC; Herrnstein, 1970; Premack, 1965; Rachlin, Green, Kagel, & Battalio, 1976) framework to examine the influence of reinforcement variables on drinking outcomes following a brief intervention.

BTC were developed to account for choice between multiple reinforcers, which makes them ideally suited for predicting drug use in real world situations where there are many available activities (McDowell, 1988; Vuchinich & Tucker, 1996). A key advantage of BTC is their potential to predict the conditions in which drugs will be highly preferred or valued reinforcers (Bickel, Madden, & Petry, 1998; Vuchinich & Heather, 2003). In laboratory settings, *reinforcing value* is quantified by the amount of behavior (e.g., lever presses) maintained by a reinforcer. According to BTC, reinforcing value is critically influenced by the environmental context of other available reinforcers (Rachlin et al., 1976). High rates of drug use are most likely in contexts devoid of substance-free sources of reinforcement, and drug use will generally decrease if access to alternative

---

James G. Murphy and Rudy E. Vuchinich, Department of Psychology, Auburn University; Christopher J. Correia, Department of Psychiatry and Behavioral Sciences, Johns Hopkins University; Suzanne M. Colby, Center for Alcohol and Addiction Studies, Brown University.

Christopher J. Correia is now at Department of Psychology, Auburn University. Rudy E. Vuchinich is now at the Department of Psychology, University of Alabama at Birmingham.

This research was supported in part by a U.S. Department of Education Model Programs grant to Polly Dunn, Rudy E. Vuchinich, and James G. Murphy.

Correspondence concerning this article should be addressed to James G. Murphy, who is now at the Center for Alcohol and Addiction Studies, Box GBH, Brown University, Providence, RI 02912. E-mail: James\_Murphy@Brown.edu

reinforcers is increased (Higgins, Heil, & Plebani-Lussier, 2003). These predictions have received considerable empirical support through controlled laboratory research with a variety of species (e.g., rats, monkeys, humans), drugs (e.g., cocaine, ethanol, heroin, nicotine), and nondrug reinforcers (e.g., food, money, saccharin, video game playing; see reviews by Carroll, 1996; Higgins et al., 2003; Vuchinich & Tucker, 1988).

Herrnstein's (1970) matching law provides a means of quantifying the reinforcing value of qualitatively different reinforcers. The matching law [ $\log B_1/B_2 = a(\log r_1/r_2) + \log c$ ] states that the proportional resource allocation directed toward available activities ( $B_1/B_2$ ) equals the proportion of reinforcement obtained from the activities ( $r_1/r_2$ ). The  $a$  and  $c$  parameters reflect sensitivity to reinforcement frequency and bias for one or the other alternative, respectively (Baum, 1974). The matching law has accurately predicted choice in numerous laboratory studies involving a variety of species and reinforcers (Mazur, 1991), including studies examining drug administration (Anderson & Woolverton, 2000). Although behavior–reinforcement relations are more difficult to quantify in the natural environment (Vuchinich & Tucker, 1996), proportional resource allocation and enjoyment related to drugs relative to drug-free reinforcers have been used to measure the availability and reinforcing value of drugs relative to other reinforcers in the individual's environment (i.e., *relative reinforcing value*).

Relative reinforcing value might provide a novel index of drug problem severity (Correia & Carey, 1999; Tucker, Vuchinich, & Rippins, 2002; Vuchinich & Tucker, 1996). For an individual who engages in a number of reinforcing activities other than substance use, an addictive behavior pattern may decrease after a relatively minor increase in substance-free reinforcement, for example, after beginning an exercise regimen or a relationship with an abstainer. However, if substance use accounts for a large proportion of total reinforcement and there are few valued alternatives, the individual may require more intensive interventions to increase drug-free sources of reinforcement (e.g., Higgins & Silverman, 1999). Thus, the relative reinforcing value of drugs and alcohol may provide a means of discriminating among individuals with similar substance use patterns but different levels of risk on the basis of their overall pattern of resource allocation and obtained reinforcement (Murphy & Vuchinich, 2002).

For example, a recent prospective study of individuals attempting to resolve an alcohol problem without treatment used proportional money allocation to measure the relative reinforcing value of alcohol (Tucker, Vuchinich, & Rippins, 2002). The amount of discretionary money allocated to alcohol, relative to savings, was presumed to measure preference for the immediate reinforcement derived from alcohol versus the delayed reinforcement associated with saving money. The authors were interested in quantifying preference for alcohol relative to savings because a number of studies have suggested that sharp discounting of delayed rewards is a core feature of substance abuse (e.g., Baker, Johnson, & Bickel, 2003; Bickel & Marsch, 2001; Green &

Myerson, 2004). The results indicated that relative resource allocation to alcohol predicted drinking outcomes whereas traditional measures of consumption and dependence did not. Participants who relapsed within the 2-year follow-up period allocated a greater proportion of their money to alcohol in the year prior to the attempted resolution, even though they drank similar amounts of alcohol.

Several recent studies have used reinforcement survey instruments such as the Pleasant Events Schedule (MacPhillamy & Lewinsohn, 1982) to measure behavior allocation and reinforcement across substance-related and substance-free activities (Correia & Carey, 1999). Reinforcement survey instruments measure the frequency of occurrence and subjective pleasure of a variety of potentially rewarding activities. A study with college students showed that substance use was positively related to substance-related reinforcement and negatively related to substance-free reinforcement (Correia, Simons, Carey, & Borsari, 1998). The reinforcement ratio, which is based on the matching law and designed to measure the reinforcement received from substance-related activities relative to total reinforcement (i.e., relative reinforcing value), accounted for unique variance in substance use beyond substance-related reinforcement. These results were replicated with a sample of psychiatric patients (Correia & Carey, 1999) and suggest that the relative reinforcing value of substance use may be an important measure of strength of preference for drugs and alcohol (Murphy & Vuchinich, 2002). Other studies have found that college student heavy drinkers (Correia, Carey, Simons, & Borsari, 2003) and adult cocaine abusers (Van Etten, Higgins, Budney, & Badger, 1998) report lower reinforcement from several categories of nonsocial activities than do control participants.

The present study examined the prospective relations between reinforcement variables and alcohol use among a sample of heavy drinking college students who completed a brief alcohol intervention (Murphy et al., 2004). We hypothesized that the reinforcing value of substance use relative to other activities would predict students' drinking outcomes. Students who derived a larger proportion of their total reinforcement from substance use were predicted to show smaller drinking reductions than were students with greater proportional reinforcement from substance-free activities. We were also interested in identifying the impact of drinking reductions on reinforcement from substance-free activities.

## Method

### *Participants*

Potential participants were recruited through an extra-credit screening available to undergraduate students enrolled in psychology and communications courses at a large public university in the southeastern United States. After completing an informed consent form approved by the university's institutional review board, student volunteers ( $N = 331$ ) completed the screening questionnaires in exchange for 1 hr of course extra credit. The majority (77.6%) of screened students were women, which is consistent with enrollment patterns in psychology and communications courses. The

screening packet contained the baseline assessment measures described below. Participants who were in the upper 20% of the weekly drinking distribution for their gender and had reported having at least 1 alcohol-related problem in the past month were invited to participate in the study. Research staff contacted eligible participants by phone and described the study procedures. Students were told that they would receive 1 hr of extra course credit for their participation in a brief alcohol intervention and that they would have the opportunity to earn \$15.00 for participation in a 6-month follow-up assessment.

There were 54 students who qualified for the study and agreed to participate. An additional 13 participants qualified for the study but were not included because they could not be contacted (i.e., did not return phone calls) or missed two or more intervention appointments. There were no significant differences on demographic or drinking variables, including scores on the Readiness to Change Questionnaire (Heather, Rollnick, & Bell, 1993), between eligible participants who completed the intervention phase and those who did not ( $ps > .15$ ).

Participants were randomized to one of two brief intervention conditions that included personalized drinking feedback (PDF). PDF interventions are intended to motivate students to decrease levels of alcohol consumption and to avoid alcohol-related negative consequences (e.g., Dimeff, Baer, Kivlahan, & Marlatt, 1999), and research suggests that they are often associated with significant drinking reductions (Larimer & Cronce, 2002; Murphy et al., 2001). The goal of the intervention aspect of the study was to compare the efficacy of PDF delivered during a motivational interviewing counseling session (W. R. Miller & Rollnick, 2002) with PDF delivered without a counseling session (see Murphy et al., 2004, for more details about the interventions).

The mean age of the 54 participants who completed an intervention was 19.94 years ( $SD = 1.22$ , range = 18.00–25.00); 69% were women and 31% were men, 94% were Caucasian, 2% were African American, 2% were Asian American, 2% indicated "other," 74% were sophomores or juniors, and 52% belonged to a fraternity or sorority. Relative to the overall undergraduate population, treated participants were more likely to be Caucasian and to belong to a fraternity or sorority, which is as expected because these are risk factors for problem drinking (O'Malley & Johnston, 2002; Wechsler et al., 2002). Participants averaged 3.85 ( $SD = 1.27$ ) drinking days per week, 2.98 ( $SD = 1.07$ ) heavy drinking days per week, and 24.12 ( $SD = 8.74$ ) total drinks per week on the Daily Drinking Questionnaire (DDQ; Collins, Parks, & Marlatt, 1985). There were no significant differences between the intervention groups on any baseline drinking or demographic variables ( $ps \geq .10$ ).

## Measures

*Measures of alcohol consumption and alcohol-related problems.* Alcohol measures were administered at preintervention (i.e., screening) and at the 6-month follow-up. Total drinks per week and frequency of heavy drinking per week were assessed with the DDQ, which has been used frequently with college students and is highly correlated with self-monitored drinking reports (Kivlahan, Marlatt, Fromme, Coppel, & Williams, 1990). Heavy drinking was defined as four or more drinks in an occasion for a woman and five or more drinks in an occasion for a man (Wechsler et al., 2002). E. T. Miller et al. (1998) found high ( $r = .93$ ) 1-week test-retest correlations for the DDQ estimate of drinks per week. Alcohol-related problems common to college students (e.g., missing class, getting into fights or arguments, driving after drinking) were assessed with the Rutgers Alcohol Problem Inven-

tory (RAPI), a reliable and internally consistent (Borsari & Carey, 2000) instrument that accurately discriminates between young adults with and without a *Diagnostic and Statistical Manual of Mental Disorders* (3rd ed., rev.; American Psychiatric Association, 1987) alcohol-related diagnosis (White & Labouvie, 1989). This version of the RAPI assesses the occurrence of 23 alcohol-related problems over the prior 30 days. Scores can range from 0 to 23.

*Illicit drug use.* We asked participants to report the number of days in which they had used any illicit drugs during the past 30 days.

*Reinforcement variables.* We used a modified version of the Adolescent Reinforcement Survey Schedule (ARSS; Holmes, Sakano, Cautela, & Holmes, 1991), the ARSS-Substance Use Version (ARSS-SUV), to measure past-month reinforcement from substance-related and substance-free activities. Past-month activity frequency and enjoyment ratings were made with 5-point Likert scales (0–4; Correia et al., 2003). Frequency ratings ranged from 0 (*0 times over the past 30 days*) to 4 (*more than once per day*), and enjoyment ratings ranged from 0 (*unpleasant or neutral*) to 4 (*extremely pleasant*). The frequency and enjoyment ratings are multiplied to obtain a cross-product score (range = 0–16), which reflects reinforcement derived from the activity (Correia et al., 2003; MacPhillamy & Lewinsohn, 1982). Several studies by MacPhillamy and Lewinsohn (1982) have indicated that reinforcement surveys provide reliable estimates of participation in rewarding activities that are consistent with peer and observer reports and subsequent choice behavior. We modified the ARSS according to the modifications that Correia et al. (2003) made to the Pleasant Events Schedule. First, we administered each item twice to obtain substance-related and substance-free frequency, pleasure, and cross-product ratings. For example, participants rated (a) how often they talked to the opposite sex while sober and how enjoyable they found these experiences and (b) how often they talked to the opposite sex after using drugs or alcohol and how enjoyable they found these experiences. Second, we omitted two subscales that directly measured drug use so as to avoid artificially inflating correlations with drug use measures (Correia et al., 2003). We also eliminated two subscales that were not relevant to the present analysis (e.g., Romantic Fantasy Activity and Home Avoidance Activity) and six items that were either redundant (e.g., "sexual intercourse" and "sexual intercourse in a car") or dated (e.g., "go to a drive-in").

The ARSS-SUV contained 45 items and five internally consistent (coefficient  $\alpha$ s = .81–.90) substance-free and substance-related subscales (see Table 1 for a list of all subscales, alpha values, and items). These five subscales were retained from the original, factor analytically derived ARSS subscales (Holmes et al., 1991). The Leisure subscale showed low internal consistency (substance-free  $\alpha = .36$ ; substance-related  $\alpha = .68$ ), so we counted the items toward the total score but did not compute Leisure subscale scores. The average cross product from the items in each subscale represents the average reinforcement obtained from that domain. We computed both substance-related and substance-free cross products for each subscale. The other variables of interest were the average reinforcement from all substance-free activities (substance-free total), the average reinforcement from all substance-related activities (substance-related total), and the total reinforcement ratio, that is, substance-related total/(substance-free total + substance-related total). The ratio ranges from 0 to 1, with higher scores indicating a greater proportion of reinforcement from substance-related activities relative to substance-free activities (Correia et al., 1998).

Table 1  
Internal Consistency of the ARSS–SUV

ARSS–SUV factor	Internal consistency (coefficient alpha)		Items
	Substance-free cross product	Substance-related cross product	
Dating Activity (9 items)	.86	.90	Go places with opposite sex, talk with opposite sex, be noticed by opposite sex, go out to eat with opposite sex, flirt with opposite sex, get compliments from opposite sex, date opposite sex, interact with opposite sex, kiss opposite sex
Peer Interaction (14 items)	.90	.87	Go out to eat with friends, talk with same sex, go places with friends, go for walk with friends, talk on phone with friends, go to parties with friends, talk with friends about day's activities, get compliments from same sex, ride around in car with friends, meet new people my age, go hang out where friends meet, interact with people of own age and sex, receive E-mails or letters from friends, write E-mail or letters to friends
Sibling/Family Interaction (7 items)	.81	.83	Go places with siblings or family members, talk with siblings or family members, go out to eat with siblings or family members, tell secrets to siblings or family members, talk with siblings or family members about day's events, spend weekends/vacations with siblings/family, discuss school with siblings/family
Sexual Activity (4 items)	.87	.84	Heavy petting with opposite sex, sexual intercourse with opposite sex, light petting with opposite sex, weekends/vacations with opposite sex
School Activity (3 items)	.82	.81	Going to school, studying, doing chores at home
Total score (45 items)	.90	.92	<i>Other items included in total score:</i> participate in sports, read a book, go to plays, ride a bicycle, go to work, stay home and relax, go to a movie, play a musical instrument

*Note.* We created the ARSS–SUV using subscales and items from the Adolescent Reinforcement Survey Schedule (Holmes et al., 1991). See text for details. ARSS–SUV = Adolescent Reinforcement Survey Schedule—Substance Use Version.

## Results

### Data Analysis Plan

The primary goal of the analysis was to test the hypothesis that individuals who obtain a larger proportion of their total reinforcement from substance use will show smaller drinking reductions following a brief alcohol intervention. A secondary goal was to determine the impact of drinking reductions on levels of substance-free reinforcement and proportional reinforcement from substance use (i.e., reinforcement ratio). We hypothesized that students who successfully reduced their drinking would show increases in substance-free reinforcement and decreases in proportional reinforcement obtained from substance use. We were also interested in describing the more general relations between reinforcement variables, drinking variables, gender, and fraternity or sorority membership. Finally, we conducted exploratory analyses that examined the relations between reinforcement variables and illicit drug use.

### Data Distributions

The distributions for the ARSS–SUV total reinforcement ratio score, DDQ drinks per week, RAPI alcohol-related problems, and the frequency of drug use scores were square-root transformed prior to analyses to correct for significant (positive) skewness and kurtosis.

### Demographic Differences in Alcohol Consumption and Reinforcement Variables

We conducted a series of analyses of variance (ANOVAs) to examine the influence of demographic variables on alcohol consumption and reinforcement variables. Men reported significantly higher levels of baseline weekly drinking than did women,  $F(1, 50) = 8.30, p < .01$ , but there were no gender differences in levels of alcohol-related problems ( $p > .20$ ). Table 2 shows descriptive data on the reinforcement variables for men and women. Men showed significantly higher levels of substance-free school reinforcement,  $F(1, 50) = 4.17, p < .05$ , and substance-related family reinforcement,  $F(1, 50) = 9.06, p < .01$ . Men and women showed similar reinforcement ratio scores ( $M_s = .36$  and  $.35$ , respectively).

Students who were members of fraternities or sororities (52% of sample) reported levels of drinking similar to those of students who were not in Greek organizations ( $p > .50$ ), but Greek students reported higher levels of substance-free reinforcement from dating,  $F(1, 50) = 9.06, p < .01$ ; peer interactions,  $F(1, 50) = 11.51, p < .01$ ; and total substance-free reinforcement,  $F(1, 50) = 13.79, p < .01$ . Greek members also had significantly lower total reinforcement ratio scores,  $F(1, 50) = 9.34, p < .01$ , which suggests that substance use accounts for a smaller proportion of total reinforcement for heavy drinkers who are members of Greek organizations. A multivariate ANOVA found that

Table 2  
Descriptive Data on ARSS–SUV Reinforcement Variables

ARSS–SUV reinforcement scale	Substance-free cross product				Substance-related cross product			
	Men		Women		Men		Women	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Peer Interaction	7.47	2.81	7.93	3.10	4.57	2.64	4.36	1.64
Dating	9.06	2.93	8.64	3.07	6.55	3.40	6.04	6.19
Sexual Activity	7.16	3.72	5.17	3.51	5.92	3.50	4.79	3.15
School	6.31	3.79	4.13*	3.42	1.15	2.35	0.57	1.41
Family	3.84	1.65	4.42	2.55	1.40	1.90	0.34*	0.62
Total	6.50	1.69	6.08	1.84	3.88	2.16	3.20	1.15

Note. ARSS–SUV = Adolescent Reinforcement Survey Schedule—Substance Use Version.  
\*  $p < .05$

there were no significant Gender × Greek Status interactions on any reinforcement variables ( $ps > .20$ ). There were no significant age or year in school differences on any of the drinking or reinforcement variables ( $ps > .20$ ).

*Concurrent Relations Between Reinforcement Variables and Drinking Variables*

We conducted a series of correlations to determine whether baseline reinforcement variables were related to baseline drinking variables. Reinforcement from substance-related activities was positively related to weekly drinking levels ( $r = .348, p < .01$ ). The reinforcement ratio was positively related to weekly drinking ( $r = .264, p < .06$ ) and alcohol-related problems ( $r = .370, p < .01$ ). Substance-free reinforcement from dating ( $r = -.349, p < .01$ ), peer interactions ( $r = -.293, p < .04$ ), and total substance-free reinforcement ( $r = -.317, p < .02$ ) were negatively related to levels of alcohol problems.

We conducted exploratory analyses to determine whether these relations were similar across men and women (see Table 3). Women with higher levels of peer, dating, and total substance-free reinforcement showed lower levels of alcohol-related problems. Substance-free reinforcement

scales were not significantly associated with women’s drinking levels, but the reinforcement ratio was significantly correlated with rates of drinking and alcohol-related problems. Among men, substance-free peer interactions and total substance-free reinforcement variables showed non-significant, positive relations to baseline drinking (see Table 3).

*Drinking Outcomes*

The primary drinking outcomes have been reported previously (Murphy et al., 2004). Ninety-four percent of treated participants completed the 6-month follow-up. The 3 participants who did not complete the follow-up were excluded from the outcome analyses. A repeated measures ANOVA revealed a significant effect for time on reported drinks per week,  $F(1, 47) = 9.91, p < .01$ , that was qualified by a significant Time × Gender interaction,  $F(1, 47) = 4.37, p < .04$ . Contrast analyses indicated that women lowered their weekly drinking from baseline to follow-up,  $F(1, 34) = 30.86, p < .01$ , but men did not ( $p > .50$ ). There were no treatment group differences in drinking outcomes. Across both groups, women decreased their weekly drinking from 22.34 ( $SD = 8.13$ ) drinks at baseline to 15.41 ( $SD = 8.55$ ) drinks at follow-up. Men drank 29.47 ( $SD = 8.33$ ) drinks per week at baseline and 28.06 (11.86) drinks per week at follow-up. The ANOVA on reports of alcohol-related problems showed no significant effect for time and no significant Time × Group interaction ( $ps > .50$ ). Greek membership status was unrelated to drinking outcomes.

*Relations Between the Reinforcement Ratio and Drinking Outcomes*

We used hierarchical regression analyses to determine whether the proportion of total reinforcement obtained from substance use at baseline (i.e., reinforcement ratio) predicted drinking outcomes after we controlled for baseline drinking levels. Because women showed greater drinking reductions than did men, which could influence the predictive ability of the reinforcement variables, and because of the gender differences in baseline correlations, we included

Table 3  
Correlations Between Baseline ARSS–SUV Reinforcement Variables and Baseline Drinking Variables

ARSS–SUV reinforcement score	Men ( $n = 16$ )		Women ( $n = 35$ )	
	Weekly drinking	Alcohol problems	Weekly drinking	Alcohol problems
Substance Free subscale				
Peer Interaction	.443	.251	-.135	-.508**
Dating	.037	-.336	-.05	-.350*
Sexual activity	.350	-.148	-.162	-.188
School	.307	.323	-.022	-.144
Family	.163	.274	.025	-.015
Substance Free (total)	.421	.099	-.135	-.471**
Substance Related (total)	.361	.293	.278	.143
Reinforcement ratio	.154	.203	.338*	.462**

Note. ARSS–SUV = Adolescent Reinforcement Survey Schedule—Substance Use Version.  
\*  $p < .05$ . \*\*  $p < .01$

a Gender  $\times$  Reinforcement Ratio interaction term in the regression model. Table 4 shows the regression results. Both the reinforcement ratio and the gender interaction variable were significant predictors of drinking outcomes. The significant gender interaction indicates that the relation between reinforcement ratio and drinking was different for men and women, so we conducted separate models for men and women. The reinforcement ratio accounted for unique variance in the 6-month drinking outcomes of women,  $\Delta R^2 = .08$ ,  $t(34) = 2.29$ ,  $p < .03$ , but not of men (see Table 4). Women who at baseline derived a larger proportion of their total reinforcement from drinking showed higher levels of drinking at follow-up. Thus, the relative reinforcing value of substance use predicted follow-up drinking rates after we controlled for baseline drinking. There was no effect for treatment group on any reinforcement variables.

### Changes in Reinforcement Variables Following Treatment

To determine the impact of drinking reductions on reinforcement variables, we examined change in substance-free reinforcement variables and the reinforcement ratio among participants who reported moderate to large reductions in weekly drinking ( $n = 27$ ; 54% of sample). We defined a reduction of five or more drinks per week, which corresponds with a one-half standard deviation effect size reduction, as moderate (Kazdin, 1998). Table 5 shows the base-

Table 4  
Summary of Regression Analyses Predicting Drinking Outcomes

Variable	<i>B</i>	<i>SE B</i>	$\beta$	<i>t</i>	<i>R</i> <sup>2</sup>
All participants ( <i>N</i> = 51) <sup>a</sup>					
Model 1					.41
Baseline drinking	.940	.160	.644	5.89***	
Model 2					.52
Baseline drinking	.677	.166	.462	4.07***	
Reinforcement ratio	5.24	1.69	.388	3.09**	
Gender $\times$ Reinforcement Ratio	-1.41	0.49	-.353	-2.87**	
Men ( <i>n</i> = 16) <sup>b</sup>					
Model 1					.25
Baseline drinking	.715	.334	.496	2.14*	
Model 2					.27
Baseline drinking	.681	.346	.472	1.97	
Reinforcement ratio	1.70	2.60	.157	0.65	
Women ( <i>n</i> = 35)					
Model 1					.35
Baseline drinking	.782	.185	.593	4.23**	
Model 2					.43
Baseline drinking	.620	.191	.469	3.24**	
Reinforcement ratio	3.90	1.75	.322	2.23*	

<sup>a</sup> Degree of freedom for *t* tests is 50. <sup>b</sup> Degree of freedom for *t* tests is 15. <sup>c</sup> Degree of freedom for *t* tests is 34.  
\*  $p < .05$ . \*\*  $p < .01$ . \*\*\*  $p < .001$

Table 5

Changes in ARSS-SUV Substance-Free Reinforcement and Reinforcement Ratio Scores Among Participants With Moderate to Large Drinking Reductions

ARSS-SUV reinforcement scale	Baseline		Follow-up	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Peer Interaction	8.42	2.87	7.24*	2.91
Dating	9.08	3.13	8.38	3.29
Sexual Activity	5.33	3.31	4.54	3.26
School	4.17	3.03	6.00*	3.37
Substance Free (total)	6.43	1.65	5.83	1.88
Reinforcement ratio	.33	.11	.28**	.12

Note. ARSS-SUV = Adolescent Reinforcement Survey Schedule—Substance Use Version.

\*  $p < .05$ . \*\*  $p < .01$

line and follow-up substance-free reinforcement scores among students who reduced their drinking by five or more drinks per week. These students showed a significant reduction in substance-free reinforcement from peer interactions,  $t(26) = 2.16$ ,  $p < .04$ , and a significant increase in substance-free school reinforcement,  $t(26) = -2.22$ ,  $p < .03$ . Participants who reduced their drinking also showed a significant reduction in reinforcement ratio scores,  $t(26) = 2.90$ ,  $p < .01$ , which indicates that their drinking reduction was associated with a decrease in proportional reinforcement obtained from substance use. Men and women showed similar changes in these variables.

### Relations Between Reinforcement Variables and Drug Use

Although illicit drug use was not targeted in the intervention, we conducted exploratory analyses that examined the relations between reinforcement variables and drug use in this sample of heavy drinkers. The percentage of participants who reported past-month illicit drug use was 55% at baseline and 48% at follow-up. There were no gender or treatment group differences in drug use. Participants who used drugs did so on an average of 11.29 ( $SD = 9.73$ ) past-month days at baseline and 10.79 ( $SD = 9.11$ ) days at follow-up. Participants with greater levels of substance-free dating, peer, and total reinforcement reported lower levels of drug use at baseline ( $r_s = -.393$ ,  $-.280$ , and  $-.287$ , respectively;  $p_s < .05$ ). The reinforcement ratio was positively correlated with baseline and follow-up substance use ( $r = .339$ ,  $p < .02$ , and  $r = .319$ ,  $p < .03$ , respectively). The relations between reinforcement variables and drug use were similar for men and women. Multiple regression analyses indicated that the reinforcement ratio did not account for unique variance in drug use outcomes after we controlled for baseline levels of drug use, but there may have been insufficient change in drug use to detect an effect for the reinforcement ratio.

### Discussion

Basic laboratory research guided by BTC suggests that reinforcement variables are critically related to the initiation

of substance use, the progression of use, and the cessation of use (Bickel & Vuchinich, 2000; Carroll & Campbell, 2000; Higgins et al., 2003; Hursh & Winger, 1995). The present results suggest that reinforcement variables are also related to drinking outcomes in a sample of young adults who completed a brief intervention. Female drinkers who derived a larger proportion of total reinforcement from substance use were less likely to reduce their drinking after a motivational intervention than were female drinkers who derived a greater proportion of reinforcement from substance-free activities. This measure of the relative reinforcing value of substance use accounted for unique variance in 6-month drinking outcomes after we controlled for baseline levels of drinking. These results are consistent with previous research with untreated adult drinkers (Tucker, Vuchinich, & Rippins, 2002) and suggest that the reinforcing value of substance use relative to other activities may be a novel index of strength of preference that predicts changes in use over time and response to intervention.

The finding that the reinforcement ratio did not predict drinking outcomes among men may be due to the limited variability in baseline to follow-up drinking change among men. The poor treatment response for men is surprising and inconsistent with previous brief intervention research with college drinkers (e.g., Baer et al., 2001; Fromme & Corbin, 2004; Larimer & Cronce, 2002). It is possible that the differential efficacy across gender is related to the drinking feedback elements included in the interventions. In addition to feedback on their drinking rates and the presence of alcohol-related problems, participants received information on alcohol-related caloric intake and weight gain, information that likely resonates with women more than with men. It does not appear that the differential outcomes were due to baseline differences in reinforcement variables. Men and women showed similar baseline levels of total substance-free reinforcement and proportional reinforcement from substance use. Further research is needed to determine whether reinforcement variables are related to treatment outcome among men.

#### *Implications for Substance Abuse Assessment*

Proportional reinforcement from substance use relative to substance-free activities operationalizes an important feature of young adult substance misuse: devoting considerable time and resources to substance use relative to other activities. This feature is included in the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; American Psychiatric Association, 1994) substance dependence criteria but has not been explicitly measured with young adults. Current measures of young adult substance abuse focus on consumption levels, substance-related negative consequences, and substance-related risky behavior (Tucker, Vuchinich, & Murphy, 2002; Winters, 2001). Although these measures provide important information on the immediate risks and harmful effects associated with drinking, they do not describe the relative prominence of substance use relative to other reinforcers in the student's environment, which may be more predictive of the course of

substance use over time (Tucker, Vuchinich, & Rippins, 2002). Behavioral allocation during the young adult years may impact the availability of future reinforcement related to primary life domains (e.g., employment, physical health, relationships), which will, in turn, affect risk for developmentally persistent substance abuse (Bennett, McCrady, Johnson, & Pandina, 1999; Gotham, Sher, & Wood, 2003). It would be interesting to study the prospective relations between reinforcement variables and substance use over longer periods of time and among samples of young adults with more heterogeneous substance use practices.

#### *Implications for Prevention and Treatment Programs*

The finding that reinforcement from substance-free peer interactions decreased among students who reduced their drinking is consistent with previous research showing that college drinking is associated with positive social consequences (Carey & Correia, 1997; Nyström, 1992), including increased intimacy, self-disclosure in interpersonal relationships (Nezlek, Pilkington, & Bilbro, 1994), and for male students, greater social satisfaction (Murphy, McDevitt-Murphy, & Barnett, 2005). These findings highlight the complexity of efforts to reduce student drinking and might explain why many college students continue to drink heavily despite experiencing negative consequences and being exposed to prevention programs (Larimer & Cronce, 2002; Licciardone, 2003; Murphy et al., 2004). Prevention programs should attempt to increase the availability of substance-free activities on college campuses.

Students who decreased their drinking showed increased reinforcement from academic activities. This may suggest that academic reinforcement is an important substitute for drinking or that increased academic demands place an extrinsic constraint on drinking. Perhaps university policy or curriculum changes that increased the amount of time students engage in structured activities (e.g., class, study hall, and community service) would increase the costs associated with heavy substance use, resulting in decreased use. Currently, most college students are required to attend class only for approximately 15 hr per week and can drink at fairly high levels without significant academic repercussions (e.g., Paschall & Freisthler, 2003; Wood, Sher, & McGowan, 2000).

Most individual interventions for college students use the feedback or motivational counseling approaches used in this study to increase intrinsic motivation to reduce substance use (Dimeff et al., 1999; W. R. Miller & Rollnick, 2002). However, the current results suggest that students with few valued alternatives to substance use may require an intervention that actually increases substance-free sources of reinforcement rather than one that just increases motivation to change drinking or drug use. This could be accomplished within the framework of brief motivational approaches by encouraging participation in academic, volunteer, and other substance-free activities. Students with more severe substance abuse may require intensive interventions that attempt to increase access to substance-free sources of rein-

forcement, such as social skills training, behavioral activation, or community reinforcement (Jacobson et al., 1996; Lejuez, Hopko, LePage, Hopko, & McNeil, 2001).

## References

- American Psychiatric Association. (1987). *Diagnostic and statistical manual of mental disorders* (3rd ed., rev.). Washington, DC: Author.
- American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.
- Anderson, K. G., & Woolverton, W. L. (2000). Concurrent variable-interval drug self-administration and the generalized matching law: A drug-class comparison. *Behavioural Pharmacology, 11*, 413–420.
- Baer, J. S., Kivlahan, D. R., Blume, A. W., McKnight, P., & Marlatt, G. A. (2001). Brief intervention for heavy-drinking college students: 4-year follow-up and natural history. *American Journal of Public Health, 98*, 1310–1316.
- Baker, F., Johnson, M. W., & Bickel, W. K. (2003). Delay discounting in current and never-before cigarette smokers: Similarities and differences across commodity, sign, and magnitude. *Journal of Abnormal Psychology, 112*, 382–392.
- Baum, W. M. (1974). On two types of deviation from the matching law: Bias and undermatching. *Journal of the Experimental Analysis of Behavior, 22*, 231–242.
- Bennett, M. E., McCrady, B. S., Johnson, V., & Pandina, R. J. (1999). Problem drinking from young adulthood to adulthood: Patterns, predictors and outcomes. *Journal of Studies on Alcohol, 60*, 605–614.
- Bickel, W. K., Madden, G. J., & Petry, N. M. (1998). The price of change: The behavioral economics of drug consumption. *Behavior Therapy, 29*, 545–565.
- Bickel, W. K., & Marsch, L. (2001). Toward a behavioral economic understanding of drug dependence: Delay discounting processes. *Addiction, 96*, 73–86.
- Bickel, W. K., & Vuchinich, R. E. (Eds.). (2000). *Reframing health behavior change with behavioral economics*. Mahwah, NJ: Erlbaum.
- Borsari, B. E., & Carey, K. B. (2000). Effects of a brief motivational intervention with college student drinkers. *Journal of Consulting and Clinical Psychology, 68*, 728–733.
- Carey, K. B., & Correia, C. J. (1997). Drinking motives predict alcohol-related problems in college students. *Journal of Studies on Alcohol, 58*, 100–105.
- Carroll, M. E. (1996). Reducing drug abuse by enriching the environment with alternative nondrug reinforcers. In J. Kagel & L. Green (Eds.), *Advances in behavioral economics* (Vol. 3, pp. 37–68). Norwood, NJ: Ablex.
- Carroll, M. E., & Campbell, U. C. (2000). A behavioral economic analysis of the reinforcing effects of drugs: Transition states of addiction. In W. K. Bickel & R. E. Vuchinich (Eds.), *Reframing health behavior change with behavior economics* (pp. 63–87). Mahwah, NJ: Erlbaum.
- Collins, R. L., Parks, G. A., & Marlatt, G. A. (1985). Social determinants of alcohol consumption: The effects of social interaction and model status on self-administration of alcohol. *Journal of Consulting and Clinical Psychology, 53*, 189–200.
- Correia, C. J., & Carey, K. B. (1999). Applying behavioral theories of choice to substance use in a sample of psychiatric outpatients. *Psychology of Addictive Behaviors, 134*, 207–212.
- Correia, C. J., Carey, K. B., Simons, J., & Borsari, B. E. (2003). Relationships between binge drinking and substance-free reinforcement in a sample of college students: A preliminary investigation. *Addictive Behaviors, 28*, 361–368.
- Correia, C. J., Simons, J., Carey, K. B., & Borsari, B. E. (1998). Predicting drug abuse: Application of behavioral theories of choice. *Addictive Behaviors, 23*, 705–709.
- Dimeff, L. A., Baer, J. S., Kivlahan, D. R., & Marlatt, G. A. (1999). *Brief alcohol screening and intervention for college students: A harm reduction approach*. New York: Guilford Press.
- Fromme, K., & Corbin, W. (2004). Prevention of heavy drinking and associated negative consequences among mandated and voluntary college students. *Journal of Consulting and Clinical Psychology, 72*, 1038–1049.
- Gotham, H. J., Sher, K. J., & Wood, P. K. (2003). Alcohol involvement and developmental task completion during young adulthood. *Journal of Studies on Alcohol, 64*, 32–34.
- Green, L., & Myerson, J. (2004). A discounting framework for choice with delayed and probabilistic rewards. *Psychological Bulletin, 130*, 769–792.
- Ham, L. S., & Hope, D. A. (2003). College students and problematic drinking: A review of the literature. *Clinical Psychology Review, 23*, 719–759.
- Heather, N., Rollnick, S., & Bell, A. (1993). Predictive validity of the Readiness to Change Questionnaire. *Addiction, 88*, 1667–1677.
- Herrnstein, R. J. (1970). On the law of effect. *Journal of the Experimental Analysis of Behavior, 13*, 243–266.
- Higgins, S. T., Heil, S. H., & Plebani-Lussier, J. (2003). Clinical implications of reinforcement as a determinant of substance use disorders. *Annual Review of Psychology, 55*, 15.1–15.31.
- Higgins, S. T., & Silverman, K. (Eds.). (1999). *Motivating behavior change among illicit-drug abusers*. Washington, DC: American Psychological Association.
- Hingson, R. W., Heeren, T., Zakocs, R. C., Kopstein, A., & Wechsler, H. (2002). Magnitude of alcohol-related morbidity and mortality among U. S. college age students 18–24. *Journal of Studies on Alcohol, 63*, 136–144.
- Holmes, G. R., Sakano, Y., Cautela, J., & Holmes, G. L. (1991). Comparison of factor-analyzed Adolescent Reinforcement Survey Schedule (ARSS) responses from Japanese and American adolescents. *Journal of Clinical Psychology, 47*, 749–755.
- Hursh, S. R., & Winger, G. (1995). Normalized demand for drugs and other reinforcers. *Journal of the Experimental Analysis of Behavior, 64*, 373–384.
- Jacobson, N. S., Dobson, K. S., Truax, P. A., Addis, M. E., Koerner, K., Gollan, J. K., et al. (1996). A component analysis of cognitive-behavioral treatment for depression. *Journal of Consulting and Clinical Psychology, 64*, 295–304.
- Kazdin, A. E. (1998). *Research design in clinical psychology*. Boston: Allyn & Bacon.
- Kivlahan, D. R., Marlatt, G. A., Fromme, K., Coppel, D. B., & Williams, E. (1990). Secondary prevention with college drinkers: Evaluation of an alcohol skills training program. *Journal of Consulting and Clinical Psychology, 64*, 974–979.
- Larimer, M. E., & Cronce, J. M. (2002). Identification, prevention, and treatment: A review of individual-focused strategies to reduce problematic alcohol consumption by college students. *Journal of Studies on Alcohol, 14*, 148–163.
- Lejuez, C. W., Hopko, D. R., LePage, J., Hopko, S. D., & McNeil, D. W. (2001). A brief behavioral activation treatment for depression. *Cognitive and Behavioral Practice, 8*, 164–175.
- Licciardone, J. C. (2003). Outcomes of a federally funded program for alcohol and other drug prevention in higher education. *The American Journal of Drug and Alcohol Abuse, 29*, 803–827.



- MacPhillamy, D. J., & Lewinsohn, P. M. (1982). The Pleasant Events Schedule: Studies on reliability, validity, and scale intercorrelation. *Journal of Consulting and Clinical Psychology, 50*, 363–380.
- Mazur, J. E. (1991). Choice. In I. H. Iverson & K. A. Lattal (Eds.), *Experimental analysis of behavior* (pp. 219–250). New York: Elsevier.
- McDowell, J. J. (1988). Matching theory in natural human environments. *The Behavioral Analyst, 11*, 95–109.
- Miller, E. T., Roberts, L. J., Cressler, S. O., Metrik, J., Neal, D. J., & Marlatt, G. A. (1998). [Psychometric properties of alcohol measures]. Unpublished raw data.
- Miller, W. R., & Rollnick, S. (2002). *Motivational interviewing: Preparing people for change* (2nd ed.). New York: Guilford Press.
- Monti, P. M., Colby, S. M., Barnett, N. P., Spirito, A., Rosenhow, D. J., Woolard, R., & Lewander, W. (1999). Brief intervention for harm reduction with alcohol-positive older adolescents in an emergency department. *Journal of Consulting and Clinical Psychology, 67*, 989–994.
- Murphy, J. G., Benson, T., Vuchinich, R. E., Deskins, M., Eakin, D., Flood, A. M., et al. (2004). A comparison of personalized feedback for college student drinkers delivered with and without a counseling session. *Journal of Studies on Alcohol, 65*, 200–203.
- Murphy, J. G., Duchnick, J. J., Vuchinich, R. E., Davison, J., Karg, R., Olson, A., et al. (2001). Relative efficacy of a brief motivational intervention for college student drinkers. *Psychology of Addictive Behaviors, 15*, 373–379.
- Murphy, J. G., McDevitt-Murphy, M. E., & Barnett, N. (2005). Drink and be merry? Gender, life satisfaction, and alcohol consumption among college students. *Psychology of Addictive Behaviors, 30*, 19–27.
- Murphy, J. G., & Vuchinich, R. E. (2002). Implications of behavioral theories of choice for substance abuse assessment. *The Addictions Newsletter, 9*, 2–6.
- National Institute on Alcohol Abuse and Alcoholism. (2002). *A call to action: Changing the culture of drinking at U. S. colleges* (NIH Publication No. 02–5010). Bethesda, MD: Author.
- Nezlek, J. B., Pilkington, C. J., & Bilbro, K. G. (1994). Moderation in excess: Binge drinking and social interaction among college students. *Journal of Studies on Alcohol, 55*, 342–351.
- Nyström, M. (1992). Positive and negative consequences of alcohol drinking among young university students in Finland. *British Journal of Addiction, 87*, 715–722.
- O'Malley, P. M., & Johnston, L. D. (2002). Epidemiology of alcohol and other drug use among American college students. *Journal of Studies on Alcohol, 14*, 23–39.
- Paschall, M. J., & Freisthler, B. (2003). Does heavy drinking affect academic performance in college? Findings from a prospective study of high achievers. *Journal of Studies on Alcohol, 64*, 515–519.
- Premack, D. (1965). Reinforcement theory. In D. Levine (Ed.), *Nebraska Symposium on Motivation* (pp. 123–180). Lincoln: University of Nebraska Press.
- Rachlin, H., Green, L., Kagel, J., & Battalio, R. (1976). Economic demand theory psychological studies of choice. In G. Bower (Ed.), *The psychology of learning and motivation* (pp. 129–154). New York: Academic Press.
- Roberts, L. J., Neal, D. J., Kivlahan, D. R., Baer, J. S., & Marlatt, G. A. (2000). Individual drinking changes following a brief intervention among college students: Clinical significance in an indicated prevention context. *Journal of Consulting and Clinical Psychology, 68*, 500–505.
- Tucker, J. A., Vuchinich, R. E., & Murphy, J. G. (2002). Assessment, treatment planning, and outcome evaluation for substance use disorders. In M. H. Anthony & D. H. Barlow (Eds.), *Handbook of assessment and treatment planning* (pp. 415–452). New York: Guilford Press.
- Tucker, J. A., Vuchinich, R. E., & Rippins, P. D. (2002). Predicting natural resolution of alcohol-related problems: A prospective behavioral economic analysis. *Experimental and Clinical Psychopharmacology, 10*, 248–257.
- Van Etten, M. L., Higgins, S. T., Budney, A. J., & Badger, G. J. (1998). Comparison of the frequency and enjoyability of pleasant events in cocaine abusers versus non-abusers using a standardized behavioral inventory. *Addiction, 93*, 1669–1680.
- Vuchinich, R. E., & Heather, B. N. (2003). *Choice, behavioral economics, and addiction*. Oxford, England: Elsevier.
- Vuchinich, R. E., & Tucker, J. A. (1988). Contributions from behavioral theories of choice to an analysis of alcohol abuse. *Journal of Abnormal Psychology, 92*, 408–416.
- Vuchinich, R. E., & Tucker, J. A. (1996). The molar context of alcohol abuse. In J. Kagel, & L. Green (Eds.), *Advances in behavioral economics* (Vol. 3, pp. 133–162). Norwood, NJ: Ablex.
- Wechsler, H., Lee, J. E., Kuo, M., Seibring, M., Nelson, T. F., & Lee, H. (2002). Trends in college binge drinking during a period of increased prevention efforts. *Journal of American College Health, 50*, 203–217.
- White, H. R., & Labouvie, E. W. (1989). Towards the assessment of adolescent problem drinking. *Journal of Studies on Alcohol, 50*, 30–37.
- Winters, K. (2001). Assessing adolescent substance abuse problems and other areas of functioning: State of the art. In P. M. Monti, S. M. Colby, & T. A. O'Leary (Eds.), *Adolescents, alcohol, and substance abuse* (pp. 80–108). New York: Guilford Press.
- Wood, M. D., Sher, K. J., & McGowan, A. K. (2000). Collegiate alcohol involvement and role attainment in early adulthood: Findings from a prospective high-risk study. *Journal of Studies on Alcohol, 61*, 278–289.

Received May 25, 2004

Revision received November 1, 2004

Accepted November 18, 2004 ■