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Measuring Substance-Free and Substance-Related Reinforcement in the Natural Environment

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Abstract

The present study sought to provide further evidence for the validity of a modified version of the Pleasant Events Schedule (PES; D. J. MacPhillamy & P.M. Lewinsohn, 1982) designed to measure substance-free and substance-related reinforcement. A sample of 134 young adults completed the modified PES along with measures of substance use and quality of life. The results extend previous research on the modified PES in 3 ways: (a) Information regarding the relationships between substance-related reinforcement and substance use are expanded to include substance-use frequency, quantity, and related negative consequences; (b) relationships between substance-free reinforcement and non-substance-related variables are established; and (c) the distinctiveness of the substance-free and substance-related reinforcement scores is demonstrated. The utility of reinforcement surveys in the study of substance use is discussed, with special emphasis placed on possible treatment implications.

The *behavioral choice perspective* is a collection of operant-based research and theories used to explain the establishment of preferences among available reinforcers. Behavioral theories of choice have been applied to a broad range of behaviors, including the prediction of cigarette smoking, eating and physical activity, and drug and alcohol abuse (Bickel, DeGranpre, Higgins, & Hughes, 1990; DeGranpre & Bickel, 1996; Epstein, Bulik, Perkins, Caggiula, & Rodefer, 1991; Epstein, Smith, Vara, & Rodefer, 1991; Vuchinich & Tucker, 1983, 1988). When applied to psychoactive substance use, the behavioral choice perspective recognizes that a preference for substance use develops within a broader environmental context involving the availability or use of other competing substance-free reinforcers and their associated environmental constraints. The theory predicts that substance use and related behaviors increase when access to alternative reinforcers is constrained or limited and that consumption decreases when access to the substance itself is constrained (Vuchinich & Tucker, 1983). Reviews of the literature suggest that both predictions have been supported by numerous laboratory-based experimental studies (cf. Carroll, 1996; Griffiths et al., 1980; Vuchinich & Tucker, 1988).

Vuchinich and Tucker (1996) pointed out that the application of the behavioral choice framework to research in the natural environment is still in the early stages and that important empirical and design issues need to be resolved. In basic experimental research on choice, the schedules of reinforcement associated with alternative activities can be easily manipulated, constraints on access to the alternatives are readily introduced, and the resulting changes in behavior can be precisely quantified. In contrast, conducting behavioral choice research in the natural environment poses a number of significant challenges. For

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example, constraints on important life activities in the natural environment (e.g., marital relations, employment) cannot be controlled by the experimenter. Moreover, the complexity of such activities and their constraints preclude precise description and measurement; variables of interest, such as the amount of reinforcement derived from a particular activity relative to other activities, are difficult to quantify. Thus, one pressing research issue is the measurement of behavior allocated to, and the associated reinforcement derived from, the wealth of alternatives available in the natural environment.

Reinforcement surveys have emerged as useful tools for determining possible reinforcing stimuli and their relative reinforcing value (Cautela & Kastenbaum, 1967). The Pleasant Events Schedule (PES; MacPhillamy & Lewinsohn, 1982) is a widely used reinforcement schedule. It is a self-report behavioral inventory of the frequency of occurrence and subjective pleasure of 320 commonly rewarding motor, cognitive, and emotional behaviors. The PES uses two widely accepted parameters of reinforcement: (a) the amount of time spent engaged in the activity and (b) the respondent's subjective enjoyment of the experience. The PES has demonstrated test-retest reliability as well as concurrent and predictive evidence of validity (MacPhillamy & Lewinsohn, 1982). In the natural environment, the PES has proven useful as a means of monitoring the reinforcing events engaged in by depressed patients undergoing behavior therapy (Lewinsohn, Sullivan, & Grosscup, 1982). Thus, the PES is a useful reinforcement survey that has been used to measure behavioral allocation and approximate the amount of positive reinforcement received in the natural environment.

Researchers have recently used the PES with a variety of populations to investigate naturally occurring relationships between substance use and alternative sources of reinforcement. Higgins, Budney, and Badger (1998) used the original version of the PES to compare the frequency and perceived enjoyability of naturally occurring positive reinforcement experienced by cocaine abusers with that experienced by a community control group matched on demographic and socioeconomic variables. Results indicated that cocaine abusers display reinforcement deprivation across a variety of substance-free activities. Correia, Simons, Carey, and Borsari (1998) modified the PES to obtain self-reports of behavioral allocation across substance-related and substance-free events and activities from a sample of college students and found that a ratio variable representing reinforcement received from substance-related activities relative to total reinforcement was significantly related to the frequency of substance use. The ratio accounted for unique variance, even after the contribution of substance-related reinforcement was first accounted for. This finding was replicated in another study (Correia & Carey, 1999) in which a modified PES was used to investigate relationships between substance use and behavioral allocation among a sample of psychiatric outpatients. The reported relationships between substance use and alternative sources of reinforcement are consistent with the behavioral choice perspective and attest to the utility of the model in accounting for substance use in the natural environment.

This study was designed to further explore the feasibility and utility of estimating substance-free and substance-related reinforcement in the natural environment. More specifically, the study further evaluated substance-free and substance-related reinforcement scores derived from the modified PES. Previous studies (Correia & Carey, 1999; Correia et al., 1998) have reported on relationships between the PES reinforcement scores and the frequency of substance use. We sought to expand on these findings by evaluating how scales differentially relate to concurrently collected measures of behavior. There were two hypotheses. First, substance-related scores, compared with substance-free scores, would demonstrate stronger relationships with measures of substance use (a) frequency, (b) quantity, and (c) associated negative consequences. Second, the substance-free scores would

display stronger relationships with a multidimensional quality-of-life measure. We performed secondary analyses to further explore the relationship between substance-related reinforcement and substance use.

Method

Participants

The participants were 134 undergraduates attending a large private university who were recruited for a study on substance use. The mean ($\pm SD$) age of the sample was 19.76 (± 3.76); 69% were female, and 22% were minorities (12% were African American, 6% were Latino). The majority (70%) had completed 1 year of college. Nine percent of the sample reported affiliation with the Greek system, and 1% reported a Greek house as their residence. The majority of the sample lived in campus dormitories (69%) or in an off-campus apartment (20%).

Some analyses were restricted to the 78% of the sample who reported substance use during the last 28 days ($n = 105$). This group does not differ significantly from the full sample in terms of age, education, Greek affiliation, place of residence, or ethnicity. However, 39% of male participants, compared with 19% of female participants, reported no substance use during the last 28 days, $\chi^2(1, N = 134) = 9.20, p < .01$. Seventy-six percent of the recent substance users were women. Alcohol and marijuana were the most commonly used substances: Seventy-seven percent reported alcohol use, and 26% reported marijuana use during the last 28 days. Twenty-nine percent reported using two or more substances during the same interval. The mean ($\pm SD$) number of standard drinks consumed in a typical week by those who reported alcohol use was 10.62 ($\pm .95$).

Measures

PES—The PES (MacPhillamy & Lewinsohn, 1982) is a 320-item measure assessing the frequency and subjective pleasure of potentially reinforcing events or activities. Each item yields a frequency score and an enjoyability score (subjective pleasure rating), and these two scores are multiplied to create a cross-product. A higher cross-product score indicates that the activity was engaged in with a higher amount of reinforcement potential, which is considered a useful approximation of obtained positive reinforcement. Averaging across items produces a summary index for the frequency, enjoyability, and cross-product scores.

The PES has demonstrated adequate reliability and validity across a number of studies (see *Manual for the Pleasant Events Schedule*, MacPhillamy & Lewinsohn, 1976). Test–retest reliability assessed at 1 month, 2 months, 3 months, and 2–3 years is acceptable (correlations of .71, .74, .64, .63, respectively). Internal consistency, measured by Cronbach's coefficient alpha, was excellent for the frequency (.96), enjoyability (.98), and cross-product scores (.97). Evidence for the validity of the PES is good; self-reports are consistent with peer ratings, expert ratings, and subsequent choice behavior. Further evidence of validity comes from a variety of clinical studies. For example, individuals diagnosed with depression have lower activity levels, report less pleasure from positive events, and obtain less total pleasure than normal or psychiatric controls (MacPhillamy & Lewinsohn, 1974). Daily mood is correlated with PES scores (Grosscup & Lewinsohn, 1980; Lewinsohn & Graf, 1973; Lewinsohn & Libet, 1972), and PES scores improve with treatment for depression (Lewinsohn, Youngren, & Grosscup, 1979).

Four modifications were made to the PES for this study; the first three modifications were described by Correia et al. (1998). First, participants were asked to provide two frequency and enjoyability ratings for each activity: one set of ratings for times when the participants

were substance free (“time when you were not using or under the influence of substances”) and a second set for times when participants engaged in the activity while “using or under the influence of substances.” The term *substance* was defined in the instructions as “alcohol, marijuana, and other recreational drugs” and “excluding nicotine and caffeine.” Second, enjoyability ratings were obtained only for events or activities in which participants had actually engaged during the previous 28 days. Third, the original PES items that explicitly mention substance use (e.g., “drinking beer”) were not used in calculations of summary scores or considered in the analyses. This modification avoids artificial inflation of the correlations between substance-related scores and substance use. Fourth, to increase the sensitivity of the instrument, the original 3-point Likert scale was expanded to a 5-point Likert scale (frequency: 0 = This has *not* happened in the past 28 days, 1 = This has happened *rarely*—1 or 2 times—in the past 28 days, 2 = This has happened *occasionally*—3 to 10 times—in the past 28 days, 3 = This has happened *often*—11–25 times—in the past 28 days, and 4 = This has happened *very often*—25 or more times—in the past 28 days; pleasure: 0 = This was *not* pleasant, 1 = This was *mildly* pleasant, 2 = This was *moderately* pleasant, 3 = This was *very* pleasant, and 4 = This was *extremely* pleasant).

In addition to the frequency, pleasure, and cross-product scores, we made use of a reinforcement ratio score. The reinforcement ratio, based on Herrnstein’s (1970) matching law, was devised to represent the proportion of reinforcement received from substance-related activities and experiences relative to total reinforcement received over the 28-day period. We calculated it for each participant by dividing the substance-related cross-product score by the sum of the substance-related cross-product score and the substance-free cross-product score. The reinforcement ratio ranges from 0 to 1, with a higher ratio indicative of a greater proportion of substance-related reinforcement relative to total reinforcement. This reinforcement ratio is significantly correlated with self-reported substance use (Correia et al., 1998).

The modified PES allows for distinctions between substance-related and substance-free experiences and provides the following summary scores: substance-related frequency, substance-free frequency, substance-related enjoyability, substance-free enjoyability, substance-related cross-product, substance-free cross-product, and the reinforcement ratio.

Quality of life—The Quality of Life survey (Roberts & Clifton, 1992) is a 31-item self-report instrument measuring university students’ general level of satisfaction across four factorally derived dimensions: Positive Affect (13 items, e.g., “The university is a place I enjoy being”), Interactions With Students (5 items, e.g., “I get on well with the other students in my class”), Interactions With Professors (9 items, e.g., “Professors treat me fairly”), and Negative Affect (4 items, e.g., “I feel depressed”). All four scales displayed adequate internal consistency in the original sample of college undergraduates, with Cronbach’s alpha ranging from .75 to .93. In the present sample, alpha coefficients ranged from .74 to .89.

Substance use assessment—All participants were asked to report their current and lifetime use of psychoactive substances. We used portions of the Daily Drinking Questionnaire (Collins, Parks, & Marlatt, 1985) to assess the average amount of alcohol each participant had consumed during the previous 28 days. Participants indicated how much alcohol they consumed during a typical week, the maximum number of drinks they had consumed during the last 28 days, and the number of days out of the last 28 on which they had consumed alcohol. We used parallel versions of alcohol-related items to assess use of other psychoactive substances, including the number of days out of the last 28 on which any substances (alcohol, illicit drugs, or both) were used. Extensive research supports the

validity of self-reported drug use when participants' confidentiality is assured (Johnston & O'Malley, 1985).

Substance use related problems—We assessed use-related problems with a modified version of the Rutgers Alcohol Problem Index (RAPI; White & Labouvie, 1989). The original scale consists of 23 items assessing presence or absence of specified problems with alcohol over the individual's lifetime. Ratings are provided on a 5-point Likert scale (0 = *never*, 1 = *1–2 times*, 2 = *3–5 times*, 3 = *6–10 times*, 4 = *more than 10 times*). This scale was designed for individuals between the ages of 12 and 21, making it an appropriate tool for use with college students. Previous measures of internal consistency have been adequate ($\alpha = .77-.82$; White & Labouvie, 1989), and the RAPI displayed adequate 1-month test-retest reliability in a sample of college students ($r = .72$; Borsari & Carey, 2000). Predictive validity of the measure is supported by relationships with other use-related problems, such as intoxicated driving (Johnson & White, 1989). We made two modifications to the RAPI for the present study. First, participants indicated if they had experienced problems during the previous 28 days. Second, we changed the wording of the items to reflect problems associated with both alcohol and other drug use. Sample items include “felt physically or psychologically dependent on alcohol or other drugs,” “neglected your responsibilities,” and “felt that you needed more alcohol or other drugs than you used to use in order to get the same effect.” In the present sample, the modified RAPI displayed adequate internal consistency ($\alpha = .84$).

Procedure

Participants attended group sessions to complete a set of questionnaires addressing substance use and other topics. After providing written informed consent and demographic data, participants completed the previously described measures.

Results

Recent substance use and variables used in the analyses are presented in Table 1. Because there were no gender differences, we combined men and women into one group for all subsequent analyses.

Analysis of Correlational Relationships

We calculated Pearson correlations to assess relationships between substance-free and substance-related reinforcement scores, quality of life, recent substance use, and recently experienced substance-related problems. In the top portion of Table 2 are presented correlations between the reinforcement scores and the quality of life derived from the full sample. Four notable findings emerged. First, the three substance-free reinforcement scores (frequency, enjoyability, and cross-product) displayed significant, moderate relationships with three of the four quality-of-life scales: Positive Affect ($r_s: .32-.43$), Interactions With Students ($r_s: .28-.38$), and Interactions With Professors ($r_s: .24-.36$). Second, the substance-free enjoyability score, but not the substance-free frequency score or the cross-product, displayed a significant inverse relationship with the Negative Affect scale; higher rates of self-reported substance-free enjoyment were associated with lower levels of negative affect. Third, the reinforcement ratio was inversely related to the Positive Affect scale, indicating that positive affect decreased as the proportion of reinforcement derived from substance-related activities increased. Fourth, the substance-related enjoyability and cross-product scores were significantly related to the Interactions With Students scale ($r_s: .19-.21$). In sum, the substance-free scores were more likely than the substance-related scales to display significant relationships with the quality-of-life factors, and the significant relationships were stronger and more reliable.

Correlations between the reinforcement scores and measures of substance use are presented in the bottom portion of Table 2. The three substance-related reinforcement scores and the reinforcement ratio were significantly correlated with frequency of substance use and alcohol use (r s: .54–.68), the number of standard drinks consumed in a typical week (r s: .52–.56), and related negative consequences (r s: .61–.66); these relationships were all robust ($p < .001$) and positive. In contrast, the substance-free reinforcement scores were not significantly related to any of the substance use variables.

Secondary Analyses on Relationships Between PES Scores and Substance Use

The bivariate correlations presented in the preceding section demonstrate a positive relationship between substance-related reinforcement scores and various measures of substance use. Next we sought to determine if the substance-related reinforcement scores contributed to and improved on a model of substance-related problems when the more direct effects of the frequency and quantity of substance use variables were simultaneously considered. We constructed and compared two separate regression models using RAPI score as the criterion variable (see Table 3). In Model 1, the number of recent substance use days and the total number of standard drinks consumed during a typical week emerged as significant carriers; this model accounted for 39% of the variance in substance-related problems, $F(2, 102) = 32.32, p < .001$. Model 2, which included reinforcement variables as well as the substance use variables, accounted for 52% of the variance, $F(6, 97) = 17.63, p < .001$. Number of standard drinks, substance-related frequency score, and substance-related cross-product emerged as significant carriers. Number of substance use days failed to account for significant variance in the second model. Note that the substance-related frequency score is the frequency of activities performed while using or under the influence of substances and therefore conveys unique information not provided by pure measures of substance use frequency.

We used another series of regression models to determine if the substance-related reinforcement scores contributed to an account of substance use quantity when the direct effects of the frequency of alcohol use were simultaneously considered (see Table 4). We constructed two separate multiple regression models using the number of standard drinks consumed during a typical week as the criterion variable. In Model 1, the frequency of alcohol use accounted for 53% of the variance, $F(1, 103) = 114.22, p < .001$. In Model 2, the addition of the reinforcement variables increased the amount of variance accounted for to 60%, $F(5, 98) = 29.28, p < .001$. Number of alcohol use days continued to account for a significant amount of variance, and three of the reinforcement variables (substance-related frequency, substance-related cross-product, and reinforcement ratio) contributed additional unique variance.

Discussion

In this study we evaluated a method of measuring substance-free and substance-related reinforcement in the natural environment. Researchers had previously used the PES to demonstrate relationships between the frequency of substance use and rates of reinforcement derived from substance-free and substance-related sources (Correia & Carey, 1999; Correia et al., 1998). With this study we extend existing research in two ways: (a) by demonstrating a relationship between substance-related reinforcement and measures of substance use quantity and related negative consequences and (b) by demonstrating a relationship between the substance-free reinforcement scores and measures of non-substance-related behaviors.

In this study the substance-related reinforcement scales were significantly related to substance use frequency and quantity measures, and to a measure of recently experienced substance use-related problems. The reinforcement scores continued to display a relationship

with both the quantity of substance use and the severity of substance use related problems, even after the frequency of substance use was first accounted for. One surprising finding was the negative multivariate relationship between the substance-related cross-product and substance-related problems (see Table 3). Given the significant positive bivariate relationship between the substance-related cross-product and the RAPI (Table 2), it appears likely that the reversal in the direction of the relationship is due to the level of multicollinearity among the predictors.

Frequency of substance use did not aid in a concurrent prediction of substance-use-related problems when the substance-related reinforcement scores were simultaneously entered into the model. Thus, the substance-related reinforcement variables from the PES appear to reflect more than the frequency of use. Rather, they indicate the degree to which a person's daily events and activities are associated with the use of substances. This expanded notion of substance-related reinforcement is consistent with the behavioral choice perspective. As Vuchinich and Tucker (1996) noted, whereas the majority of substance-use research focuses on relationships between internal psychological states and consumption, the choice perspective analyzes the environmental conditions that make substances use a more or less viable option. This study suggests that as more activities are regarded as opportunities to engage in substance use, the frequency, quantity, and negative consequences of use also increase.

Regarding the quality-of-life measure, positive affect, positive interactions with students, and positive interactions with professors were all positively and significantly related to substance-free reinforcement. In addition, negative affect was inversely related to the enjoyment of substance-free activities. These findings support the validity of the substance-free reinforcement scores. At least one study has found that positive attitudes toward substance-free experiences serve as a protective factor against high levels of substance use and associated negative consequences (Simons & Carey, 2000). More research is needed to determine the role substance-free reinforcement plays in the initiation and development of naturally occurring substance use and related problems.

Among the substance-related reinforcement scores, only the relationships between the positive interactions with students and the substance-related enjoyment and cross-product scores emerged as significant. This result is consistent with the notion that substance use is an important social facilitator among college students (Carey & Correia, 1997; Simons, Correia, & Carey, 2000; Simons, Correia, Carey, & Borsari, 1998). However, a negative relationship between positive affect and the reinforcement ratio also emerged as a significant finding, suggesting that positive emotional experiences begin to diminish as the proportion of reinforcement derived from substance-related activities increases. Once again, more research is needed to determine the optimal balance between substance-free and substance-related reinforcement and to determine at what point the proportion of reinforcement derived from substance-related activities becomes problematic.

Previous research has shown that the substance-free and substance-related reinforcement scores are correlated with one another, suggesting that one's overall activity level may influence ability to derive reinforcement across a variety of settings (Correia et al., 1998). In this study the substance-free and substance-related reinforcement scores displayed differential relationships with both substance-use and quality-of-life measures. Thus, these findings demonstrate that the substance-free and substance-related scores are theoretically and practically distinct from one another. This study failed to find significant relationships between the substance-related enjoyability score and measures of substance use after the other reinforcement variables were accounted for. Other studies do support the distinctiveness and utility of both the frequency and enjoyability scores from the original

PES. For example, Van Etten et al. (1998) found that individuals with cocaine use disorders differed from controls in their frequency of engagement in a variety of activities. However, the cocaine abusers generally did not differ from controls in their subjective enjoyment of the same sets of activities. The authors suggested that drug abuse is associated with a decreased amount of behavior allocated to substance-free options and not with a decreased capacity to experience pleasure or reinforcement. The modified PES might prove useful in future studies investigating the generalizability of this observation to other drugs of abuse and populations.

This research has a number of limitations. The number of statistical tests conducted raises concerns about alpha inflation and the increased probability of committing a Type I error. There are a variety of ways researchers can limit the probability of committing a Type I error (e.g., Bonferroni correction, Tukey test, Scheffé test). However, (1991) warned against overzealously guarding against Type I errors, because the commonly used strategies often lead to less powerful analyses and may impede progress in new areas of research. In this study we outlined all of the primary analyses before collecting any data, and we tied closely each hypothesis to an empirically derived theory, thus minimizing concerns about Type I errors. On a related note, more research is needed to determine whether these results generalize to other populations of college students, as 76% of our recent users were female. Thus, replication of these findings, along with additional research using a variety of samples, would increase confidence that these results demonstrate the utility of the modified PES as a measure of substance-related and substance-free reinforcement in the natural environment.

Additional concerns involve the definition and measurement of reinforcement and reinforcers. A *reinforcer* is defined as “an event that increases the probability of a response when presented after it” (Lieberman, 1993, p. 73). Strictly speaking, reinforcers and reinforcement can be measured only through the careful observation of behavior, and such measures do not rely on subjective accounts of pleasure or enjoyability. Consequently, the PES does not provide a measure of reinforcement as strictly defined. Instead, the instrument measures engagement in potentially rewarding or reinforcing events. On a related note, our study should not be viewed as a formal test of Herrnstein’s (1970) matching law, and our reinforcement ratio should not be considered a direct derivative of any formal matching equations.

A number of treatment approaches attempt to alter the contingencies affecting an individual’s behavior, such that substance-free behaviors become more rewarding than substance-related behaviors (e.g., Higgins & Silverman, 1999; Robles, Silverman, & Stitzer, 1999; Smith & Meyers, 1995). The modified PES, or other measures of behavior allocation, could be used to determine the degree to which successful treatment for substance-use disorders is dependent on an individual’s ability to access substance-free reinforcers that compete with substance use. Conducting multiple assessments during the course of a treatment could help determine whether changes in substance-free reinforcement precede or follow changes in substance use. Such data would aid clinical decisions regarding whether the initial treatment target should be cessation of substance use or an increase in access to substance-free reinforcers.

Marlatt and Kilmer (1998) recently suggested that treatment strategies derived from the behavioral choice perspective could emerge as effective components in broader cognitive-behavioral treatments for substance abuse and dependence. They specifically mentioned motivational interviewing (Miller & Rollnick, 1991), in which feedback regarding substance-related behaviors and consequences is used to promote contemplation or initiation of behavior change. For example, in their study of college students, Kilmer, Larimer,

Alexander, and Marlatt (1998) used time allocation data to assess the relationship between drinking and environmental constraints limiting engagement in preferred activities. The results revealed a positive relationship between perceived constraints and time engaged in drinking. The authors suggested that information regarding constraints on access to valued substance-free activities could be used as sources of motivational feedback. More research is needed to assess the impact such information would have on the efficacy of treatment; however, it remains clear that information from the behavioral choice perspective could inform not only an understanding of substance-use behavior but also the way in which the treatment of substance-related problems is viewed.

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References

- Bickel WK, DeGranpre RJ, Higgins ST, Hughes JR. Behavioral economics of drug self-administration: I. Functional equivalence of response requirement and drug dose. *Life Science*. 1990; 47:1501–1510.
- Borsari B, Carey KB. Effects of a brief motivational intervention with college student drinkers. *Journal of Consulting and Clinical Psychology*. 2000; 68:728–733. [PubMed: 10965648]
- Carey KB, Correia CJ. Drinking motives predict alcohol-related problems in college students. *Journal of Studies on Alcohol*. 1997; 58:100–105. [PubMed: 8979218]
- Carroll, ME. Reducing drug abuse by enriching the environment with alternative non-drug reinforcers. In: Green, L.; Kagel, J., editors. *Advances in behavioral economics*. Vol. Vol. 3. Norwood, NJ: Ablex; 1996. p. 37-68.
- Cautela JR, Kastenbaum R. A reinforcement survey for use in therapy, training, and research. *Psychological Reports*. 1967; 20:1115–1130.
- Collins RL, Parks GA, Marlatt GA. Social determinants of alcohol consumption: The effects of social interaction and model status on the self-administration of alcohol. *Journal of Consulting and Clinical Psychology*. 1985; 53:189–200. [PubMed: 3998247]
- Correia CJ, Carey KB. Applying behavioral theories of choice to drug use in a sample of psychiatric outpatients. *Psychology of Addictive Behaviors*. 1999; 13:207–212.
- Correia CJ, Simons J, Carey KB, Borsari BE. Predicting drug use: Application of behavioral theories of choice. *Addictive Behaviors*. 1998; 23:705–709. [PubMed: 9768306]
- DeGranpre, RJ.; Bickel, WK. Drug dependence and consumer demand. In: Green, L.; Kagel, J., editors. *Advances in behavioral economics*. Vol. Vol. 3. Norwood, NJ: Ablex; 1996. p. 1-36.
- Epstein LH, Bulik CM, Perkins KA, Caggiula AR, Rodefer J. Behavioral economic analysis of smoking: Money and food as alternatives. *Pharmacology, Biochemistry, and Behavior*. 1991; 38:715–721.
- Epstein LH, Smith JA, Vara LS, Rodefer JS. Behavioral economic analysis of activity choice in obese children. *Health Psychology*. 1991; 10:311–316. [PubMed: 1935865]
- Griffiths, RR.; Bigelow, GE.; Henningfield, JE. Similarities in animal and human drug-taking behavior. In: Mello, NK., editor. *Advances in substance abuse: Behavioral and biological research*. Vol. Vol. 1. Greenwich, CT: JAI Press; 1980. p. 1-90.
- Grosscup SJ, Lewinsohn PM. Unpleasant and pleasant events, and mood. *Journal of Clinical Psychology*. 1980; 36:252–258. [PubMed: 7391239]
- Herrnstein RJ. On the law of effect. *Journal of the Experimental Analysis of Behavior*. 1970; 13:243–266. [PubMed: 16811440]
- Higgins, ST.; Silverman, K., editors. *Motivating behavior change among illicit-drug abusers: Research on contingency management interventions*. Washington, DC: American Psychological Association; 1999.
- Johnson V, White HR. An investigation of factors related to intoxicated drinking behaviors among youth. *Journal of Studies on Alcohol*. 1989; 50:320–330. [PubMed: 2787875]

- Johnston, LD.; O'Malley, PM. Issues of validity and population coverage in student surveys of drug use. In: Rouse, BA.; Kozel, NJ.; Richards, LG., editors. Self-report methods of estimating drug use: Meeting current challenges to validity (National Institute on Drug Abuse Research Monograph No. 57, ADM 85-1402). Washington, DC: National Institute on Drug Abuse; 1985. p. 31-54.
- Keppel, G. Design and analysis: A researcher's handbook. 3rd ed.. Englewood Cliffs, NJ: Prentice Hall; 1991.
- Kilmer, JR.; Larimer, ME.; Alexander, EN.; Marlatt, GA. Bait for the hook in motivation enhancement programs: Contributions from molar behavioral theory of choice. In: Kilmer, JR., editor. Interventions with college student drinkers: Reducing alcohol-related harm; Symposium conducted at the 32nd annual convention of the Association for the Advancement of Behavior Therapy; Washington, DC. 1998 Nov.
- Lewinsohn PM, Graf M. Pleasant activities and depression. *Journal of Consulting and Clinical Psychology*. 1973; 41:261–268. [PubMed: 4147832]
- Lewinsohn PM, Libet J. Pleasant events, activity schedule, and depression. *Journal of Abnormal Psychology*. 1972; 79:291–295. [PubMed: 5033370]
- Lewinsohn, PM.; Sullivan, JM.; Grosscup, SJ. Behavioral therapy: Clinical applications. In: Rush, AJ., editor. Short-term psychotherapies for depression. New York: Guilford Press; 1982. p. 50-87.
- Lewinsohn, PM.; Youngren, MA.; Grosscup, SJ. Reinforcement and depression. In: Depue, RA., editor. The psychobiology of depressive disorders. New York: Academic Press; 1979. p. 291-316.
- Lieberman, DA. Learning: Behavior and cognition. 2nd ed.. Pacific Grove, CA: Brooks/Cole; 1993.
- MacPhillamy DJ, Lewinsohn PM. Depression as a function of desired and obtained pleasure. *Journal of Abnormal Psychology*. 1974; 83:651–657. [PubMed: 4155711]
- MacPhillamy, DJ.; Lewinsohn, PM. Manual for the Pleasant Events Schedule. University of Oregon; 1976. Unpublished manuscript
- MacPhillamy DJ, Lewinsohn PM. The Pleasant Events Schedule: Studies on reliability, validity, and scale intercorrelation. *Journal of Consulting and Clinical Psychology*. 1982; 50:363–380.
- Marlatt GA, Kilmer JR. Consumer choice: Implications of behavioral economics for drug use and treatment. *Behavior Therapy*. 1998; 29:567–576.
- Miller, WR.; Rollnick, S. Motivational interviewing: Preparing people for change. New York: Guilford Press; 1991.
- Roberts LW, Clifton RA. Measuring the affective quality of life of university students: The validation of an instrument. *Social Indicators Research*. 1992; 27:113–137.
- Robles, E.; Silverman, K.; Stitzer, ML. Contingency management therapies. In: Strain, EC.; Stitzer, ML., editors. Methadone treatment for opioid dependence. Baltimore: Johns Hopkins University Press; 1999. p. 196-222.
- Simons J, Carey KB. Attitudes toward marijuana use and drug-free experience: Relationships with behavior. *Addictive Behaviors*. 2000; 25:323–331. [PubMed: 10890287]
- Simons J, Correia CJ, Carey KB. A comparison of motives for marijuana and alcohol use among experienced users. *Addictive Behaviors*. 2000; 25:153–200. [PubMed: 10708331]
- Simons J, Correia CJ, Carey KB, Borsari BE. Validating a five-factor marijuana motives measure: Relations with use, problems, and alcohol motives. *Journal of Counseling Psychology*. 1998; 45:265–273.
- Smith, JE.; Meyers, RJ. The community reinforcement approach. In: Hester, RK.; Miller, WR., editors. Handbook of alcoholism treatment strategies. 2nd ed.. Boston: Allyn & Bacon; 1995. p. 251-266.
- Van Etten ML, Higgins ST, Budney AJ, Badger GJ. Comparison of the frequency and enjoyability of pleasant events in cocaine abusers vs. non-abusers using a standardized behavioral inventory. *Addiction*. 1998; 93:1669–1680. [PubMed: 9926530]
- Vuchinich RE, Tucker JA. Behavioral theories of choice as a framework for studying drinking behavior. *Journal of Abnormal Psychology*. 1983; 92:408–416. [PubMed: 6643819]
- Vuchinich RE, Tucker JA. Contributions from behavioral theories of choice to an analysis of alcohol abuse. *Journal of Abnormal Psychology*. 1988; 97:181–195. [PubMed: 3133403]

- Vuchinich, RE.; Tucker, JA. The molar context of alcohol abuse. In: Green, L.; Kagel, J., editors. Advances in behavioral economics. Vol. Vol. 3. Norwood, NJ: Ablex; 1996. p. 133-162.
- White HR, Labouvie EW. Towards an assessment of adolescent problem drinking. Journal of Studies on Alcohol. 1989; 50:30–37. [PubMed: 2927120]

Table 1

Means and Standard Deviations of Key Variables

Variable	Full sample (N = 134)		Men (n = 44)		Women (n = 92)	
	M	SD	M	SD	M	SD
Quality of Life Scale						
Positive Affect	40.59	5.28	40.02	6.03	40.80	4.90
Negative Affect	9.33	2.42	9.07	2.22	9.43	2.50
Interactions With Students	15.50	2.32	15.02	2.32	15.71	2.28
Interactions With Professors	27.28	3.59	27.07	5.27	27.37	3.23
Pleasant Events Schedule						
Substance-free frequency	1.28	0.32	1.23	0.25	1.29	0.35
Substance-free enjoyability	1.55	0.42	1.57	0.41	1.54	0.42
Substance-free cross-product	3.88	1.43	3.73	1.26	3.94	1.50
Substance-related frequency	0.33	0.35	0.31	0.35	0.34	0.35
Substance-related enjoyability	0.49	0.47	0.48	0.51	0.50	0.45
Substance-related cross-product	1.00	1.14	0.97	1.20	1.03	1.11
Reinforcement ratio	0.18	0.16	0.17	0.18	0.18	0.15
Substance use assessment (last 28 days)						
Alcohol use days	5.50	5.89	5.79	6.61	5.47	5.56
Marijuana use days	2.18	5.46	0.86	2.29	2.77	6.30
Substance use days	7.20	7.61	6.55	7.58	7.58	7.62
Standard drinks consumed during a typical week	8.16	9.01	8.55	10.29	8.09	8.44
Rutgers Alcohol Problem Index (last 28 days)	3.74	5.03	3.98	5.12	3.64	4.99

Note. Substance refers to alcohol, other illicit substances, or both.

Table 2
Correlations Among Pleasant Events Schedule—Substance Use Version, Quality of Life Scale, and Substance Use Variables

Variable	Substance-free frequency	Substance-free enjoyability	Substance-free cross-product	Substance-related frequency	Substance-related enjoyability	Substance-related cross-product	Reinforcement ratio
Quality of Life Scale ^a							
Positive Affect	.32***	.41***	.43***	-.09	-.05	-.02	-.22*
Negative Affect	.01	-.19*	-.13	.08	.00	.02	.10
Interactions With Students	.28**	.38***	.36***	.16	.19*	.21*	.05
Interactions With Professors	.24**	.36***	.33***	.00	.04	.04	-.10
Substance use ^b							
Revised RA PI	.10	.07	.05	.66***	.61***	.62***	.63***
Substance use days	-.13	-.13	-.13	.68***	.62***	.62***	.77***
Alcohol use days	-.11	-.02	-.05	.54***	.56***	.53***	.63***
Total standard drinks	-.10	-.02	-.02	.52***	.56***	.54***	.62***

Note. RAPI = Rutgers Alcohol Problem Index.

^a
n = 134.

^b
n = 105.

*
p < .05.

**
p < .01.

p < .001.

Table 3
Summary of Regression Analysis Accounting for Rutgers Alcohol Problem Index Scores

Variable	β	SE β	B	t^a	Model R^2
Model 1					.39***
Substance use days	0.25	0.07	0.35	3.67***	
Total standard drinks	0.20	0.06	0.35	3.64***	
Model 2					.52***
Substance use days	0.03	0.08	0.04	0.38	
Total standard drinks	0.19	0.06	0.33	3.35***	
Substance-related frequency	17.55	5.34	1.14	3.29***	
Substance-related enjoyability	2.21	2.36	0.19	0.94	
Substance-related cross-product	-3.32	1.63	-0.72	-2.03*	
Reinforcement ratio	-6.25	6.83	-0.17	-0.92	

Note. $n = 105$.

^a $df = 102$ for Model 1; $df = 97$ for Model 2.

* $p < .05$.

$p < .001$.

Table 4

Summary of Regression Analyses Accounting for Quantity of Alcohol Use

Variable	β	SE β	B	r^2	Model R^2
Model 1					.53***
Alcohol use days	1.13	0.11	0.73	10.69***	
Model 2					.60***
Alcohol use days	0.82	0.13	0.53	6.34***	
Substance-related frequency	-21.13	7.85	-0.80	-2.69**	
Substance-related enjoyability	-0.90	3.70	-0.04	-0.24	
Substance-related cross-product	5.76	2.45	0.73	2.35*	
Reinforcement ratio	25.90	9.70	0.42	2.67**	

Note. $n = 105$.

^a $df = 103$ for Model 1; $df = 98$ for Model 2.

* $p < .05$.

** $p < .01$

*** $p < .001$.