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The Effect of Drink Price and Next-Day Responsibilities on College Student Drinking: A Behavioral Economic Analysis

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Abstract

More than $\frac{3}{4}$ of U.S. college students report a heavy drinking episode (HDE; 5/4 or more drinks during an occasion for a man/woman) in the previous 90 days. This pattern of drinking is associated with various risks and social problems for both the heavy-drinkers and the larger college community. According to behavioral economics, college student drinking is a contextually-bound phenomenon that is impacted by contingencies such as price and competing alternative reinforcers, including next-day responsibilities such as college classes. The current study systematically examined the role of these variables by using hypothetical alcohol purchase tasks to analyze alcohol consumption and expenditures among college students who reported recent heavy drinking ($N = 207$, 53.1% women). The impact of gender and the personality risk factor sensation-seeking were also assessed. Students were asked how many drinks they would purchase and consume across 17 drink prices and 3 next-day responsibility scenarios (no responsibilities, a 10:00 AM class without a test, and a 10:00 AM class with a test). Mean levels of hypothetical consumption were highly sensitive to both drink price and next-day responsibility, with the lowest drinking levels associated with high drink prices and a next-day test. Men and participants with greater levels of sensation-seeking reported more demand overall (greater consumption and expenditures) than women and students with low sensation-seeking personality. Contrary to our hypotheses women appeared to be less sensitive to increases in price than men. The results suggest that increasing drink prices and morning academic requirements may be useful in preventing heavy drinking among college students.

Keywords

Behavioral economics; demand curve; alcohol prevention; college drinking; reinforcement

Heavy drinking among college students poses a significant public health concern. As many as 84% of U.S. college students report a heavy drinking episode (HDE; 5/4 or more drinks during an occasion for a man/woman; Wechsler, Dowdall, Davenport, & Rimm, 1995) in the previous 90 days (Ham & Hope, 2003; Vik, Carrello, Tate, & Field, 2000), and approximately 40% of college students report an HDE in the previous two weeks (O'Malley & Johnston, 2002). Although many college students eventually moderate their alcohol use

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on their own (Jackson, Sher, Gotham, & Wood, 2001), heavy drinking places them at an increased risk of experiencing various alcohol-related problems including missing class, blackouts, fights, and assaults. A national study of alcohol-related consequences in college students estimated that each year there are approximately 1,825 deaths, 599,000 injuries, 646,000 assaults, and 97,000 sexual assault or date rapes related to alcohol consumption (Hingson, Zha, & Weitzman, 2009).

Two of the most prominent risk factors for college drinking are male gender and sensation-seeking personality. Although both men and women engage in heavy drinking, college men drink more frequently and drink larger quantities than college women (Borsari, Murphy, & Barnett, 2007; Ham & Hope, 2003; O'Malley & Johnston, 2002). For example, in one nationwide study 29.2% of men reported drinking 10 or more times in the past 30 days, compared to 16.8% of women (Wechlser, et al., 2002). Another nationwide study found that 50% of male students reported an HDE in the past month versus 34% of female students (O'Malley & Johnston, 2002). Men also report higher levels of alcohol-related consequences than women (Ham & Hope, 2003; O'Malley & Johnston, 2002; Read, Wood, Davidoff, McLacken, & Campbell, 2002).

Sensation-seeking (SS) is a personality trait that has been consistently associated with heavy drinking among college students (Ham & Hope, 2003). SS is associated with seeking out novel and exciting experiences and has been found to be positively associated with alcohol use and other risky behaviors (Roberti, 2004). In general, high levels of SS are related to higher levels of drinking and problems, whereas lower levels of SS are related to abstinence or lower levels of drinking and problems (Ham & Hope, 2003). SS is also a risk factor for an escalating pattern of drinking during college (Del Boca, Darkes, Greenbaum, & Goldman, 2004; White et al., 2006).

Examining College Drinking from a Behavioral Economic Perspective

The high prevalence of heavy drinking and associated problems among college students makes theory-based prevention efforts particularly important. Behavioral economics uses principles and methods of micro-economics and operant psychology to understand and predict how organisms allocate valued resources (e.g., money and time/behavior) to attain various commodities or reinforcers such as food, drugs, and alcohol (Bickel, DeGrandpre, Higgins, Hughes, & Badger, 1995; Madden, 2000; MacKillop et al., 2010; Petry & Bickel, 1998; Vuchinich & Heather, 2003). Behavioral economic theory predicts that drug use is most likely when drugs are readily available and inexpensive, and when there are few substance-free alternative reinforcers to compete with drug use. Drug use is viewed as choice behavior, and there is a special emphasis on the inter-temporal context of individuals' decisions to use drugs versus allocating behavior towards other reinforcers (Rachlin, 1997). Indeed, in contrast to the immediate effects of drugs (euphoria, stress reduction, social facilitation), the substance-free reinforcers that may show the strongest functional relations to substance use (health, relationship success, employment, educational attainment) are not discrete outcomes that are temporally contiguous with an individual drug use episode, but are instead delayed outcomes that nevertheless often maintain high rates of behavior over time (i.e., function as positive reinforcers) and are highly relevant to decisions to reduce or quit substance use (Higgins, Heil, & Lusier, 2004). Similarly, the direct negative consequences associated with drug use are delayed; hangovers are experienced the day after drinking, and health and educational consequences may be delayed by several weeks, months, or years (Murphy, Correia, & Barnett, 2007). Given the centrality of reward delay to the choice between regularly engaging in drug use versus behaviors associated with the larger delayed rewards of good health and educational/career outcomes, it is not surprising that drug and alcohol abusers tend to discount or devalue rewards that are delayed relative to immediate rewards, a decision making bias that may be a defining feature of substance

abuse (Green & Myerson, 2004; Heil, Johnson, Higgins, & Bickel, 2006; Rachlin, 1997; Tucker, Roth, Vignolo, & Westfall, 2009; Vuchinich & Heather, 2003). The behavioral economic model of substance abuse is supported by data indicating that: (1) rates of drug use are highly sensitive to alterations in cost or price, (2) drug use occurs at high rates in contexts devoid of substance-free sources of reinforcement, (3) drug abusers discount delayed rewards more steeply than controls, and (4) greater access to alternative reinforcers generally results in a decrease in drug use (Higgins et al., 2004).

From a behavioral economic perspective, the college environment may be especially conducive to frequent alcohol use (Correia, Carey, Simons, & Borsari, 2003; Murphy et al., 2007). College students typically drink at parties where alcohol is free or available in unlimited quantities for a single price (all-you-can-drink), or at bars that offer low price drinks (Kuo, Wechsler, Greenberg, & Lee, 2003). Additionally, for many students, there may be few alternatives that are as reinforcing as alcohol. A recent study found that college students rated alcohol-related activities as more enjoyable than alcohol-free activities, and that there was a positive relation between the level of enjoyment of alcohol-related activities and the amount of alcohol consumed (Murphy, Barnett, & Colby, 2006). This may, in part, explain why college students drink heavily despite the high risk of alcohol-related consequences. College students also report experiencing a number of positive consequences from heavy drinking. Park (2004) found that college students experienced positive consequences more frequently than negative consequences. These positive consequences included meeting new friends, expressing themselves, and romantic encounters (Corbin, Morean, & Benedict, 2008). Heavy drinking may also be associated with social benefits that extend beyond drinking contexts. Heavy drinking students reported higher frequency of participation in and enjoyment derived from various substance-free peer and sex-related activities than light drinking students (Skidmore & Murphy, 2010) an outcome that is likely related to both the direct social facilitative effects of alcohol (Kirchner Sayette, Cohn, Moreland, & Levine, 2006) as well as to personality characteristics (e.g., sensation seeking, extraversion) that are associated with both alcohol and social activity (Ham & Hope, 2003).

Although heavy drinking may be associated with higher levels of reinforcement related to substance-free social or sexual activities, two recent behavioral economic studies suggest that there are other categories of substance-free reinforcement that may be inversely related to drinking. Correia, Benson, and Carey (2005) assigned participants to receive behavioral instructions to decrease their substance use or to increase their engagement in exercise or creative activities. Participants were instructed to self-monitor the targeted behavior. Four weeks after the intervention, participants who had received instructions to increase their substance-free activity level showed a reduction in their substance use that was greater than the reduction among the participants who were specifically instructed to reduce their substance use. Another study found that students who reduced their drinking following a brief intervention increased their engagement in academic activities, suggesting that academics may be a key substitute for drinking (Murphy, Correia, Colby, & Vuchinich, 2005).

Morning classes may be a promising alternative to drinking because they are at least somewhat incompatible with heavy drinking. This may be especially true if the class includes a test; presumably even if a student does attend the class, the hangover and fatigue associated with heavy drinking might lower performance. Wood, Sher, and Rutledge (2007) found that students without Friday morning classes drank twice as much on Thursday nights as those students with early Friday morning classes, even after controlling for high school alcohol consumption, GPA, and ACT score. Classes before 10:00 had the largest impact on Thursday night drinking. However, as noted previously, although academic success is often a powerful reinforcer for college students – students allocate large amounts of money and

time over four or more years to obtain a degree – it is a delayed reward and thus may be discounted by students when faced with the option to experience the immediate reinforcement associated with alcohol use. Choices between drinking versus preparing for or attending class occur throughout college and are key indicators of the relative value of these competing reinforcers.

Using alcohol purchase tasks to measure students' demand for alcohol—A demand curve plots drug consumption as a function of price (see Figure 1). Typically, demand curves are generated through laboratory studies that measure actual drug administration over a series of response cost or price conditions. Demand curves directly model the impact of price and other experimental manipulations (e.g., establishing operations such as stress induction or other drug administration) on drug consumption, and can also assess several different dimensions of the reinforcement value of a substance (Bickel, Marsch, & Carroll, 2000; Hursh & Silberberg, 2008; MacKillop & Murphy, 2007; MacKillop et al., 2010). Intensity is equal to consumption when the price is zero, and provides a measure of free-access demand for drugs. O_{max} is the maximum expenditure, and P_{max} is the price associated O_{max} , or the point at which demand become elastic. Breakpoint is the first price at which consumption equals zero. Finally, elasticity is the rate at which demand for a reinforcer decreases as a function of price. A factor analysis demonstrated that although these demand metrics are all correlated as they all reflect various elements of the reinforcement value of alcohol, they form two distinct factors (MacKillop et al., 2009). *Amplitude*, which represents the maximum spent and consumed, is comprised of intensity and O_{max} . *Persistence*, which represents the sensitivity to increasing price, is comprised of elasticity, P_{max} , breakpoint, and O_{max} .

Because the drug self administration methods required to generate demand curves would be logistically difficult to carry out in many clinical and applied research settings, several researchers have developed hypothetical purchase measures to provide a more cost and time efficient measure of the reinforcement value associated with a given drug (Jacobs & Bickel, 1999; Murphy & MacKillop, 2006). Simulation procedures have been widely used in experimental economics (Camerer, 1999), and in behavioral economic studies of addiction. For example, over 20 published studies provide strong support for the reliability, validity, and utility of the hypothetical delayed reward discounting (DRD) task with a variety of human populations (see Green & Myerson, 2004 for a review), and a recent study found close correspondence between hypothetical, questionnaire-based alcohol purchases and subsequent actual choices between alcohol and money in a laboratory session (Correia & Little, 2006). In the Alcohol Purchase Task (APT; Murphy & MacKillop, 2006), participants are presented with a hypothetical drinking scenario (e.g., an evening at a bar with friends) and asked how many drinks they would purchase and consume across a range of drink prices. Murphy and MacKillop (2006) administered the APT to a sample of college student drinkers. Intensity, breakpoint, and O_{max} exhibited significant associations with alcohol use and alcohol-related problems. Overall, students' demand for alcohol was high and inelastic at lower prices (average consumption was ≥ 5 drinks at prices up to \$2 per drink) but became elastic as the price per drink increased. Moreover, when drinks cost 50¢ or less approximately 85% of participants would have engaged in a heavy drinking episode, this percentage dropped to 37% when drink price was increased to \$3.00. These findings are consistent with epidemiological research indicating that drink prices less than \$1 or specials that offer an unlimited number of drinks for a set price predict binge drinking among college students (Wechsler, Kuo, Lee, & Dowdall, 2000). Both of these pricing scenarios are typical on or around college campuses due to drink specials offered at bars and parties (Kuo et al., 2003).

Current Study

The purpose of the current study was to examine the effects of next-day academic responsibilities and drink price on heavy drinking college students' reported alcohol consumption using a hypothetical purchase task. Previous epidemiological and behavioral economic research has demonstrated that college student drinking is price sensitive (Kuo et al., 2003; Murphy & MacKillop, 2006; Wechsler, Lee, Kuo, & Lee, 2000) and that alternative reinforcers including next-day responsibilities also impact drinking levels (Correia et al., 2005; Wood et al., 2007). The current study extends this research by examining the effects of a range of drink prices and next-day responsibilities, simultaneously. Specifically, we used a within-subject design to compare three different APTs. In each APT participants were asked how many alcoholic drinks they would purchase at 17 different prices during a hypothetical drinking scenario. The three APTs included the same price increments but varied according to the next-day responsibilities presented to the participants. In the first scenario there were no next-day responsibilities. In the second there was a 10:00 AM class the next day that did not include a test. The final scenario's next-day responsibility was a 10:00 AM class that included a test.

We hypothesized that participants' reported demand for alcohol (drink purchases/ expenditures) would be inversely related to price and to the level of next day responsibility. Specifically, we hypothesized that a) consumption would decrease as a function of price across all 3 APTs, and that b) the demand metrics - intensity, breakpoint, O_{max} , and P_{max} , - would be greatest in the No Responsibilities condition and lowest in the Next-Day Test condition, with the values for Next-Day Class falling between the two other conditions. We hypothesized that elasticity would increase as a function of next-day responsibilities (i.e., next-day responsibilities would make drinkers more sensitive to increases in price). Finally, because of previous research indicating that a) male gender and sensation seeking are risk factors for alcohol misuse, and b) the demand metrics are associated with various dimensions of problem drinking (alcohol consumption, alcohol problems, poor response to treatment), we hypothesized that men and high sensation seekers would report greater alcohol related demand and less sensitivity to next-day class contingencies. The later construct has not been previously studied but, like insensitivity to price, we believe that it reflects a high reinforcement value related to alcohol and should therefore be associated with known risk factors for alcohol misuse.

Method

Participants

Participants were 207 heavy drinking college students (53.1% female, 46.9% male) from a large public university in the south. The sample was ethnically diverse and consistent with the general student population at the university: 68.1% of participants self-identified as White/Caucasian, 27.5% as Black/African-American, 3.4% as Hispanic/Latino, 1.4% as Asian, 1.9% as Native American and .5% as Hawaiian/Pacific Islander. Participants were allowed to choose multiple ethnic identities. The mean age was 19.50 years ($SD = 1.99$) and participants reported consuming an average of 16.45 ($SD = 15.17$) standard drinks per week. The sample was predominantly (67.1%) freshmen, and also included 11.6% sophomores, 11.1% juniors, and 10.2% seniors. Additionally, 23.2% of the participants were members of sororities or fraternities.

Procedure

All procedures were approved by the university's Institutional Review Board. Participants were part of a larger study that evaluated brief alcohol intervention approaches, but all data for the present analyses were collected prior to the interventions. Participants were screened

through the on-campus student health center, introductory psychology courses, or a required course for first-year students. Participants were enrolled in the study if they reported one or more heavy drinking episodes (5/4 or more drinks in one occasion for a man/woman) during the past month on a screening survey. They completed the study measures during individual research appointments in a university research laboratory. A research assistant met with the participant, reviewed the informed consent materials, provided instructions about the assessment packet, and responded to any participant questions. Participants were assured of confidentiality and received extra course credit or a monetary payment in exchange for their participation.

Measures

Alcohol consumption—Drinking was measured using the Daily Drinking Questionnaire (DDQ; Collins, Parks, & Marlatt, 1985). The DDQ asks participants to think about a typical drinking week in the past month. Participants are then instructed to estimate the total number of standard drinks that they consumed on each day during this typical week. These drinking totals are summed to generate an estimate of typical weekly drinking. The DDQ has been used frequently with college students and is a reliable measure that is highly correlated with self-monitored drinking reports (Kivlahan, Marlatt, Fromme, Coppel, & Williams, 1990).

Sensation-seeking—Sensation-seeking was measured using the Brief Sensation Seeking Scale-4 (BSSS-4; Stephenson, Hoyle, Palmgreen, & Slater, 2003). Participants are presented with four statements: *I would like to explore strange places, I prefer friends who are exciting and unpredictable, I like frightening things, and I like new and exciting experiences, even if I have to break the rules.* Participants then rate how much they agree with each statement ranging from 1 *Strongly Disagree* to 5 *Strongly Agree*. The BSSS-4 has demonstrated strong internal consistency, reliability, and associations with longer sensation-seeking scales (Stephenson, et al., 2003). Internal consistency for the BSSS-4 in our sample was .74.

Demand for Alcohol—Alcohol demand was measured with a modified version of the Alcohol Purchase Task (APT; Murphy & MacKillop, 2006). The APT is a task that asks participants to estimate the number of standard drinks they would purchase and consume at different prices during a hypothetical drinking scenario. Both the raw consumption values and several of the computed demand or reinforcement metrics (intensity, O_{max} , and breakpoint) show good to excellent 2-week test-retest reliability (Murphy, MacKillop, Skidmore, & Pederson, 2009). Elasticity and P_{max} have shown adequate test-retest reliability values (.67 & .68). The APT has also demonstrated construct validity; it has shown consistent relations with measures of alcohol problem severity, including predicting changes in drinking following an intervention (MacKillop & Murphy, 2007; Murphy et al., 2009). Participants completed three APTs that differed as a function of next-day responsibility. In each APT participants read the instructions and then reported the number of standard drinks they would consume at 17 different prices, ranging from free to \$20 per drink. For each price they were prompted with *How many drinks would you have if they were \$XX each?* All participants completed the No-Responsibilities APT, followed by the Next-Day Test APT, and finally the Next-Day Class APT.

No Responsibilities APT—In this scenario participants were instructed to consider the hypothetical drinking scenario and report their drinking as if they had no next-day responsibilities. The following instructions were provided: *In the questionnaire that follows we would like you to pretend to purchase and consume alcohol. Imagine that you and your friends are at a party on a Thursday night from 9:00 PM until 2:00 AM to see a band. Imagine that you do not have any obligations the next day (i.e., no work or classes). The*

following questions ask how many drinks you would purchase at various prices. The available drinks are standard size domestic beers (12 oz.), wine (5 oz.), shots of hard liquor (1.5 oz.), or mixed drinks containing one shot of liquor. Assume that you did not drink alcohol or use drugs before you went to the party and that you will not drink or use drugs after leaving the party. Also, assume that the alcohol you are about to purchase is for your consumption only during the party (you can't sell or bring drinks home). **Please respond to these questions honestly, as if you were actually in this situation.**

Next-Day Test APT—In this APT, the drinking scenario described above was modified by instructing participants to report the number of drinks they would purchase/consume if they had a test to take the next morning. The supplemental instructions were: *The only difference from the last scenario is that we now ask that you imagine that you have a test (worth 25% of your course grade) for a college class the next morning at 10:00 AM.*

Next-Day Class APT—In this APT, the drinking scenario described above was modified by instructing participants to report the number of drinks they would purchase/consume if they had a class to attend the next morning. The supplemental instructions were: *The only difference from the last scenario is that we now ask that you imagine that you have a college class the next morning at 10:00 AM, but there is no test and the teacher does not take attendance.*

Generating demand curve indices—For each participant separate consumption and expenditure demand curves were plotted for each of the three conditions (six total curves per participant). Consumption values are participants' reports of how many drinks they would purchase/consume at each of the 17 prices. Expenditures are computed by multiplying participants' reported consumption at each price, by the price value, to derive 17 expenditure values. These demand curves are in turn used to generate five reinforcement or demand metrics for each of the three conditions. Intensity is the reported number of drinks consumed when drinks are free. $O_{\max}$ is the greatest expenditure value. $P_{\max}$ is the price associated with $O_{\max}$ and the point at which demand becomes elastic. Breakpoint is the first price at which reported consumption is zero. Elasticity (α) is the rate at which demand for a reinforcer decreases as a function of price. It is derived from the following exponential equation (Hursh and Silberberg, 2008):

$$\ln Q = \ln Q_0 + k(e^{-\alpha P} - 1), \quad (1)$$

Where Q is the quantity consumed, k specifies the range of the dependent variable (alcohol consumption) in logarithmic units, and α specifies the rate of change in consumption with changes in price (elasticity). The value of k is constant across all curve fits. For the current study $k = 2.834$, which is the value that was derived when the sample mean consumption values were fit to Equation 1 and k was allowed to vary in order to converge on the best fit solution. As recommended by Hursh and Silberberg (2008), holding k constant allows for individual differences in elasticity to be scaled with a single parameter (α) which is standardized and independent of reinforcer magnitude. Demand curves were fit according to the Hursh and Silberberg (2008) guidelines using the calculator provided on the Institute for Behavioral Resources website (http://www.ibrinc.org/centers/bec/BEC_demand.html). When fitting the data to Equation 1, zero values (which cannot be log transformed) were replaced by an arbitrarily low but nonzero value of .01 (Jacobs & Bickel, 1999). Larger α values reflect more elastic demand (greater price sensitivity).

Data Analysis Plan

Outliers were corrected using the method described by Tabachnik and Fidell (2001). For each variable, values that were greater than or equal to 3.29 standard deviations above the mean were changed to be one unit greater than the greatest non-outlier value. Variables that were skewed or kurtotic were transformed (using square root transformations) prior to analysis. First, to examine the impact of price on consumption we plotted demand curves using raw consumption and expenditure values. Individual participant demand curves were plotted to generate intensity, $O_{\max}$, $P_{\max}$, and breakpoint values for each condition. Elasticity for each condition was generated using Equation 1. Each of these demand metrics was significantly skewed and kurtotic except No Responsibility breakpoint. All of these variables were corrected by square root transformations except No Responsibility intensity which remained somewhat kurtotic (kurtosis = 2.25, $SE = .34$) and each of the elasticity values which remained slightly skewed and kurtotic (skewness = 1.49, 1.59, 1.86, $SEs = .17, .19, .17$ and kurtosis = 2.84, 3.13, 4.50, $SEs = .34, .38, .35$ respectively). To evaluate the impact of next-day responsibility on alcohol demand, five repeated-measures ANOVAs were run, one for each demand metric. We tested for within-subjects effects of the different conditions of the APT (no responsibilities, test, and class). In addition, we included between subjects factors of gender, and sensation-seeking (which was dichotomized using a median split, median = 15), to evaluate the impact of these variables, and their interaction, on demand for alcohol across the three APT conditions.

Results

Descriptive Data on the APT and Adequacy of Demand Curve Model Fit

The raw demand curve data were consistent with our hypotheses: reported alcohol consumption exhibited a decelerating curve in response to increasing price, and expenditures exhibited the characteristic inverted U-shaped curve. Figures 1 and 2 plot mean consumption and expenditures, respectively, across the 17 different prices. The demand curve equation (Hursh and Silberberg, 2008) provided an excellent fit for the aggregated data (i.e., sample mean consumption values across No Responsibilities, Next-Day Class, and Next-Day Test conditions; $R^2 = .98, .96, \& .97$, respectively), but only an adequate fit to individual participant data (Mean $R^2 = .60, .55$, and $.51$, respectively). Although there is no accepted criterion for adequacy of demand curve fit, and R^2 may not function well as a measure of curve fit with nonlinear models (cf. Johnson & Bickel, 2008), the authors used a similar criteria as Reynolds and Schiffbauer (2004) and only included elasticity values for analyses when the demand equation accounted for at least 30% of the variance in the participant's consumption (47 participants were excluded from the elasticity analyses for this reason). These participants reported drinking significantly less ($M = 11.61$, $SD = 10.31$) than those participants who were included ($M = 17.39$, $SD = 14.04$; $t(205) = -2.62$, $p < .001$). This is likely due to the fact that relatively lighter drinking participants reported fewer purchases on the APT, thus minimizing the number of data points and reducing the potential for adequate curve fits. Because the other demand parameters were directly observed from participants' raw consumption and expenditure data and not derived from the regression parameters, data from these participants were included in the analyses that examined the other demand curve indices.

The Effect of Next-Day Responsibilities on Alcohol Demand

The means and standard deviations for each of the demand metrics are presented in Table 1 (Figures 1 and 2 provide an illustration of mean raw consumption and expenditure values). The within-subjects factor of next-day responsibility (No Responsibilities, Next-Day Class, and Next-Day Test) was assessed and the between-subject factors of gender and sensation-

seeking were examined using repeated measures ANOVAs. The F values for these main effects are also presented in Table 1.

There was a statistically significant effect of the within subjects factor next-day responsibilities for all of the demand metrics ($ps < .01$; Table 2). As hypothesized, participants reported that they would drink more when drinks were free (intensity), continue to drink at least one drink to higher prices (breakpoint), spend more money (O_{max}), reach higher prices before their drinking became elastic (P_{max}), and report lower elasticity when they had no responsibilities the following day. The means for each of these variables (other than elasticity) were smallest in the Next-Day Test condition and largest in the NoResponsibilities condition. Demand for alcohol became more elastic as the hypothetical next-day responsibilities became more stringent.

There were also several main effects of gender; women reported higher breakpoint and P_{max} values, and lower intensity values than men (Table 2). The gender effect for intensity was qualified by a significant condition X gender interaction effect, $F(1.81, 356.53) = 5.27, p = .007$. Men reported greater intensity values overall and individual contrast tests revealed that the differences between these values was smaller in the Next Day Test condition ($D = .30$) than the No Responsibilities condition ($D = .58$). There was also a significant interaction of gender and condition for elasticity, $F(1.75, 273.34) = 3.19, p = .049$. Men and women reported nearly equivalent elasticity in the No Responsibilities and Next-Day Class condition. In the Next Day Test condition, however, men reported slightly greater elasticity ($D = .30$) but individual contrast tests showed that this was not significant, $t(159) = 1.08, p = .28$. There were no significant condition X gender interactions for any of the other demand metrics.

An examination of the raw consumption values for men and women indicates that women consistently reported less consumption than men did at lower prices. However, the relative gender differences in consumption decreased as price increased across the three next-day responsibility conditions. The mean consumption of both men and women converges at around \$4 in the No Responsibilities condition, \$5 in the Next-Day Test condition, and \$3 in the Next-Day Class condition. Moreover, the overall gender differences were greatest in the No Responsibilities condition and smallest in the Next-Day Test condition.

There was also a main effect of SS on Intensity, and O_{max} , with high SS drinkers reporting greater Intensity and O_{max} values in each of the conditions (Table 2). Additionally, there was a main effect of SS on elasticity, with high SS drinkers reporting less elastic demand for alcohol than low SS drinkers across all of the responsibility conditions. Overall, high SS drinkers reported that they would consume more standard drinks than light SS drinkers even up to higher prices. There were no significant condition X SS interaction effects for any of the demand metrics.

The Impact of Drink Price and Next-Day Responsibility on Hypothetical Heavy Drinking Episodes

As highlighted by Figure 1, aggregate level drinking decreased sharply as a function of price in each of the conditions. To evaluate the effect of price on heavy drinking (consuming 5/4 drinks for men/women) more specifically, we calculated the percentage of students reporting that they would purchase at least 5 (for men) or 4 (for women) drinks on the APT at each price and within each condition. Figure 3 plots the percentage of students whose reported consumption would have met heavy drinking criteria at each price for the No Responsibilities, Next-Day Class, and Next-Day Test conditions. In the No Responsibilities condition, at the lowest prices (free and 25¢) about 90% of the heavy drinking college students in our sample reported that they would have purchased at least 4/5 drinks. Even

when drinks are \$1.50 approximately 78% of students reported that they would purchase at least 4/5 drinks. Only when drink price reaches \$4 do less than half of the students (39.5%) report heavy drinking. In the Next-Day Class condition, about 75% of students would reach heavy drinking levels at low prices (free through 50¢). At \$2.50, less than half of the students would drink heavily (48%). Finally, in the Next-Day Test condition, approximately 43% of students would drink heavily when drinks are free. This percentage decreases to about 25% at \$2.00.

Discussion

Across all 3 next-day responsibility conditions, participants reported consumption decreased as price increased (Figure 1), which is consistent with previous findings using the APT (Murphy & MacKillop, 2006) and with epidemiological research on the influence of drink price on consumption (Kuo et al., 2003). In the No Responsibilities condition about 90% of the participants reached heavy drinking levels at low prices (< \$1); at these prices mean consumption was around 10 drinks. This high level of heavy drinking might be expected in light of the fact that all participants reported one or more past month heavy drinking episodes. Demand for alcohol was inelastic at lower prices but became increasingly elastic as prices increased. Indeed, even in this heavy drinking sample, students' reported consumption on nights with no next-day responsibilities was fairly moderate (sample mean of 3–4 drinks) when drink price was in the \$3 to \$4 range.

Next-day academic obligations had a substantial impact on hypothetical alcohol demand. Consumption when drinks were free (demand intensity) was approximately 11 drinks in the No Responsibilities condition; the presence of a next-day class or test reduced this value by about 30 and 60%, respectively. Next-day responsibilities had a similar impact on the other demand metrics; participants reported lower maximum alcohol expenditures ($O_{\max}$) and greater price sensitivity (i.e., greater elasticity and lower breakpoint and $P_{\max}$ values). These results suggest that the reinforcing value of alcohol among young adult heavy drinkers is sensitive to contingencies (Correia & Little, 2006; Murphy et al., 2007). This is consistent with a previous study indicating that college student drinkers who reduced their drinking following an alcohol intervention reported lower alcohol reinforcement value using a measure of relative behavioral allocation and enjoyment to substance-related and substance-free activities (Murphy et al., 2005). Next-day day classes or tests can be viewed as either an alternative reinforcer or as an indirect means of increasing the real cost of drinking. Thus, our results are consistent with basic behavioral economic laboratory research indicating that substance use is influenced by response cost and the presence of alternative reinforcers (Babor, Mendelson, Greenberg, & Kuehnle, 1978; Bickel et al., 1995; Higgins et al., 2004; Hursh & Silberberg, 2008).

These results also support the prevention axiom that when students have something important to do the next day they drink less, and importantly, are less likely to reach heavy or binge drinking levels (Kuo et al., 2003; Murphy et al., 2007; Wood et al., 2007). The more stringent the next-day responsibilities the more overall consumption decreased. For example, in the Next-Day Test condition consumption at the lowest prices was about half that in the No-Responsibilities condition (Figure 1). Thus, these results are consistent with previous research indicating that Friday morning classes have the potential to decrease the amount that college students drink on Thursday night (Wood et al., 2007). Our findings also extend this line of research in that the nature of the work for the next morning class (test vs. no test) is a critical factor in influencing Thursday night drinking.

Across all conditions heavy-drinking women reported that they would drink fewer drinks than heavy-drinking men. This is consistent with epidemiological research indicating that

college men drink more than college women (Ham & Hope, 2003; O'Malley & Johnston, 2002; Wechsler et al., 2002). However, our results provide more nuanced information on the contextual influences on drinking among college men and women. Gender differences were most pronounced at the lower drink prices in the No Responsibilities condition. Men reported that they would drink to extreme levels (≥ 11 drinks) when there were no next-day responsibilities and drink prices were under \$1. Interestingly, while men drink to extremes in the absence of price or responsibility contingencies, they rapidly decrease their consumption in response to next-day contingencies such that gender differences diminish as responsibility increases. Men also had significantly lower $P_{\max}$ and breakpoint values, indicating that their expenditure levels were more price sensitive. Specifically, women reported purchasing one drink at substantially higher prices than men. Whereas women may enjoy having one or two drinks even at high prices, men may drink in a more all or nothing manner that is heavily influenced by contextual factors such as drink price and next-day responsibilities. Also, it is important to note that although women report drinking fewer drinks across the lower price range, previous research has demonstrated that women reach similar BACs despite lower consumption (Wechsler et al., 1995). Thus, although men reported greater overall consumption, in drinking scenarios similar to our hypothetical scenario, women may be drinking to similarly high BAC levels.

We also investigated the role of sensation-seeking (SS), which is an established risk factor for heavy drinking in college students (Ham & Hope, 2003; White et al., 2006). High SS drinkers reported significantly greater levels of alcohol consumption and expenditures than low SS drinkers in all conditions. This supports previous research that has found that high SS is predictive of heavy drinking in college students (Del Boca et al., 2004; White et al., 2006). This study afforded a detailed look at how SS may be associated with specific decision making related to contextually embedded drinking scenarios. High SS participants reported greater intensity and $O_{\max}$ values, but the findings regarding SS and price sensitivity were mixed; high SS participants reported lower elasticity values (indicating less price sensitivity) but there were no differences on breakpoint or $P_{\max}$. The hypothesis that higher sensation-seeking drinkers would be less sensitive to next-day responsibilities than lower sensation-seeking drinkers was not supported. Thus, the impact of next-day classes, and perhaps more generally of price and alternative reinforcement manipulations, is significant even for students with elevated risk as a function of SS personality characteristics. Like male gender, high SS may confer greatest risk for heavy drinking in situations in which there are few contingencies against drinking, but may not reflect a general diminished sensitivity to environmental contingencies intended to decrease drinking.

Implications

The results of this study may have several policy-level implications. First, regardless of next-day responsibilities, this sample of heavy drinking college students reported drinking quite heavily when drinks were under \$3, with especially high levels of consumption when drinks were under \$1. A recent study reported that almost $\frac{3}{4}$ of bars surrounding college campuses have weekend specials and promotions offering low drink prices (Kuo et al., 2003). While the mean price of a drink was about \$1.95, the weekend specials at some bars include free drinks and "all you can drink" for a flat price (Kuo et al., 2003). This same study found that the lower average prices of alcohol at an establishment were associated with higher rates of heavy drinking among college students. The current study suggests that moderate increases in the price of drinks (for example, increasing drink price from \$1 to \$3) could potentially reduce mean consumption levels by as much as 50%, (from ~ 8 to ~ 4.5 drinks) even in the absence of next-day responsibilities. When combined with a next-day class or test, this price increase could reduce consumption to ~ 3.5 and 2 drinks, respectively. Our results also suggest that such an increase in drink price would also increase overall

expenditures (see Figure 2) and might therefore be profitable for college bars, assuming such a price increase was implemented across all bars in a given college community. However, it is important to note that the results of these hypothetical purchase tasks, in particular the specific changes in consumption or expenditures, might not generalize to actual drink purchases, which occur in social context and (other than the first drink) after participants have consumed alcohol. Moreover, college administrators may not be able to implement this type of policy change at off-campus bars.

Previous survey research (Wood et al., 2007) found that college students with a Friday morning class drank less on Thursday nights than those students with no class. Because college students' "weekends" often begin on Thursday evening (Wood et al., 2007), one potential intervention for heavy drinking on Thursday nights is to implement Friday morning classes. Wood and colleagues (2007) suggested that the reasons for Friday morning classes' impact on Thursday night drinking may be twofold. First, students with Friday morning classes probably consider the consequences of heavy drinking on Thursday and imagine that being hung over or not getting enough sleep is not compatible with attending class. Second, for classes with homework or testing some students may put off completing class assignments for Friday classes until Thursday night, forcing them to choose to stay in on Thursday to complete the work. The present results offers support for the utility of increasing early morning course offerings, and in particular suggest these courses should include mandatory attendance and frequent testing in order to be maximally effective as a drinking deterrent. These academic contingencies may be especially important for men and individuals with sensation-seeking personality traits, who, in the absence next-day responsibilities or high drink prices, reported dangerous levels of consumption (Ham & Hope, 2003). There would of course be significant barriers to increasing early morning (and especially Friday) class offerings and more general contingencies related to attendance/performance. Early morning classes may not be popular with students or faculty, and the present data suggest that many students would continue to drink despite a class or even a test, which might result in lower attendance and decreased class engagement or performance. Increasing the number of tests and assignments also increases the workload for instructors and teaching assistants. Also, instituting Friday morning classes would not be a simple intervention and there may be unforeseen consequences. For example, while drinking among college students may decrease on Thursday nights, it may increase on other nights. Nevertheless, in light of the longstanding and significant public health burden associated with college drinking, colleges and universities may need to think carefully about changing significant elements of the college experience in order to create an environment that is less conducive to heavy drinking (Borsari et al., 2007).

Limitations and Future Directions

This study had several limitations, including the use of hypothetical measures. Although it is possible that if demand for alcohol was assessed using actual operant procedures (real purchases and consumption, actual next-day responsibilities) in a real drinking scenario the results may have been different, a number of studies support the reliability and validity of similar hypothetical purchase tasks (Jacobs & Bickel, 1999; MacKillop & Murphy, 2007; Murphy et al. 2009), and it would have been infeasible to systematically explore the impact of drink price and next-day responsibility using a real alcohol purchase task. Moreover, our results are consistent with numerous basic laboratory studies supporting the influence of price and alternative reinforcers on drug consumption (Higgins et al., 2004), and with epidemiological studies indicating the influence of drink price and Friday morning classes on alcohol use among college students (Kuo et al., 2003). These simulation methods complement the aforementioned laboratory and epidemiological research by using a range of price and responsibility manipulations that would not be possible to study naturalistically,

yet may be important in establishing the relevance of these variables. Second, because these measures were embedded in a larger questionnaire battery, the order of administration of the three APTs was not counterbalanced. Although it is possible that participants' answers on the initial No Responsibilities APT caused them to respond differently on the subsequent Next Day Class and Test APTs, demand did not change as a linear function of order and instead varied as a negative linear function of the amount of next day responsibility. Third, the sample was comprised entirely of heavy drinkers, which increases the relevance of the conclusions to this at-risk population, but may limit the generalizability of these results to the larger population of college drinkers (which includes many light drinkers). Similarly, the comparison of high sensation-seeking versus low sensation-seeking drinkers might have been limited by the restricted range in sensation-seeking in the heavy drinking sample as well as the use of a dichotomized sensation-seeking variable. Another limitation is that in the Next-Day Class condition the class time was listed as 10:00. Wood and colleagues (2007) found that Friday morning classes before 10:00 had the most impact on previous night drinking. In order to examine this relation it may be beneficial to assess the difference between classes before and after 10:00. Similarly, this study only examined the impact of next-day academic responsibilities. Future research should examine the relationship between drinking and next-day responsibilities that are related to other activities such as volunteering or work. Finally, due to poor curve fit, we excluded almost 25% of our sample from the analyses related to this variable. Excluded participants tended to be lighter drinkers which may have influenced observed relations between elasticity, gender, and sensation seeking.

Summary

This study examined the impact of price and next-day responsibilities on hypothetical alcohol consumption among heavy drinking college students. The results provide support for a behavioral economic model of college student drinking as a contextually bound phenomenon that is responsive to contingencies. We found that as price increased (regardless of next-day responsibilities) consumption decreased and as the next-day responsibilities became more stringent consumption decreased further. Men drank more than women but were especially sensitive to these contingencies. High sensation-seeking participants also moderated their drinking in response to next day responsibilities. These results provide support for the utility of prevention approaches that attempt to increase drink prices and academic responsibilities that occur the morning after common drinking nights.

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Figure 1.
Mean ($\pm$ 1 standard error) hypothetical consumption values across the 17 different prices for each of the APT next-day responsibility conditions.

Figure 2.

Mean ($\pm$ 1 standard error) hypothetical expenditure values across the 17 different prices for each of the APT next-day responsibility conditions.

Figure 3. Percentage of students whose reported drinking reached heavy drinking levels at each price in the three different conditions of the APT.

Table 1

Means, *SDs*, and *F* values for each of the demand metrics by next-day responsibility condition, gender, and sensation-seeking status. *F* values reflect main effects for condition, gender, or sensation-seeking.¹

Intensity ²				
No Responsibilities 10.24 (7.47)		Class 7.49 (5.20)	Test 3.99 (3.08)	F (1.81, 356.53) 239.51**
Female 8.23 (6.33)	Male 12.43 (8.03)	Female 6.15 (3.93)	Male 8.95 (6.00)	Female 3.37 (2.49)
Low SS 8.52 (6.02)	High SS 11.93 (8.36)	Low SS 6.29 (4.75)	High SS 8.67 (5.38)	Low SS 3.29 (2.51)
Breakpoint				
No Responsibilities 9.26 (5.24)		Class 7.39 (5.01)	Test 5.65 (4.85)	F (1.77, 109.14) 121.09**
Female 9.88 (5.11)	Male 8.58 (5.34)	Female 8.09 (5.21)	Male 6.61 (4.68)	Female 6.17 (4.68)
Low SS 8.80 (5.17)	High SS 9.70 (5.30)	Low SS 7.02 (4.89)	High SS 7.74 (5.13)	Low SS 5.58 (4.87)
O _{max}				
No Responsibilities 18.27 (11.36)		Class 15.38 (11.65)	Test 8.95 (7.85)	F (1.80, 361.22) 185.21**
Female 17.02 (9.96)	Male 19.67 (12.64)	Female 14.46 (10.68)	Male 16.41 (12.63)	Female 8.75 (7.02)
Low SS 16.12 (8.59)	High SS 20.33 (13.19)	Low SS 13.02 (8.84)	High SS 17.63 (13.48)	Low SS 8.07 (6.82)
P _{max}				
No Responsibilities 4.00 (2.53)		Class 3.61 (2.09)	Test 3.55 (2.59)	F (1.78, 322.57) 11.01**
Female 4.42 (2.68)	Male 3.52 (2.27)	Female 3.97 (2.19)	Male 3.19 (1.91)	Female 4.11 (2.70)
Low SS 3.93 (2.35)	High SS 4.07 (2.70)	Low SS 3.65 (2.19)	High SS 3.56 (2.01)	Low SS 3.75 (2.77)
Elasticity ³				
No Responsibilities .009 (.008)		Class .015 (.020)	Test .027 (.031)	F (1.75, 273.34) 115.59**
Female .009 (.008)	Male .008 (.007)	Female .015 (.020)	Male .015 (.020)	Female .023 (.017)
Low SS .010 (.008)	High SS .007 (.007)	Low SS .017 (.019)	High SS .013 (.021)	Low SS .031 (.033)

* $p < .05$,
 ** $p < .01$

¹ Greenhouse-Geisser tests for within-subjects effects were used due to violations in the assumption of sphericity; this resulted in degrees of freedom values that were not whole numbers.

² There was a significant gender X condition interactions for intensity, $F(1.81, 356.53) = 5.27$, $p = .007$.

³There was a significant gender X condition interactions for elasticity, $F(1.75, 273.34) = 3.19, p = .049$.