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Is Talk 'Cheap'? An Initial Investigation of the Equivalence of Alcohol Purchase Task Performance for Hypothetical and Actual Rewards

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Abstract

Background—Behavioral economic alcohol purchase tasks (APTs) are self-report measures of alcohol demand that assess estimated consumption at escalating levels of price. However, the relationship between estimated performance for hypothetical outcomes and choices for actual outcomes has not been determined. The present study examined both the correspondence between choices for hypothetical and actual outcomes, and the correspondence between estimated alcohol consumption and actual drinking behavior. A collateral goal of the study was to examine the effects of alcohol cues on APT performance.

Methods—Forty one heavy-drinking adults (56% male) participated in a human laboratory protocol comprising APTs for hypothetical and actual alcohol and money, an alcohol cue reactivity paradigm, an alcohol self-administration period, and a recovery period.

Results—Pearson correlations revealed very high correspondence between APT performance for hypothetical and actual alcohol (*p*s < .001). Estimated consumption on the APT was similarly strongly associated with actual consumption during the self-administration period ($r = .87$, $p < .001$). Exposure to alcohol cues significantly increased subjective craving and arousal, and had a trend-level effect on intensity of demand, in spite of notable ceiling effects. Associations among motivational indices were highly variable, suggesting multidimensionality.

Conclusions—These results suggest there may be close correspondence both between value preferences for hypothetical alcohol and actual alcohol, and between estimated consumption and actual consumption. Methodological considerations and priorities for future studies are discussed.

Keywords

Alcohol; Behavioral Economics; Purchase Task; Demand; Craving; Cue Reactivity

Introduction

Behavioral economics integrates theories and methods from psychology and economics to study human behavior (Camerer, 1999). The approach has been widely used to understand healthy and unhealthy decision making, especially in the area of alcohol and other drug addiction (Bickel and Vuchinich, 2000; Vuchinich and Heather, 2003). In that domain, one

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major focus has been the development of methods for quantifying drug demand (Hursh et al., 2005), or, simply, how much a person values a drug. More specifically, demand refers to the relationship between drug consumption and its costs. Typically, at low costs, drug demand is insensitive (inelastic), but as costs increase, it becomes increasingly sensitive (elastic) and decreases, eventually terminating at zero. In turn, behavioral economic demand curve analysis translates the relationship between consumption and cost into multiple indices of motivation, including Intensity (i.e., consumption at zero-cost), Breakpoint (i.e., the first price at which consumption is completely suppressed), P_{max} (i.e., the price interval at which demand first become elastic, also reflecting price sensitivity), and O_{max} (i.e., the maximum expenditure allocated to the drug). Exponential demand curve modeling (e.g., Hursh and Silberberg, 2008) allows for the calculation of an index of Elasticity, also referred to as "essential value" because it provides an index of proportionate price sensitivity that is unaffected by absolute magnitudes of consumption or price. These different indices are theorized to be conceptually related to each other, but not redundant (Bickel et al., 2000).

Historically, substance demand has been examined using progressive-ratio operant self-administration paradigms (Hursh et al., 2005), often defining costs as behavioral responses. Studies applying this approach have tested and affirmed a number of seminal behavioral economic hypotheses (DeGrandpre et al., 1994; Higgins et al., 1994; Shahan et al., 1999), but also have a number of experimental limitations (Jacobs & Bickel, 1999; MacKillop et al., 2008). For example, because they require multiple sessions of long duration, they are time- and resource-intensive, and are potentially onerous for participants. This limits the number of participants and prices that can be studied. Moreover, in research with human participants, variability in consumption and expenditures may be artificially truncated by ethical and safety concerns. As a result of these methodological parameters, these paradigms cannot easily examine individual differences in demand in relation to addiction severity and are also not well-suited for measuring dynamic changes in the value of a drug.

To address these challenges, a number of studies have employed hypothetical purchase tasks as alternatives to self-administration paradigms (Jacobs and Bickel, 1999 MacKillop et al., 2008; Murphy & MacKillop, 2006). A purchase task is a self-report measure of estimated consumption across an array of different prices under highly specific conditions provided by an instructional set and, because they are comparatively short, comprise a wide array of prices, and focus on either typical substance use or state-level motivation, they address several of the aforementioned limitations of self-administration paradigms. This approach has been applied most extensively in alcohol research, where an alcohol purchase task (APT) has yielded a number of substantive findings. Individual differences in alcohol demand have been found to be significantly associated with both alcohol consumption and alcohol-related problems. Specifically, greater alcohol demand is associated with greater weekly alcohol consumption (MacKillop et al., 2009; MacKillop et al., 2010b; Murphy and MacKillop, 2006), including frequency of heavy drinking (Murphy and MacKillop, 2006), and alcohol-related problems (MacKillop et al., 2010a; Murphy and MacKillop, 2006; Murphy et al., 2009). Alcohol demand has also been shown to predict treatment response (MacKillop and Murphy, 2007). In terms of temporal stability, APTs oriented to general drinking practices exhibit good-to-excellent test-retest reliability, *ceteris paribus* (all other things being equal) (Murphy et al., 2009). Of note, similar findings have also been demonstrated using a cigarette purchase task in smokers (Hitsman et al., 2008; MacKillop et al., 2008; Murphy et al., 2011).

Interestingly, indices of alcohol demand have also been found to complement subjective measures of craving for alcohol (MacKillop et al., 2010a; MacKillop et al., 2010b), providing a quantifiable economic dimension to craving. For example, a recent study using an alcohol cue reactivity paradigm revealed both the characteristic increase in subjective craving for alcohol (Carter and Tiffany, 1999) and also significant increases in behavioral economic indices of demand (MacKillop et al., 2010b). The changes in craving and demand in this study were variably associated, suggesting these domains are not redundant. The utility of applying a behavioral economic approach to craving remains in its infancy, however, and requires considerable further study.

Despite the promising research applying an APT approach to alcohol use disorders reviewed above, no studies have directly examined the relationship between estimated behavior on an APT and behavior when the alcohol and money in consideration are real. Establishing this correspondence is a critical element in validating the approach. In other areas of behavioral economics, there has been consistent evidence of high correspondence between decision making for hypothetical and actual rewards (e.g., Bickel et al., 2009; Johnson and Bickel, 2002; Madden et al., 2003), but, for purchase tasks, this remains an open question. A second, related question pertains to the degree of correspondence between estimated consumption and actual subsequent behavior. It is possible that participants in studies using an APT are overestimating how much they would actually drink in a given situation, but this has not been directly examined to date.

The goal of the current study was to address these issues. First, we examined the relationship between decision-making on an APT for hypothetical outcomes versus an APT that determined subsequent access to alcohol and money. Second, we examined the relationship between estimated alcohol consumption at a given price and actual consumption once the alcohol was provided. Based on previous studies examining hypothetical versus actual outcomes in behavioral economics, we predicted substantial correspondence in both cases. Third, based on the previous study revealing alcohol cues significantly increased craving and multiple demand indices, we sought to replicate these findings, predicting alcohol cues would significantly increase craving and demand.

Materials and Methods

Participants

Participants were recruited from the community via advertisements. Inclusion criteria were: i) 21+ years old; and ii) alcohol consumption of 14+/7+ drinks/week for males/females (i.e., heavy drinkers) (NIAAA, 2005). Exclusion criteria were: i) seeking treatment for alcohol problems currently or in the past 90 days; ii) currently taking psychotropic medications; iii) pregnancy/trying to conceive (females only); iv) current employee/retiree of the University of Georgia (based on university policies on incentives); and v) attending a session with a positive breath alcohol level (BrAC). Sample characteristics are provided in Table 1.

Assessment

Participants completed a comprehensive demographics assessment. Alcohol use over the past month was assessed using the 28-day Timeline Follow-back procedure (TLFB; Sobell and Sobell, 1992). Level of alcohol misuse was assessed using the AUDIT (Saunders et al., 1993). BrAC was measured using a commercially-available breathalyzer system (Intoximeters, Inc.; St Louis, MO).

The APT was based on previous studies using state-based purchase task assessment (Hitsman et al., 2008; MacKillop et al., 2010b) and adapted from procedures used in laboratory alcohol self-administration paradigms (Anton et al., 2004; O'Malley et al., 2002). Participants received the following information: i) each person had a $15 "bar tab" for purchasing alcohol during the study's one-hour self-administration period; ii) the alcohol available was their typical alcoholic beverage; iii) a maximum of 8 'mini-drinks,' approximately half the size of standard drinks, were available for purchase; iv) the total amount of alcohol available would be sufficient to raise their blood alcohol level to .07%; v) the drinks they received could only be consumed during the self-administration period and could not be stockpiled for a later time; and vi) a 3-hour recovery period was required, regardless of choice outcomes (i.e., choosing fewer drinks would not speed up the session). For the hypothetical version, the following instructions were used: *This version is hypothetical. This means the questions ask you to make your best estimates of how much you would spend AS IF you would actually receive the drinks and money, but in reality you will not.* For the APT resulting in actual rewards, the following instructions were used: *This task is for ACTUAL alcohol and money. Any money you do not allocate to alcohol will be yours to keep and you will receive it today. You will receive the alcohol and money from one of your choices.*

All APTs assessed 24 prices ($0–$15/drink) (see Table 2). Participants completed the APTs using computer-based assessment that provided interactive feedback with regard to how many drinks were available by price and associated change. A mini-drink approach was used because it permitted more variability in choice behavior and provided parallels to existing alcohol self-administration paradigms (e.g., Anton et al., 2004; O'Malley et al., 2002). Of note, however, the current study's protocol was by no means identical to previous self-administration paradigms, which employed priming doses and two-stage choice procedure. Participants were first familiarized with the APT procedure using a demonstration version for hypothetical sodas. The APT was administered on three occasions, first for hypothetical and actual outcomes under neutral conditions, then for actual outcomes following exposure to alcohol cues.

Standard cue reactivity measures were also administered. Subjective craving was assessed using the Alcohol Urge Questionnaire (AUQ; Bohn et al., 1995; MacKillop, 2006). Approach/avoidance motivation was assessed using individual items assessing how much they wanted to consume (approach) or to avoid consuming (avoidance) alcohol on a scale from 0 to 100 (least to most) (Stritzke et al., 2004). Affect was assessed using five 100-pt individual circumplex items: Tense↔Calm, Sad↔Happy, Nervous↔Relaxed, Bored↔Excited, Stressed↔Serene, and Depressed↔Elated (Posner et al., 2005). Psychophysiological arousal was assessed via heart rate and mean arterial pressure [MAP] (Miranda et al., 2008) using an electronic wrist blood pressure cuff (Welch Allyn, Inc.; Skaneateles Falls, NY).

Procedure

Participants underwent a telephone screen, an in-person screen, and an extended laboratory session one week later. In-person screens lasted two hours and comprised informed consent, TLFB, a pregnancy test (females), self-report assessment using MediaLab software (Empirisoft; New York, NY), and full orientation to the laboratory session procedures, including all of the parameters (i.e., alcohol availability, bar tab, self-administration period, durations). The second session was scheduled on a day identified by the participant as having no factors that might affect choice behavior.

Laboratory sessions lasted five hours and always took place in the afternoon or early evening for correspondence with typical drinking hours (see Figure 1 for a time line for the laboratory sessions). Participants were asked to abstain from eating for two hours prior to the session. Sobriety was confirmed via breathalyzer and, for females, pregnancy status was again verified by pregnancy test.

In a neutral laboratory context, participants were asked to complete the hypothetical and actual versions of the APT, as well as the other motivational measures, after which HR and MAP were assessed. Participants were aware that following the hypothetical version, they would complete additional APTs for actual outcomes. The neutral cues comprised a standard laboratory testing room with neutral décor in the presence of a neutral beverage (water). Participants next underwent an alcohol cue exposure based on an established multimodal exposure (MacKillop and Lisman, 2005; MacKillop and Lisman, 2007; MacKillop and Lisman, 2008; MacKillop et al., 2010b; Monti et al., 1987). Specifically, participants were introduced to a bar laboratory, including a bar, alcohol-related decorations, representative bottles of alcohol, dimmed lights, and their typically consumed alcoholic beverage in a standard size. In both neutral and alcohol environments, participants underwent an acute exposure to visual, olfactory, tactile, and proprioceptive cues (viewing and handling the beverage, intermittent inhalation of the smell of the beverage [olfactory exposure = five exposures of 5s each]). Cue exposure procedures were standardized via digital audio-recording and lasted 10 minutes. Alcohol cues were always presented following the water cues based on previous evidence of carryover effects from alcohol cues (e.g., Monti et al., 1987). Following the alcohol cues exposure, participants were again assessed with the APT for actual outcomes and other motivational measures. During the actual-outcome APTs, the $15 bar tab in $1 bills was placed in plain sight of the participant to remind the participant of the contingencies of the choices, and the experimenter noted aloud that these choices would determine the bar tab and mini-drinks received.

Actual outcomes were based on receipt of one-randomly selected choice from the two administrations of the APTs for actual outcomes. This is a common behavioral economic procedure to permit multiple items from which one real outcome will be selected (e.g., Kirby et al., 1999). Immediately following the post-alcohol cues assessment, participants selected a poker chip from a fish bowl containing chips pertaining to the individual item numbers from all actual-outcome APT choices (48 possible outcomes). Participants then received the outcome of the choice they made for that trial (i.e., mini-drinks and change) at that moment. Calculations to determine the overall beverage volume used the alcohol concentration in the participant's typical beverage in combination with sex, age, height, and weight (Brick, 2006). Mini-drinks were prepared as the participants' typical alcoholic beverages and presented using glassware to create mini-drinks that were proportionate and approximately half-sized versions of those beverages. A bottle of spring water was also provided as an alternative beverage to control for thirst. Participants were permitted to drink *ad libitum* in the bar laboratory over the next hour and could put any mini-drinks they chose in a small refrigerator. Per the instructions, regardless of alcohol access/consumption, participants remained in the bar lab for one hour and completed a three-hour recovery period in a neutral lounge, including a meal and access to soft drinks. During the recovery period, participants were given access to their personal belongings and a variety of reading materials (e.g., popular magazines). They were permitted to use personal electronics, but cell phone use was only permitted for arranging transportation home. Maximum departure BrAC was 0.04%.

Participants were compensated $15/hour (total = $105) and their bar tab outcome (max = $15). All procedures were approved by the University of Georgia Institutional Review Board.

Data Analysis

All variables were screened for missing data, outliers (Zs > 3.29), and distribution abnormalities (Tabachnick and Fidell, 2001). Indices of alcohol demand were generated using a data-driven observed values approach (e.g., Murphy and MacKillop, 2006) and a model-driven derived values approach using exponential demand curve modeling (Hursh and Silberberg, 2008). Observed values (Intensity, Breakpoint, O_{max}, and P_{max}) were calculated by either directly examining raw responses on the APT or arithmetically calculating values on the basis of responses; derived values (Elasticity) were obtained using values generated by the exponential demand equation in Hursh and Silberberg (2008) (described below). Intensity was defined as consumption when drinks were free (zero cost). Breakpoint was defined as the first price at which consumption was completely suppressed. O_{max} was defined as the maximum alcohol expenditure, and P_{max} was defined as the price associated with O_{max}. Elasticity was derived using the following nonlinear exponential demand curve model (Hursh and Silberberg, 2008):

$$\log_{10}Q=\log_{10}Q_0+k\left(e^{-\alpha}Q_0C-1\right) \quad (1)$$

where Q = quantity consumed, Q_0 = derived Intensity, k = the range of the dependent variable (standard drinks) in logarithmic units, and α = elasticity (rate constant determining the rate of decline in log consumption based on increases in price). The overall mean performance across all three APT assessments was first analyzed to obtain the best-fitting k parameter, which was determined to be 4.0 and used for all individual demand curves. Correspondence between hypothetical and actual APT performance under neutral conditions was assessed via Pearson product-moment correlations. The effect of cue exposure on demand, subjective motivation, and arousal was assessed via separate repeated-measures ANOVAs. For those participants who received alcohol, estimated alcohol consumption on the APT price and actual alcohol consumption during the self-administration period was assessed via Pearson product-moment correlations. For exploratory purposes, associations were examined among the variables affected by cues to determine the overlap among the motivational indices. In addition, associations between typical drinking behavior and laboratory motivational variables were examined. For all analyses, a conventional Type I error rate of α = .05 was used and effect sizes are provided as r and η_p^2. All analyses were conducted using SPSS 18.0 and GraphPad Prism.

Preliminary Analyses

Complete data were obtained from all participants, but four showed evidence of very low effort on the APT (e.g., highly inconsistent responding across prices) and were excluded from subsequent analysis, resulting a final N of 41. No outliers were observed. Intensity and P_{max} were significantly skewed. Logarithmic transformations improved P_{max} (Zs < 2.5, ps > .10), but not intensity, which was not transformed. Ceiling effects in the form of maximum responses under neutral conditions were present for several demand indices, especially Intensity. This prevented testing the hypothesized increase following alcohol cues, therefore, the individual ANOVAs only included participants who were not at ceiling, as indicated by individual degrees of freedom (Table 3). In general, alcohol demand was prototypic across APT assessments, with consumption decreasing as a function of escalating price and expenditure conforming to an inverted U-shaped function (Figure 2). The exponential demand curve model provided an excellent fit to the data (hypothetical: median R^2 = .95, IQR: .90–.96; neutral cues: median R^2 = .94, IQR: .91–.96; alcohol cues: median R^2 = .94, IQR: .91–.97).

Results

Correspondence between APT Performance for Hypothetical and Actual Outcomes

For the hypothetical and actual versions of the APT, preferences were highly similar. Statistically significant, high magnitude associations were present for all five demand indices (Table 2). In addition, demand at individual prices was also highly similar across both assessments, with large magnitude, statistically significant associations (Table 2).

Correspondence between Estimated and Actual Consumption

Based on the outcome of the random poker chip selection procedure, 30 participants (73%) received at least one drink during the consumption period (*M* drinks provided = 5.6; *SD* = 2.4). On average, participants consumed 87.1% of the alcohol that was provided at the price associated with their choice. Specifically, the average number of mini-drinks consumed was 4.7 (*SD* = 2.1), resulting in an average BrAC of .049% (*SD* = .031) at the end of the consumption period. The correlation between the number of drinks provided and the number of drinks actually consumed was of high magnitude and was statistically significant (r = .87, p < .001; Figure 3).

Effects of Alcohol Cues on Behavioral Economic, Subjective, and Psychophysiological Motivational Indices

Alcohol cue reactivity effects are presented in Table 3. Compared to neutral cues, alcohol cues produced a trend-level increase in intensity of demand, but no other behavioral economic indices. Alcohol cues also significantly increased craving, excitement, approach motivation, blood pressure, and significantly decreased avoidance motivation. Significant effects were not present for other indices of affect or heart rate. Significant correlations were present at both time points and for changes, but the pattern of associations did not suggest redundancy. Correlation coefficients and proportion of overlapping variance are provided in Table 4.

Typical Alcohol-related Behavior and Laboratory Performance

Drinks/week was significantly correlated with AUDIT (r = .74, p <.001), and both were positively associated with intensity on all three APT assessments (rs > .39, ps < .01), retaining all values. In addition, AUDIT scores were significantly positively associated with approach motivation following alcohol cues (r = .34, p < .05), but no other variables were significantly associated with typical alcohol-related behavior (ps > .14).

Discussion

The primary goal of this study was to examine the correspondence between APT decisions for hypothetical and actual alcohol rewards, both in terms of decision making itself and the behavior following those choices. The first hypothesis - that there would be a close correspondence between demand for alcohol across the hypothetical and actual outcomes conditions - was supported at both the level of individual prices and demand indices. The second hypothesis was also supported, with estimated consumption on the actual APTs closely corresponding with actual alcohol consumption. A secondary goal of the study was to examine the effects of cues on alcohol demand and the findings in this area were mixed. Exposure to alcohol-related cues significantly affected subjective craving, approach/avoidance motivation, affect, arousal, and produced a trend-level increase in intensity of demand, but not the other behavioral economic indices.

The present study extends the literature on the behavioral economics of heavy alcohol use in several ways. This study is the first to offer evidence of the equivalence of hypothetical and actual APT versions, suggesting that individuals' decisions for hypothetical rewards may provide a generally valid assessment of their preferences when actual money and alcohol are at stake. This finding converges with previous similar behavioral economic studies (e.g., Bickel et al., 2009; Johnson and Bickel, 2002; Little and Correia, 2006; Madden et al., 2003) and is presumably because these tasks assess choices that are quantitatively discrete for highly familiar commodities. This study also provides initial evidence that estimated consumption at a given price on an APT is closely associated with actual alcohol consumption at that price during a self-administration period. Taken together, these findings add to a growing literature validating purchase tasks in alcohol research (e.g., MacKillop et al., 2010a; MacKillop et al., 2009; MacKillop et al., 2010b; Murphy and MacKillop, 2006; Murphy et al., 2009).

The modest support for the prediction that alcohol cues would increase demand is worthy of a more fine-grained discussion and raises one of the study's limitations. On one hand, some notable parallels to the previous study were present, such as increases in Intensity and craving with remarkably similar effect sizes. For Intensity, the previous study detected an effect (η_p^2) of .20 and the present study detected an effect of .23; for craving, the previous study detected an effect of .51 and the current study detected an effect of .50. On the other hand, contrary to previous findings, the other demand indices were not significantly affected by alcohol cues in this study. One clear explanation for these differences is the difference between the APT assessments. Most obviously, the APTs were for hypothetical outcomes in the previous study and actual outcomes in the current study. Moreover, due to logistical and ethical considerations, the range of prices, drink size, and consumption limits in the current study were substantially narrower than in the previous study. Indeed, the presence of ceiling effects for a number of participants indicates that the actual APT could not accommodate the full range of preferences, and is a limitation of the current study. Thus, the restriction of range may be the reason cue effects were not observed and greater variability may be necessary for purchase task approaches to be sensitive to environmental manipulations. However, this is necessarily conjecture and a goal for future studies will be to understand both method-specific and cue-specific influences on changes in alcohol demand more fully.

This study provided the opportunity to examine the interrelationships among multiple motivational domains, revealing substantial heterogeneity. Craving was significantly associated with approach motivation, but was largely unrelated to the other variables. Avoidance motivation was only significantly associated with approach motivation (inversely). Blood pressure was negligibly associated with all the other variables. In terms of changes, two notable patterns were present. Changes in craving, approach, and Intensity were all positively associated, and there was a substantial positive relationship between changes in excitement and Intensity. Taken together, the overall patterns suggested that although these diverse assays of motivation were related to one another in some instances, they were not redundant indicators of a single underlying drive state. This further supports multidimensional theories of alcohol motivation (MacKillop and Monti, 2007; Sayette et al., 2000), in which acute motivation is comprised of diverse and distinct underlying processes.

These findings should be interpreted cautiously and in the context of several considerations. As noted above, ceiling effects and experimentally constrained APT choices may have exerted method-specific effects, obscuring meaningful variability. Constraining the total amount of money available for purchasing alcohol restricted the range of available drinks at higher prices (i.e., at $2.00 and above, the maximum amount of available drinks decreased as a function of escalating price), thus, the total volume of alcohol available may have played a role in participants' choices. Furthermore, the hypothetical and actual APT measures were administered in a consistent order under neutral conditions so potential order effects cannot be examined. Participants were also explicitly told that subsequent actual-outcome APTs would follow the hypothetical version. It is unclear what influence, if any, this expectancy may have had on participant responses on the different APT versions. Finally, the evaluation of estimated and actual alcohol consumption was nested within the number of drinks the participant received, with several consequences. Most obviously, a sizable minority of participants did not have the opportunity to consume any alcohol and were omitted from these analyses. Participants were also not given the opportunity to select more alcohol during the consumption period, meaning the study was able to assess whether individuals overestimated how much they would drink, but not underestimates. However, it is also important to keep in mind that, after the first drink, actual decisions about drinking are influenced by acute alcohol intoxication and the current study was intentionally focused on examining choice behavior, *ceteris paribus*. Parsing consistency of preferences with no intervening acute influences and alcohol-induced effects on inconsistency and preference reversals will be an important focus of future studies. An additional consideration is the sample investigated. Although participants were recruited from the community, the sample comprised young educated adults of generally low income. Future studies would benefit from a larger and more diverse sample, which would increase both statistical power and the number of participants with access to alcohol.

One final consideration that deserves particular emphasis is the time interval between the hypothetical and actual APT assessments. Administering the two forms of the APT at relatively short temporal proximity creates the possibility of a demand characteristic (i.e., participants responding similarly because they perceived it was how they *should* respond), which would substantially undermine the current study's findings. Future studies should directly address this issue via different experimental designs. For example, administering hypothetical and actual-outcome APTs at substantially different times (e.g., 30 days apart) and recruiting a comparison group that received the hypothetical version twice with the same separation would largely remove performance expectations. More generally, excluding the influence of demand characteristics should be a priority for future studies.

Importantly, this study reflects the first in this area and these conclusions should not be considered definitive at this point. The approach is consistent with previous similar behavioral economic validation studies (Johnson & Bickel, 2002; Kirby et al., 1999) and provided a logical starting point, but future studies using alternative designs will be necessary to determine these relationships fully. In future studies, it will be important to keep in mind that the superordinate question is more nuanced than testing the null hypothesis - that there is no relationship between choices for hypothetical outcomes and actual outcomes. The data from previous studies using APTs and the current study suggest this is almost certainly not the case. However, it is probably equally certain that decision-making for hypothetical and actual outcomes are not completely interchangeable in all cases. Thus, the larger questions pertain to how close the correspondence is under different parameters and the conditions that are associated with higher or lower correspondence. More generally, it will be important to determine when estimated consumption is sufficient (or preferable) and when are multi-session progressive-ratio paradigms or, like the current study, APT paradigms for actual alcohol are more appropriate. The goal of this line of research is not for one methodology to replace another, but rather to develop complementary tools for tackling diverse research questions.

In summary, this study provides initial evidence that performance on an APT for hypothetical outcomes appears to closely correspond with choices for actual outcomes, and that estimated consumption similarly corresponds to actual drinking behavior. The study also provides further evidence that alcohol cues dynamically increase the relative value of alcohol, albeit only in the case of a trend-level increase in Intensity, and also suggests APT assessment parameters play an important role in its capacity to detect dynamic changes. Taken together, although a number of considerations apply, these findings further support the purchase task methodology and the promise of future studies to further optimize its application in research on addictive behavior.

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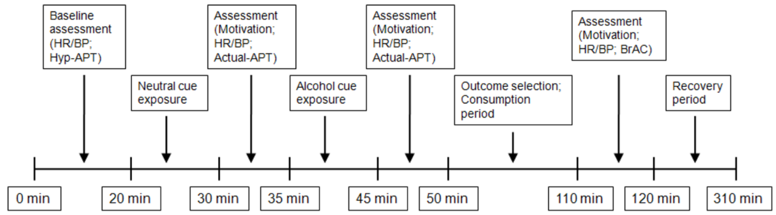
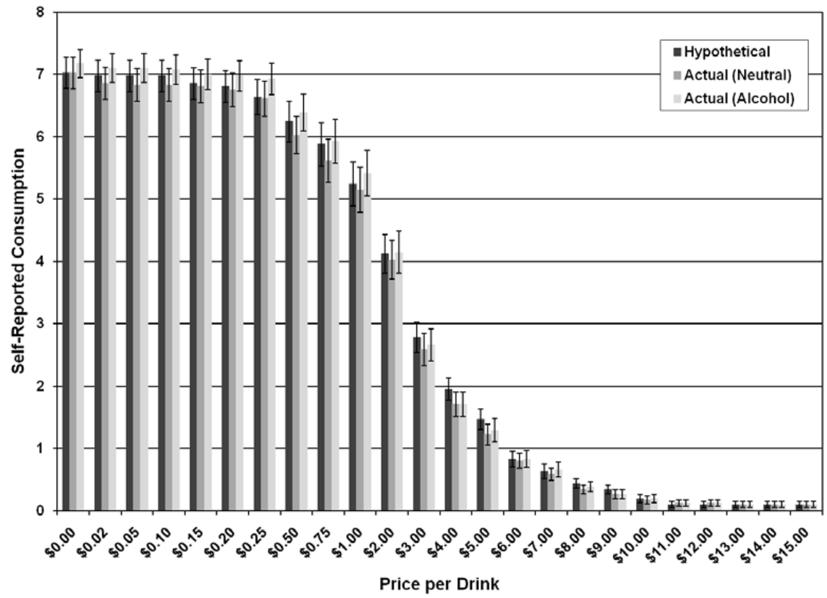


Figure 1.

Schematic time line of study procedures. *Note*. HR/BP, Heart-rate/blood pressure (MAP); Motivation assessments included craving, approach-avoidance, and affect; Hyp-APT, Alcohol purchase task for hypothetical rewards; Actual-APT, Alcohol purchase task for actual rewards; BrAC, breath alcohol level.

A.



B.

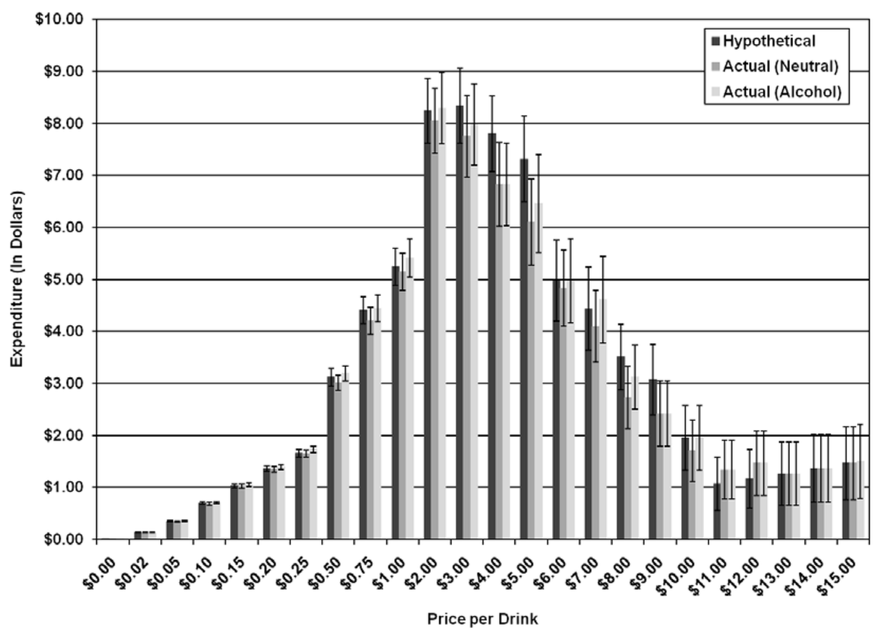


Figure 2.

Average demand (A) and expenditure (B) curves across all three alcohol purchase task assessments. Price per drink is presented in conventional logarithmic coordinates for proportionality. Individual data points represent mean (+/− standard error).

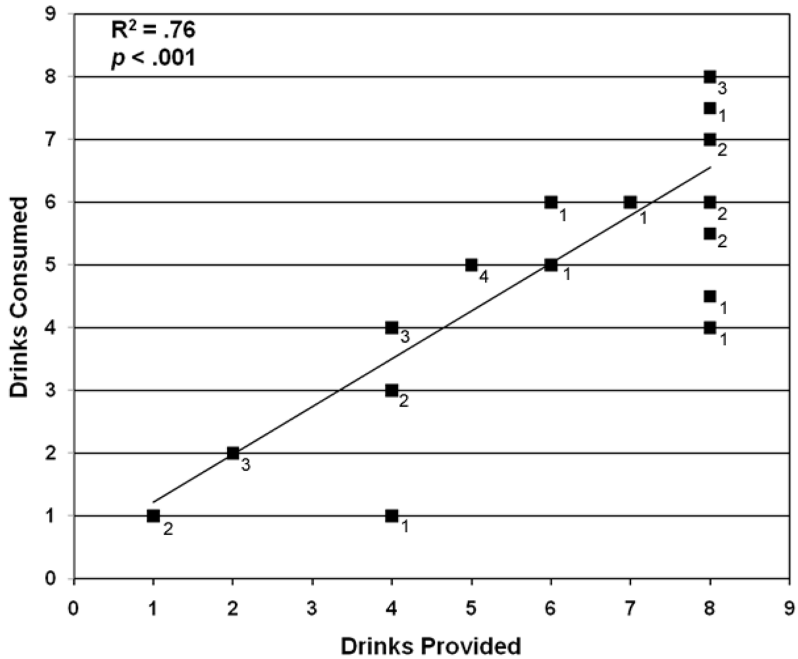


Figure 3.
Relationship between estimated alcohol consumption at a given price (Drinks Provided) and actual consumption (Drinks Consumed) during the one-hour consumption period. The number of participants represented by each datapoint is indicated with subscripts (N = 30).

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Table 1

Participant characteristics (N = 41).

Characteristic	Mean (*SD*)/Median [IQR]/%
Sex	56% Male; 44% Female
Age	22.8 (3.0)
Race	71% White; 17% Black; 12% Asian
Ethnicity	98% Non-Hispanic
Education (Years)	15.5 (1.4)
Income	$15,000 [$4,500 – $55,000]
Drinks/Week	26.7 (17.2)
AUDIT	12.6 (5.2)

Note. AUDIT, Alcohol Use Disorders Identification Test; IQR, inter-quartile range; SD, standard deviation.

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Table 2
Alcohol purchase task performance for hypothetical and actual rewards

Associations between the Alcohol Purchase Task (APT) for hypothetical outcomes and the APT for actual outcomes under neutral conditions. APT Response Range indicates the range of participant responses on the hypothetical and actual-outcome APT assessments. The range of participant responses at each price point was identical on both assessments.

Demand Index/Price	*r*	APT Response Range
Intensity	.90***	-
O_{max}	.96***	-
P_{max}	.87***	-
Breakpoint	.92***	-
Elasticity	.97***	-
$0.00	.90***	3–8
$0.02	.91***	3–8
$0.05	.91***	3–8
$0.10	.91***	3–8
$0.15	.95***	3–8
$0.20	.94***	3–8
$0.25	.93***	3–8
$0.50	.87***	2–8
$0.75	.90***	1–8
$1.00	.92***	1–8
$2.00	.94***	0–7
$3.00	.90***	0–5
$4.00	.84***	0–3
$5.00	.74***	0–3
$6.00	.87***	0–2
$7.00	.85***	0–2
$8.00	.81***	0–1
$9.00	.73***	0–1
$10.00	.76***	0–1
$11.00	.88***	0–1
$12.00	.88***	0–1
$13.00	1.00***	0–1
$14.00	1.00***	0–1
$15.00	1.00***	0–1

Note. N = 41;

*** $p<.001$;

Table 3

Effects of alcohol cue exposure

Effects of alcohol cues on subjective motivation, psychophysiological arousal, and behavioral economic indices of value. F ratios, p values, and effect sizes are provided for each variable (between-subjects degrees of freedom for each analysis are indicated via superscripts).

	F	*p*	η_p^2
Subjective Motivation			
AUQ	39.5[a]	<.001	.50
Approach	24.7[a]	<.001	.38
Avoidance	11.8[a]	.001	.23
Tense-Calm	0.5[a]	.46	.01
Sad-Happy	0.2[a]	.68	.00
Nervous-Relaxed	0.6[a]	.43	.02
Bored-Excited	4.3[a]	.05	.10
Stressed-Serene	0.6[a]	.46	.01
Depressed-Elated	0.0[a]	.93	.00
Physiological Arousal			
MAP	6.0[a]	.02	.13
HR	2.2[a]	.15	.05
Behavioral Economic Indices			
Intensity	3.6[b]	.08	.23
O_{max}	0.7[c]	.84	.02
P_{max}	0.4[d]	.54	.00
Breakpoint	1.0[e]	.33	.03
Elasticity	0.4[a]	.52	.01

Note.

[a] *df*=40;

[b] *df*=12;

[c] *df*=31;

[d] *df*=36;

[e] *df*=36; AUQ, Alcohol Urge Questionnaire; MAP, mean arterial pressure; HR, heart rate.

Table 4

Associations among the significant motivational indices in the cue reactivity paradigm

Pearson product-moment (*r*) correlation coefficients are provided in the upper right quadrants and variance proportions (R^2) are presented in the lower left quadrants.

Variable	AUQ	Approach	Avoid	Bored-Excited	MAP	Intensity[a]
			Neutral Cues			
AUQ	**1**	.38*	−.28†	.07	−.18	.58*
Approach	14%	**1**	−.54***	.12	.20	.37
Avoid	8%	29%	**1**	−.14	−.29†	−.38
Bored-Excited	0%	1%	2%	**1**	.17	.61*
MAP	3%	4%	8%	3%	**1**	−.24
Intensity[a]	34%	14%	14%	37%	6%	**1**
			Alcohol Cues			
AUQ	**1**	.57***	.16	.32*	−.05	.35
Approach	32%	**1**	−.62***	.39*	.21	.40
Avoid	3%	38%	**1**	−.11	−.21	−.38
Bored-Excited	10%	15%	1%	**1**	.01	.44
MAP	0%	4%	4%	0%	**1**	.09
Intensity[a]	12%	16%	14%	19%	1%	**1**
			Δ Neutral→Alcohol			
AUQ	**1**	.35*	.04	.00	.09	.67*
Approach	12%	**1**	−.14	−.14	.18	.40
Avoid	0%	2%	**1**	−.20	−.03	−.46
Bored-Excited	0%	2%	4%	**1**	.05	.81***
MAP	1%	3%	0%	0%	**1**	.39
Intensity[a]	45%	16%	21%	66%	15%	**1**

Note. $n = 41$ (

[a] n=13);

† p<.10;

*
$p<.05$;

**
$p<.01$;

***
$p<.001$; AUQ, alcohol urge questionnaire; MAP, mean arterial pressure.

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