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Effects of Alcohol and Initial Gambling Outcomes on Within-Session Gambling Behavior

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Abstract

Concurrent drinking and gambling is prevalent among young adults and may increase negative consequences associated with each behavior. The effects of alcohol, initial gambling outcomes, gambling-related cognitions, and impulsivity on gambling behavior were evaluated. Initial gambling outcomes, gambling-related cognitions, and impulsivity were also assessed as potential moderators of the relation between alcohol and gambling behavior. Participants (*N* = 130) were randomly assigned to receive active placebo or alcohol (0.84 g/kg and 0.76 g/kg for men and women, respectively) and were invited to wager on a simulated slot machine programmed to produce 1 of 3 initial outcomes (win, breakeven, or loss) before beginning a progressive loss schedule. Alcohol consumption was associated with larger average bets and more rapid loss of all available funds, though no evidence was found for predicted main effects and interactions for gambling persistence. The effect of impulsivity was moderated by beverage condition, such that higher levels of impulsivity were associated with larger average bets for participants in the placebo but not the alcohol group. Results have direct implications for individual-focused and public-health interventions.

Keywords

alcohol; gambling; persistence; betting behavior; impulsivity

Late adolescence and young adulthood is marked by engagement in risky behaviors, including frequent and heavy use of alcohol (Arnett, 1992, 2000). Approximately 73% of Americans between the ages of 21 and 30 consume alcohol at least monthly, 6% use alcohol daily, and over 37% engage in heavy episodic consumption (i.e., five or more drinks on a single occasion in the past 2 weeks; Johnston, O'Malley, Bachman, & Schulenberg, 2008). Rates of heavy episodic consumption and drinking to intoxication are consistently higher among college students relative to their noncollege peers (Johnston et al., 2008), increasing their risk for experiencing harm associated with alcohol misuse, including impaired academic performance, legal involvement, sexual victimization, physical illness and injury, and death (Perkins, 2002).

Most research on alcohol-related harm in college students has focused on the influence of alcohol on other health-risk behaviors common to this population, such as unsafe sexual practices (Cooper, 2002), drug use (Mohler-Kuo, Jae, & Wechsler, 2001), and aggression

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(Giancola, 2002). Gambling is another health-risk behavior that is prevalent among college students (Engwall, Hunter, & Steinberg, 2004; Platz, Knapp, & Crossman, 2005) and can have serious consequences, including impaired academic, occupational and social functioning, financial losses, legal involvement, and increased risk for comorbid mental illness and suicide (American Psychiatric Association, 2000; Black & Moyer, 1998; Stinchfield, Hanson, & Olson, 2006). Gambling also frequently co-occurs with alcohol use. Approximately 26% of college students frequently or always drink when they gamble (Giacopassi, Stitt, & Vandiver, 1998). The relatively poor enforcement of minimum drinking age and minimal cost of alcohol served to patrons who are actively gambling encourages an even higher percentage of underage college students to engage in casino gambling in order to obtain alcohol (35.4%; Giacopassi, Stitt, & Nichols, 2006).

Despite their demonstrable association, relatively little research has been conducted on the co-occurrence of alcohol use and gambling, with even fewer studies evaluating the impact of alcohol on gambling behavior. Maladaptive behavior occurring within a single gambling session (i.e., continued play with the goal of recouping money lost earlier in a gambling occasion) may set the stage for the development of gambling psychopathology. This type of *within-session chasing* may lead to long-term gambling problems by precipitating *between-session chasing* (i.e., initiation of future gambling sessions to win back money lost on preceding occasions). Considering the ubiquitous availability of alcohol in many gambling venues, understanding how alcohol influences persistence and other betting behaviors that may serve as precursors to disordered gambling is a necessary step to inform prevention efforts for both behaviors.

Although limited in scope, there is some evidence to suggest that alcohol use may contribute to longer duration of gambling episodes and increased amount of money spent. Compared to college students who never or rarely consume alcohol while gambling, those who frequently or always drink while gambling are more likely to report typical gambling episodes lasting 2 or more hours (Giacopassi et al., 1998). Among adult patrons of gambling establishments, strong positive associations have been found between total amount of alcohol consumed and both total amount spent within a single gambling session and self-reported impaired control over gambling (Baron & Dickerson, 1999).

Additional support for alcohol's impact on within-session gambling behavior comes from three alcohol administration studies. Ellery, Stewart, and Loba (2005) found that participants randomly assigned to consume a moderate dose of alcohol (target Blood Alcohol Concentration [BAC] = .06 g%) played significantly longer than no-alcohol controls when allowed to gamble on a video lottery terminal. Although not statistically significant, individuals in the alcohol condition also evidenced a trend ($p < .06$) toward increased rates of power-betting (i.e., increasing one's wager up to double during the course of a single gamble), and examination of group means suggested that participants in the alcohol condition spent more money per bet and overall. Kyngdon and Dickerson (1999) also found greater persistence in gambling after alcohol consumption in a sample of moderate-to-heavy male drinkers placed on a progressive loss schedule. This study used a computerized card game in which participants were asked to bet on whether the next card drawn would be high or low. Compared to 15% of participants in the placebo condition, 50% of participants in the alcohol condition continued to gamble until they had lost their entire original stake. The inclusion of a placebo control in this study suggests that the effects were not simply due to expectancies about alcohol's effects. However, these results should be interpreted with caution given a marginally higher level of trait impulsivity at baseline among participants in the alcohol condition. Finally, Phillips and Ogeil (2007) had male social gamblers play a computer-based simulated blackjack game before and after consuming alcohol (average BAC = 0.048 g%). Participants demonstrated shorter latency between betting decisions (i.e., placing initial wagers and deciding whether to “hit” or “stand”) and evidenced a steeper cumulative loss function (i.e., lost points much more quickly) following alcohol.

Although these studies provide important initial results regarding alcohol’s effect on within-session gambling, methodological differences across these studies leave certain questions unanswered. In addition, these studies have relied minimally on theory to drive study hypotheses. One prominent theory within the alcohol literature that may explain how alcohol promotes gambling persistence is the Attention Allocation Model (Steele & Josephs, 1990). This model suggests that alcohol impairs individuals’ ability to process available information and restricts their attention to only the most salient internal and environmental cues, a phenomenon referred to as *alcohol myopia*. Under conditions where both impelling and inhibiting cues are present, the model posits that behavior will be determined by the relative strength of the cues. Thus, alcohol effects should be moderated by contextual and intrapersonal factors that influence cue salience.

There are several possible contextual and intrapersonal factors that may influence the salience of internal and environmental cues for the individual. Perhaps the most obvious contextual factor is recent gambling outcomes. With respect to monetary gains and losses, Prospect Theory (Kahneman & Tversky, 1979) suggests that when individuals are given a choice between certain and uncertain outcomes they tend to be more risk-averse in the domain of gains and loss-averse (or risk-seeking) in the domain of losses (Breslin, Sobell, Cappell, Vakili, & Poulos, 1999; Camerer, 1998; George, Rogers, & Duka, 2005; Kahneman & Tversky, 1979). Thus, individuals who win during the initial portion of a gambling occasion should be more risk-averse (i.e., less willing to persist and risk their certain winnings), and individuals who initially lose should be more risk-seeking (i.e., more likely to persist and risk potential future losses rather than accept certain losses). As previously described, the Attention Allocation Model (Steele & Josephs, 1990) suggests that this behavioral pattern should be more pronounced following alcohol consumption as alcohol will serve to heighten the influence of the most salient cues.

In terms of intrapersonal factors, maladaptive cognitions related to potential gambling outcomes may enhance the salience of cues for reward, thereby exerting direct effects on gambling behavior, as well as potentially moderating the effect of alcohol. Irrational beliefs about gambling may lead individuals to continue gambling even when objective information suggests that they should stop. For example, a person who fails to win after wagering several successive bets on a slot machine may think that they are “due for a win,” clearly misperceiving random events as connected. Gambling-related cognitions have been empirically linked to specific behaviors that would promote escalating losses, including increased average bet size (Delfabbro & Winefield, 2000) and initiation of a new gambling session (Breen & Zuckerman, 1999).

Finally, certain personality traits may affect cue salience. For example, individuals high in impulsivity tend to focus less on potential costs and more on cues for reward. Dispositional factors that incline an individual to demonstrate poor behavioral control may thus directly influence gambling behavior as well as serve to moderate the effects of alcohol. A number of studies have demonstrated relations between measures of personality and gambling behavior (Blaszczynski, Steel, & McConaghy, 1997; McDaniel & Zuckerman, 2003; Nower, Derevensky, & Gupta, 2004; Vitaro, Arsenault, & Tremblay, 1999), though gambling behaviors that may most strongly relate to impulsivity (i.e., persistence in the face of losses) have received limited attention and have generally relied on use of a single self-report measure. Even when multiple measures have been used, they have typically assessed a single dimension of impulsivity (e.g., sensation-seeking), which may partially explain the absence of moderating effects on the relation between alcohol and gambling behaviors in prior research (Breslin et al., 1999).

The purpose of the current study was (a) to evaluate the impact of alcohol consumption on gambling behavior (i.e., persistence and betting behavior); (b) to evaluate the extent to which initial within-session gambling outcomes, gambling-related cognitions, and impulsivity, exert direct (main) effects on gambling behavior; and (c) to examine the potential moderating effects of initial within-session gambling outcomes, gambling-related cognitions, and impulsivity on the relation between alcohol consumption and gambling behavior. In pursuit of these aims, a two-group (alcohol vs. active placebo) paradigm was utilized, and participants completed a gambling task (a simulated slot machine) that permitted manipulation of initial gambling outcomes (win vs. breakeven vs. loss) between subjects.

Consistent with prior research on alcohol-related disinhibition, individuals in the alcohol condition were expected to persist longer and bet more on average than participants in the active placebo condition (Easdon & Vogel-Sprott, 2000; Reynolds, Richards, & de Wit, 2006). Based on Prospect Theory (Kahneman & Tversky, 1979), individuals who experienced initial losses were expected to show greater persistence and increased average bets, and those who initially won were expected to be less likely to persist and to place lower average wagers, relative to those who broke even. Individuals with more erroneous beliefs about control over gambling outcomes and individuals scoring higher on measures of trait impulsivity were also expected to persist longer and wager more. Based on the Attention Allocation Model (Steele & Josephs, 1990), initial gambling outcomes, gambling-related cognitions, and trait impulsivity were expected to moderate the association between beverage condition and gambling outcomes. Specifically, alcohol effects were expected to be strongest among individuals experiencing initial losses, and among those with more distorted cognitions and higher levels of impulsivity.

Method

Participant Recruitment and Screening

Participants between the ages of 21 and 30 were recruited from several New England college campuses and their surrounding communities. To qualify for participation an individual had to complete a telephone screen and report that he or she (a) consumed three or more drinks on at least one occasion per week over the last 3 months; (b) engaged in one or more forms of gambling at least once in the last 3 months; and (c) played a slot machine or gambled at a casino at least once during his or her lifetime. Minimum inclusion criteria were selected to ensure that participants had sufficient familiarity with drinking and gambling (of a nature consistent with the requirements of the study protocol), thereby minimizing any effects due to inexperience or novelty. Individuals were excluded from participation if they received a score of 5 or greater on the South Oaks Gambling Screen (SOGS; Lesieur & Blume, 1987), which is indicative of gambling psychopathology, or if they reported any physical or psychological contraindications to alcohol consumption, including physical symptoms of dependency, a flushing response to alcohol, prior participation in an abstinence-oriented alcohol treatment program, or chronic health conditions (cf., Armor, Polich, & Stambul, 1978). Of the 449 individuals who completed the telephone screen, 228 (51%) were deemed eligible for participation, of which 181 (79%) subsequently participated in the study. The first 15 participants provided pilot data leading to a change in the gambling task used to collect the criterion data (see *simulated slot machine* description below).[1] In addition, uncontrollable computer failures resulted in the loss of criterion data for 36 participants, leaving a final sample of 130 participants with complete data. Demographic and behavioral characteristics of the sample are provided in Tables 1 and 2.

Study Protocol

The protocol was implemented in groups of two to four individuals on weeknight evenings, with groups randomly assigned to alcohol and active placebo conditions. Participants were asked to refrain from consuming alcohol or other drugs during the preceding 24 hours, and to refrain from eating for 4 hours prior to the protocol. Upon arriving at the lab, participant age was verified, informed consent was obtained, and breathalyzer tests were administered to ensure a zero breath alcohol concentration (BrAC). Female participants were required to perform a urine test to rule out pregnancy. Participants were subsequently asked to complete a set of computer-based self-report measures assessing (a) demographic characteristics; (b) gambling-related cognitions; (c) personality traits; (d) experience with and preference for specific types of gambling; and other constructs unrelated to the current study. Participants also completed interviewer-administered retrospective-recall measures of gambling and alcohol behavior.

Following completion of the interviews and self-report measures participants were administered three drinks over 30 minutes in a simulated bar setting. In order to keep research assistants who served the drinks blind to the beverage condition, alcohol and active placebo presentations (alcohol bottles filled with pure 80 proof vodka or a 4:1 ratio of flat tonic water to 80 proof vodka, respectively) and the delivery vehicle (a nonalcoholic mixer comprising a 6:3:1 ratio of lemon-lime soda, cranberry juice, and lime juice), were prepared in advance by a protocol supervisor. The volume of alcohol/placebo in each drink was adjusted based on participants' weight and gender. A target BrAC of 0.08 g% was chosen for the alcohol condition (alcohol dose = 0.84 g/kg and 0.76 g/kg for men and women, respectively) because it has reliably produced effects of alcohol that exceed those associated with the active placebo (Corbin & Cronce, 2007), and it is ecologically meaningful as it is equivalent to the legal limit for intoxication in the United States. Moreover, this target is consistent with the higher range of BACs that are evident among individuals who engage in heavy episodic drinking (i.e., consumption of 4 or more drinks for women, or 5 or more drinks for men, on a single occasion), a behavior that is common among young adults in general (Johnston et al., 2008) and among college student gamblers specifically (Engwall et al., 2004). In addition to including a small amount of alcohol in the placebo mixture and floating a small amount of alcohol on the top of each drink, beverage glasses were rimmed with alcohol to enhance the credibility of the placebo. The total volume of alcohol served to participants in the active placebo condition was calculated to achieve a target BrAC of 0.01 g%. Both alcohol and placebo presentations were poured in full view of participants before being added to the nonalcoholic mixer at a 1:3 ratio. Following a 15-min absorption period, the protocol supervisor assessed BrAC using an Alco-Sensor III Breathalyzer (Intoximeters, Inc., St. Louis, MO) and an Intoxilyzer5000 (CMI, Inc., Owensboro, KY). Participants and research assistants were kept blind to participants' BrAC readings until the end of the

[1]During the pilot testing phase, the criterion task was divided into two administrations, one occurring prior to beverage administration and one occurring following beverage administration. The initial gambling outcome manipulation described in the study protocol was applied during the prebeverage administration of the task, and consisted of only two groups: win and loss. Computers used by individuals in the win condition were set to deliver a 150% net return on wagers, whereas computers used by individuals in the loss condition were set to provide a 50% net return on wagers. During the postbeverage administration, all participants were set on a gradual progressive loss schedule, with a 90% net return on wagers made during the first block of trials, and a 10% decrease in net return on wagers in each subsequent block, consistent with the methodology used by Kyngdon and Dickerson (1999). Also consistent Kyngdon and Dickerson's study, participants were handed a $10 bill before the beginning of each administration and asked to return the $10 bill to the protocol supervisor if he or she wished to play the simulated slot machine. Using this procedure, the majority of individuals opted not to complete the task, and of those who did complete the prebeverage administration, most declined to participate in the postbeverage administration. Thus, the task was restructured into its current configuration in order to address the high refusal rate and reduce participant burden.

protocol. Concurrent with BrAC assessments, participants were asked to provide estimates of subjective intoxication as a manipulation check.

Participants were subsequently given the opportunity to play a simulated slot machine (the *criterion task*) in an adjoining room. The task was set up in blocks of 15 trials to allow manipulation of contingencies, and participants were assigned to one of three initial gambling outcome conditions (win, breakeven, loss). Participants in the win and loss conditions experienced a net return on their wagers of 140% and 100%, respectively during the first block of trials, with a 20% reduction in net return in each of the two successive blocks. The net return for participants in the breakeven condition was set at 100% across all three initial blocks. Following the third block of trials, all participants were put on a progressive loss schedule, with a net return of 80% during the fourth block of trials and a 20% reduction in net return in each successive block. As all participants completed the task simultaneously in the same room (similar to playing slot machines in a casino), assignment to initial gambling outcome condition was stratified to avoid arousing suspicion. On evenings when two or three participants were present, each participant was assigned to a different initial gambling outcome condition; when four participants were present, one condition was repeated. Participants were instructed that $10 worth of credits (25¢ each) had been preloaded into the slot machine and that they would be given a bonus above and beyond the hourly rate they were being paid, equivalent to the amount remaining on the screen when they were done playing. They were also told that they would receive the $10 in credits that were preloaded on the slot machine if they chose not to gamble. Participants were told that they could play for as long as they chose. However, the program was terminated when all credits were exhausted. Participants who chose not to wager on the slot machine task (n = 8) were allowed to complete a different computer task that did not involve wagering money to minimize potential social pressure on other participants to discontinue gambling. Following play on the slot machine, participants completed two additional tasks unrelated to the current study. BrAC measurements were taken by the protocol supervisor and estimates of subjective intoxication were provided by participants following each task.

At the end of the protocol all participants were debriefed, and individuals in the placebo condition were allowed to leave. In accordance with recommendations from the National Advisory Council on Alcohol Abuse and Alcoholism (2005), participants in the alcohol condition were required to remain in the laboratory until their BrAC dropped to 0.02 g%. Regardless of their performance on the simulated slot machine, each participant received $12 per hour plus a bonus of $20. All procedures outlined above were reviewed and approved by the Yale University Faculty of Arts and Sciences Human Subjects Committee.

Self-Report Measures

Demographics—Demographic information assessed included age, sex, ethnic and racial identity, educational background, academic standing, and socioeconomic status.

Gambling-related cognitions—The Gambling Attitudes and Beliefs Scale (GABS; Breen & Zuckerman, 1999) comprises 35 items assessing the extent to which individuals agree with erroneous statements about gambling behaviors such as “If I have lost my bets recently, my luck is bound to change.” Higher total scores reflect the perception that gambling outcomes can be controlled through use of specific strategies and/or by acting on personal feelings of luck. The GABS evidenced good internal consistency reliability (Cronbach’s alpha = .89).

Impulsivity—The Barratt Impulsiveness Scale-11 (BIS-11; Patton, Stanford, & Barratt, 1995) comprises 30 items that assess three factors: motor impulsiveness (i.e., physical action without thought); attentional impulsiveness (i.e., lack of concentration); and nonplanning impulsiveness (i.e., spontaneity and present-focused orientation). Internal consistency reliability alpha coefficients for the three subscales were .66, .70, and .67, respectively.

The 19-item impulsive unsocialized sensation seeking subscale of the Zuckerman Kuhlman Personality Questionnaire III – Revised (ZKPQ-IIIR; Zuckerman, Kuhlman, Joireman, Teta, & Kraft, 1993) consists of true/false items. This larger subscale comprises two separate subscales assessing sensation seeking needs (*sensation seeking; 11 items*), and lack of planning and tendency to act without thinking (*impulsivity; 8 items*). Internal consistency reliability alpha coefficients were .64 and .80 for the sensation-seeking and impulsivity subscales, respectively.

Preference for slot machines as a form of gambling—Participants were asked to indicate how much they enjoy engaging in 10 different types of gambling (taken from the SOGS, Lesieur & Blume, 1987) on a 7-point Likert scale with anchors at 1 (*dislike very much*), 4 (*neither like nor dislike*), and 7 (*like very much*). Participants were also asked to rank the different types of gambling from 1 (*most like to engage in*) to 10 (*least like to engage in*).

Beverage condition manipulation check—Two separate items were used to assess perceived amount of alcohol consumed (i.e., number of standard drinks) and perceived BAC using visual analog scales. Whole numbers (0 to 6), with nine evenly spaced intervening tick marks (representing one-tenth increments; e.g., 1.3 drinks), were provided as anchors for the standard drink question. Two-digit decimals (.00 to .12), with four evenly spaced intervening tick marks (representing two-thousandth increments; e.g., .062 BAC), were provided as anchors for the BAC question. For each question, participants were asked to place an X on a line corresponding to their estimate. The 14-item Biphasic Alcohol Effects Scale (BAES; Martin, Earlywine, Musty, Perrine, & Swift, 1993) was used to assess subjective experiences of alcohol stimulation (e.g., energized, talkative) and sedation (e.g., heavy head, slow thoughts). Participants rated the extent to which they experienced each effect on 11-point Likert-type scales with anchors at 0 (*not at all*) and 10 (*extremely*). Coefficient alpha was calculated at each of the four separate assessment points. Values were in excess of .96 and .87 for the two subscales, respectively.

Interviewer-Administered Measures

A standard alcohol Timeline Followback interview (TLFB; Sobell & Sobell, 1992) was employed to provide a retrospective assessment of drinking frequency (number of drinking episodes) over the past 30 days, as well as estimates of drinking quantity for each episode and the time span over which each episode occurred. Total number of drinking days in the past month, hours spent drinking per drinking day, and number of drinks consumed per drinking day served as the primary indices from this measure.

A modified version of the Gambling Timeline Followback interview (G-TLFB; Weinstock, Whelan, & Meyers, 2004) was used to assess gambling behavior occurring in the 3 months prior to the experimental session. With the assistance of the interviewer and a 90-day calendar, participants were asked to identify on which days they had gambled. For each gambling episode, participants were asked to indicate the (a) game played or activity engaged in; (b) time spent gambling; (c) amount of money they *intended* to bet; (d) amount of money *actually* risked (i.e., their total stake); (e) net amount of money won or lost; (f) number of standard drinks consumed while playing; and (g) point at which they initiated drinking relative to when they began gambling. Three indices capturing different aspects of quantity and frequency of gambling activity during the past 3 months were computed:

number of gambling days; hours spent gambling per gambling day; and dollars gambled per gambling day.

Simulated Slot Machine

A computerized slot machine program originally developed by MacLin, Dixon, and Hayes (1999) was used to administer the initial gambling outcome manipulation and assess gambling persistence and betting behavior (the *criterion variables*). The program visually simulates a three-reel, single pay-line slot machine with five symbols, including the motion of the reels spinning and stopping; no additional sensory features (e.g., sound) were included. The number of credits bet and the outcome of the spin (amount won/lost) were recorded for each spin. Persistence was measured as the total number of trials played and betting behavior was measured by the average amount bet per trial played.

Results

Data Screening and Consolidation

Statistical outliers—Prior to conducting the primary analyses, data were screened for the presence of univariate outliers. If necessary, data were transformed to normalize their distribution. If transformations failed to sufficiently normalize the distribution, outliers in the untransformed variable were reassigned a raw score one unit more extreme than the next most extreme score in the distribution, and the new truncated variable was inspected for outliers (Tabachnick & Fidell, 2001). If extreme values were still evident, another transformation was performed. Data screening and all analyses were conducted using SPSS 15.0 for Windows.

Self-report impulsivity measures—Statistically significant bivariate correlations were evident between the five subscales of the BIS-11 and ZKPQ-IIIR (*r*s = .23 to .74), and a reliability analysis resulted in a high Cronbach's alpha value (.81). Thus, a single composite was created to eliminate potential problems with multicollinearity and to address concerns about use of individual scales with reliability coefficients below .70 (Loewenthal, 1996).

Efficacy of Alcohol Dosing Procedure and Manipulation Checks

Alcohol dose—BrAC observations were analyzed using a 2 (beverage condition) by 4 (assessment time) analysis of variance (ANOVA), with beverage condition serving as a between-subjects factor and assessment time serving as a within-subject factor. As anticipated, there were statistically significant main effects for beverage condition, $F(1, 128) = 2045.74$, $p < .001$, and time, $F(3, 384) = 33.21$, $p < .001$, with individuals in the alcohol condition providing higher BrAC samples at each time point relative to participants in the placebo condition, and participants in both groups evidencing decreased BrAC levels over time. These main effects were qualified by a beverage condition by time interaction, $F(3, 384) = 25.60$, $p < .001$, owing to temporal differences in onset of peak BrAC. Individuals in the alcohol and placebo condition attained mean peak BrACs of 0.073 g% (*SD* = .01) and 0.012 g% (*SD* = .01), respectively. Actual BrACs before and after completion of the criterion task were .068 g% and .073 g% for the alcohol group, and .011 g% and .007 g% for the placebo group, respectively (see Figure 1).

Participants' estimates of subjective intoxication—Participants' estimates of number of standard drinks consumed and subjective alcohol effects were also analyzed using 2 (beverage condition) by 4 (assessment time) ANOVA. As expected, there were statistically significant main effects for beverage condition, $F(1, 126) = 26.84$, $p < .001$, and time, $F(3, 378) = 7.23$, $p < .001$, for number of standard drinks consumed. Although the two groups differed significantly, the estimates provided by the placebo group were relatively high. At postabsorption, participants in the placebo group estimated they had received an average of 2.56 (SD = 1.10) standard drinks, representing approximately 74% of the average estimate provided by the alcohol group. Consistent with participants' drink estimates, main effects of beverage condition for stimulation, $F(1, 128) = 32.83$, $p < .001$, and sedation, $F(1, 128) = 13.21$, $p < .001$, as well as main effects of time for stimulation, $F(3, 384) = 90.97$, $p < .001$, and sedation, $F(3, 384) = 7.90$, $p < .001$, emerged. At postabsorption, participants in the placebo group reported a mean stimulation rating of 2.89 (SD = 2.34) and a mean sedation rating of 1.37 (SD = 1.58), representing approximately 58% and 63% of the average ratings provided by the alcohol group.

Effectiveness of Random Assignment

Prior to testing the primary hypotheses, the equivalency of the experimental beverage groups and initial gambling outcome groups was assessed with respect to gender, age, drinking and gambling behaviors, preference for slot machines, and baseline self-report measures of gambling-related cognitions and impulsivity. There were no statistically significant differences by beverage condition (all ps > .11) or initial gambling outcome condition (all ps > .06).

Tests of Primary Hypotheses

A General Linear Model (GLM) framework was used to test the hypothesized effects on total number of trials and average amount bet via separate univariate analyses. These outcomes were selected to quantify individuals' ability to inhibit and adjust their gambling behavior in response to progressive loss, respectively. Data from the eight individuals who selectively refused to participate in the criterion task were excluded.[2]

Gambling persistence (total number of trials)—The total number of trials played by participants ranged from 4 to 122, M = 46.10, SD = 32.10. A total of 26 participants (13 in each of the two beverage conditions) persisted until they had zero credits remaining. The hypothesized main effects of beverage condition, initial gambling outcome, gambling-related cognitions and impulsivity were not supported in the GLM analysis (all ps > .29). The hypothesized moderating effects of initial gambling outcomes, gambling-related cognitions and impulsivity on the relation between beverage condition and gambling persistence were likewise not supported by the data (all ps > .42; see Table 3). Commensurately, the overall model including all predictors and interactions was not significant, $F(15, 101) = 0.39$, $p = .98$.[3]

As previous research (Phillips & Ogeil, 2007) has suggested a possible effect of alcohol on the rate of cumulative loss, a post hoc independent samples t test was conducted among the 26 individuals who persisted gambling on the slot machine until they had zero credits remaining. Results indicated that individuals in the alcohol condition who lost all of their

[2]All decisions regarding statistical analyses were made a priori to ensure that the published findings would not be influenced by post hoc knowledge of the results. The decision to exclude the eight individuals who did not gamble from the analyses was made as these individuals did *not* engage in betting behavior. Although an average bet of $0 is quantitatively meaningful, it is not conceptually meaningful insofar as saying one wagered *an average amount* implies that betting occurred, which was not the case with the individuals who refused to gamble. Although the refusal to gamble corresponds to a quantitatively and conceptually meaningful value with respect to gambling persistence (i.e., 0 total trials denotes the total absence of persistence), data from these eight individuals were also excluded from analyses of gambling persistence to be consistent. The results did not differ when their data were included in these analyses.

[3]As total number of trials played could be considered a count variable versus a scaled variable, we also conducted a logistic regression using the same predictor model reported in the GLM. Logistic regression was selected in order to determine the unique contribution of individual variables and interaction terms to the prediction of terminal persistence (i.e., gambling until 0 credits are remaining). The results were comparable to the GLM analysis—the overall model and all predictors were nonsignificant.

available funds did so in significantly *fewer* trials, M = 81.38, SD = 19.17, than individuals in the placebo condition, M = 97.62, SD = 15.14, $t(24) = 2.396$, $p = .03$.

Betting behavior (average bet per trial)—The average bet placed by participants who engaged in the gambling task ranged from 1 to 3 in whole-credit increments, M = 1.69, SD = 0.65. The overall model including all predictors and interactions was statistically significant, $F(15, 101) = 2.04$, $p = .02$, accounting for approximately 12% of the variance (adjusted R^2 = .12). Consistent with study hypotheses, a statistically significant main effect of beverage condition was observed, $F(1, 101) = 4.68$, $p = .03$, with individuals in the alcohol condition betting more on average, M = 1.82, SE = 0.08, than individuals in the placebo condition, M = 1.57, SE = 0.08. The size of the effect was in the medium range, partial eta squared (η_p^2)=.044.

A statistically significant interaction between beverage condition and impulsivity was also observed, $F(1, 101) = 3.97$, $p < .05$, $\eta_p^2=.038$. Tests of simple slopes as outlined by Aiken and West (1991) indicated that impulsivity was not significantly associated with average bet in the alcohol group, $B = -.110$, SE = .108, $p = .311$, whereas the effect approached statistical significance in the placebo group, $B = .131$, SE = .065, $p = .05$. For each unit increase on the impulsivity composite variable, placebo participants increased their average bet by 0.131 units (approximately 3¢; see Figure 2). Examination of the figure further suggested that beverage condition impacted betting behavior among individuals low in impulsivity. To examine this possibility, an independent samples t test was conducted among individuals with lower impulsivity composite scores (i.e., less than or equal to one standard deviation below the mean). This analysis revealed that alcohol, M = 1.88, SD = .81, disinhibited betting behavior relative to placebo, M = 1.31, SD = .26, among individuals low in impulsivity, $t(21) = -2.221$, $p = .038$. No effect was evident when individuals higher in impulsivity were compared, $t(22) = -.36$, $p = .72$.

Although not hypothesized, a statistically significant interaction between initial gambling outcome and gender was also observed, $F(2, 101) = 3.31$, $p = .041$, $\eta_p^2=.062$. Male and female participants evidenced similar betting behavior under conditions of loss and gain. However, in the breakeven condition, men demonstrated risk-seeking behavior (i.e., placed higher average wagers per trial) while women demonstrated risk-aversion behavior (i.e., bet more conservatively on average). Other hypothesized main and moderating effects on betting behavior were not supported by the data (all ps > .23; see Table 4).

Discussion

The current study utilized a two-group, laboratory-based, alcohol administration paradigm to test hypotheses regarding the effects of alcohol, initial gambling outcomes, gambling-related cognitions, and impulsivity on gambling persistence and betting behavior. For both criterion variables, main effects were expected for each of the predictor variables, and interactions between alcohol and each of the other predictor variables were hypothesized in accordance with the Attention Allocation Model (Steele & Josephs, 1990). Specifically, alcohol (relative to placebo) was expected to be most strongly related to high-risk gambling for individuals who were high in impulsivity and irrational beliefs about gambling, and when initial gambling outcomes were negative (loss condition). The results provided partial support for these hypotheses as evidenced by a significant main effect of alcohol and a significant alcohol by impulsivity interaction when average bet was the criterion measure. However, none of the predicted effects on gambling persistence were evident.

Although it may be the case that alcohol, initial gambling outcomes, gambling-related cognitions, impulsivity, and their interactions exert limited influence on gambling persistence, this conclusion would be premature based solely on the results of this study. This is especially true in light of previous research demonstrating reliable and robust effects of alcohol (Ellery et al., 2005; Kyngdon & Dickerson, 1999) and trait impulsivity (Breen & Zuckerman, 1999) on gambling persistence. Differences between the results in the current study and those in prior studies may be explained by differences in sample characteristics. The aforementioned studies utilized more homogenous samples of individuals who engaged in frequent gambling or who evidenced gambling psychopathology, whereas the sample recruited for this study comprised men and women who reported a more variable range of gambling patterns.

The social gambling nature of the current sample may have most profoundly impacted the effects for gambling-related cognitions, as irrational beliefs about gambling tend to increase with gambling frequency (Griffiths, 1994) and problem severity (Baboushkikna, Hardoon, Derevensky, & Gupta, 2001). Individuals who gamble more frequently have greater opportunity than social gamblers to develop irrational gambling-related cognitions by virtue of their increased exposure, and it has been suggested that increasing levels of gambling frequency and problem severity may be associated with an increase in the influence of irrational beliefs on behavior (Delfabbro, 2004). That is, social gamblers and problematic gamblers may possess the same number of irrational cognitions; however, problematic gamblers may believe in the veracity of their cognitions more deeply, and may thus be less capable of challenging them. Use of a behavioral measure, such as the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998; cf., Zack, Stewart, Klein, Loba, & Fragopoulos, 2005), alone or in conjunction with more sensitive self-report measures of gambling cognitions could be used to test this hypothesis.

The social gambling nature of the current sample may have also attenuated the effect of the initial gambling outcome manipulation. Relative to social gamblers, more frequent or problematic gamblers may be more sensitive to subtle changes in gambling contingencies (i.e., shifts in perceived patterns of wins and losses), both in terms of their ability to detect these changes as well as their behavioral response to these perceived changes. Replication of the current study in a sample containing sufficient numbers of social/nonproblem gamblers, frequent/nonproblem gamblers, and problem/pathological gamblers to test for group differences would allow for evaluation of these hypotheses (cf., the evaluation of differential effects of alcohol on social and probable pathological gamblers conducted by Ellery et al. [2005]).

Although alcohol effects were not observed for total number of trials played, significant effects were found in a post hoc test using a different conceptualization of gambling persistence—total number of trials played to expend all available funds. Although the percentage of individuals who gambled until they had zero credits remaining did not differ by beverage condition, individuals who consumed alcohol lost all of their available funds in significantly fewer trials than individuals who consumed a placebo. This result is consistent with research suggesting that alcohol may contribute to more rapid cumulative loss (Phillips & Ogeil, 2007).

Study hypotheses were also supported with respect to the main effect of alcohol on betting behavior. Individuals who consumed alcohol placed significantly higher average wagers than individuals who consumed a placebo beverage. This finding is consistent with prior research suggesting a possible connection between alcohol consumption and elevated average wagers (Ellery et al., 2005), as well as the broader literature on the association between drinking and increased behavioral risk-taking (Cooper, 2002; Giancola, 2002;

Mohler-Kuo et al., 2001). Although other research (Kyngdon & Dickerson, 1999) has failed to find a significant effect of alcohol on average bet, it seems probable that limited statistical power (0.46) may have obscured the effect (Cohen's $d = 0.52$). Additional research utilizing a skills-based gambling task (blackjack) has suggested that alcohol may contribute to more rapid cumulative loss via tendencies to make riskier errors of judgment (Phillips & Ogeil, 2007). Findings from the current study suggest that alcohol's effect on rate of cumulative loss may also be mediated by alcohol's influence on average amount wagered.

The predicted interaction between beverage condition and trait impulsivity also emerged, though the nature of the interaction was not consistent with study hypotheses. Within the placebo group, participants higher in impulsivity were more likely to place large wagers, whereas no such effect was found among individuals within the alcohol group. Alternatively, between-subjects analyses suggest that a high dose of alcohol may serve to selectively disinhibit the betting behavior of individuals low in trait impulsivity, making them behave like individuals high in trait impulsivity. Replication of this finding in a larger sample is necessary given equivocal associations between self-reported impulsivity and bet size in prior research (Anderson & Brown, 1984). Inclusion of a lower dose alcohol condition in future studies might also illuminate potential differences in the effects of different alcohol doses on gambling behavior among highly impulsive individuals.

An unexpected interaction between gender and initial gambling outcome also emerged with respect to betting behavior. Although men and women placed similar sized wagers under conditions of loss and gain, men who initially broke even tended to place relatively higher wagers on average than did women. This finding runs counter to what would be predicted by Prospect Theory (i.e., differences in risk-vs. loss-averse behavior should only be evident under conditions of gain and loss). Moreover, the absence of a main effect for gender is contrary to research on gender differences in decision-making under conditions of risk and uncertainty (Brynes, Miller, & Schafer, 1999; Levin, Synder, & Chapman, 1988), which suggests that men are almost universally more willing to accept risk than women. Perhaps breaking even during the initial part of the gambling session represented a unique condition of uncertainty in which impelling and inhibiting cues (i.e., wins and losses) were put in greater conflict. This high level of uncertainty may have contributed to more conservative betting behavior by female participants. However, additional research is necessary to test this hypothesis.

The current findings have direct implications for prevention and intervention programs targeting college-student and young-adult gamblers. Existing indicated prevention programs have utilized personalized-feedback approaches (Takushi et al., 2004). Feedback has typically included awareness-raising and exploration of ambivalence regarding the individual's typical drinking and gambling patterns; normative reeducation; and cognitive correction of erroneous beliefs. Feedback regarding harm-minimization strategies (e.g., refraining from drinking and gambling simultaneously) is also provided, but only for those who express a desire to reduce their gambling. While available data suggest that this approach is efficacious in reducing gambling frequency and negative consequences (Larimer et al., 2009), there is limited evidence supporting its efficacy in reducing concomitant drinking and gambling (Takushi et al., 2004), which may help to explain the absence of intervention effects on indices of gambling *quantity* (e.g., amounts wagered, won, and lost). Although individuals who receive the intervention may engage in gambling less frequently, to the extent that they consume alcohol on those occasions they do gamble, data from the current study of social gambling young adults suggest they may be spending more money.

While additional evaluation of this particular intervention may ultimately show reliable effects on concomitant drinking and gambling, it is possible that this harm-minimization strategy is too vague. Research suggests that young adults tend to underestimate their personal risk for experiencing negative life events (Weinstein, 1980); that increased engagement in health-risk behaviors may widen the disparity between actual and perceived risk (Cronce, Corbin, & Fromme, 2007); and that such optimistic biases regarding personal risk may hinder appropriate action to prevent or minimize risk (Weinstein & Lyon, 1999). Thus, college students who receive a generic tip regarding behavioral risk may disregard or minimize its personal applicability. This may be especially true for individuals who concurrently drink and gamble on a regular basis, but have not yet experienced, or have failed to recognize, the associated negative consequences. The Health Belief Model (see Janz, Champion, & Strecher, 2002) suggests that highlighting the personal impact of concomitant drinking and gambling within the feedback component of the intervention may be more effective. For example, the amount of money spent on gambling occasions when alcohol was consumed could be juxtaposed with the amount spent on nondrinking gambling occasions, thus highlighting the individual's susceptibility to negative consequences. In addition, the amount of money spent on drinking versus nondrinking gambling occasions could be quantified in terms of other tangible goods that may be more desirable to the individual, thus placing the benefits of altering their behavior into sharper relief. In line with the current findings, this approach may prove especially effective in reducing harm associated with concurrent alcohol use and gambling among individuals low in trait impulsivity. Messages highlighting the personal economic cost of drinking when gambling may also prove effective in primary prevention approaches targeting the general college-student population.

The current findings also have potential implications for public policy regarding the sale of alcohol in gambling venues. As previously indicated, alcohol is readily available in most gambling venues and is typically supplied to patrons at no or minimal cost provided that they are actively engaged in gambling. Additionally, to the extent that alcohol is served on the gaming floor, monitoring patrons' level of intoxication and ensuring consumption only occurs by individuals of age can often be difficult. Prior research has documented this confluence of low cost and less stringent regulation of alcohol as a motive for underage drinkers to frequent casinos and engage in gambling (Giacopassi et al., 2006). Free and convenient service of alcohol may also motivate adult gamblers to persist in gambling, even if the pharmacological effects of alcohol do not specifically disinhibit their behavior. Routine evaluation of venues' efforts to enforce regulations related to underage drinking/gambling and alcoholic beverage server liability could further encourage casinos to serve alcohol under more limited conditions, potentially leading to a reduction in both problems related to the effect of alcohol on gambling and problems associated with underage drinking.

The current study had a number of strengths, including use of an active placebo; use of an externally valid gambling task with the ability to strictly control contingencies; multiple measures of impulsivity; and inclusion of both men and women. Despite these relative strengths, certain limitations should be considered when interpreting the results. The failure of all participants to persist through the first 45 trials that formed the initial gambling outcome manipulation poses a threat to internal validity. However, the results did not differ when only individuals who completed the manipulation were included in the analyses. As in all placebo-controlled studies, participants receiving placebo did not report feeling as intoxicated as participants receiving alcohol. However, the estimates of subjective intoxication provided by placebo participants were substantial, and high in comparison to other alcohol administration studies (cf., Easdon & Vogel-Sprott, 2000; Fillmore & Vogel-Sprott, 2000; Marczinski & Fillmore, 2003). With respect to external validity, sample characteristics may limit generalizability of the findings. Due to ethical concerns, individuals were excluded if they reported behaviors that are indicative of gambling and alcohol psychopathology. Thus, the findings may not apply to young adults experiencing or most at risk for developing these problems. Finally, a relatively high dose of alcohol was administered in the current study. Some reports suggest that individuals who drink when they gamble consume more moderate amounts (cf., Ellery et al., 2005; Focal Research, 1998). However, the majority of participants in the current study (59.2%) reported a pattern of alcohol consumption on days when they gambled that would likely have resulted in a peak BAC of .08 g% or greater. Nonetheless, the findings may be limited in their generalizability to individuals exhibiting more limited or moderate drinking.

Characteristics of the experimental setting and stimuli may also restrict generalizability of the findings. Although a simulated bar was used for drink administration and assessment of subjective intoxication, participants had to enter an adjoining laboratory to play the slot machine. Furthermore, although the simulated slot machine was more externally valid than many of the other gambling tasks used in prior research, the program lacked additional sensory features (e.g., lights and sounds), and participants interacted with the program via use of a computer mouse as opposed to using a touch-sensitive interactive screen or buttons on the hardware casing. Additionally, participants were unable to obtain additional funds to continue gambling once all their credits were spent. This may have created a ceiling effect on the total number of trials that could be played, limiting the maximum mean difference between the two beverage groups with respect to gambling persistence. Future research in this area may benefit from using an alternative paradigm in which additional funds are available and the amount of time spent gambling serves as the criterion variable. Such a paradigm would help disentangle number of trials played from average bet size. Finally, exclusive use of the slot machine poses a threat to construct validity insofar as observed effects may not generalize to other forms of gambling.

Despite these limitations, the current study helped to advance existing knowledge regarding the effects of alcohol on gambling behavior. Alcohol was shown to influence the average amount bet and lead to more rapid loss of available funds, with trait impulsivity moderating alcohol’s effect on average bet. As concurrent alcohol and gambling behavior is prevalent among young adults, the current findings have direct implications for interventions targeting at-risk gamblers as well as implications for increasing public health.

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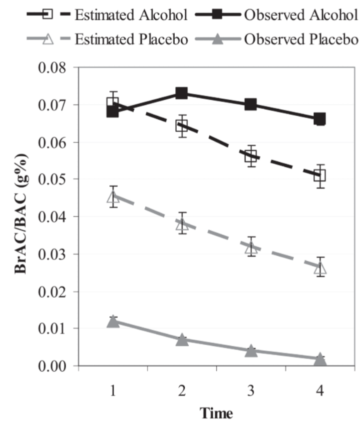

Figure 1.

Observed BrACs and estimated BACs by beverage condition at postabsorption (Time 1), following play on the simulated slot machine (Time 2), and after two successive 15-min intervals (Time 3 and 4).

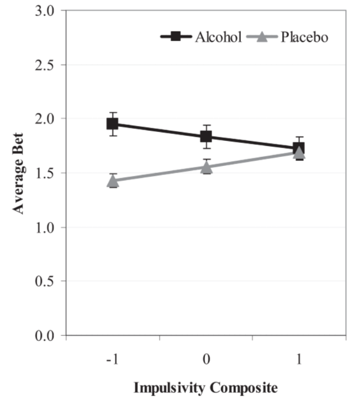

Figure 2.
Beverage condition by impulsivity interaction on average bet.

Table 1

Demographic Characteristics of the Sample and Experimental Groups

Demographic category	Total sample (N = 130)	Alcohol (n = 65)	Placebo (n = 65)
Age	22.96 (2.37)	23.11 (2.64)	22.82 (2.10)
Sex (female)	46.2%	44.6%	47.7%
Ethnicity (Hispanic/Latino/a)	7.7%	10.8%	4.6%
Race			
Asian	12.3%	9.2%	15.4%
Black/African American	5.4%	6.2%	4.6%
White	73.1%	70.8%	75.4%
Multiracial/other	6.9%	9.2%	4.6%
Highest level of education			
High school diploma or GED	1.5%	0%	3.1%
Vocational or technical degree	0.8%	1.5%	0%
In college (no degree)	34.6%	41.5%	27.7%
Associate or Bachelor degree	18.5%	12.4%	24.6%
In graduate school (no degree)	22.3%	23.1%	21.5%
Master degree	9.2%	7.7%	10.8%
In professional program (no degree)	4.6%	4.6%	4.6%
Professional degree (e.g., MD, JD)	0.8%	1.5%	0%

Note. Values for age represent group means (standard deviations). Percentages within a given category may not sum to 100% due to missing data for individual cases. No statistically significant differences were present when experimental groups were compared.

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Table 2

Estimates of Drinking and Gambling Behavior (N = 130)

Behavioral index	*M* (*SD*) or %	Minimum	Maximum
Drinking days	10.74 (4.54)	2	24
Hours spent drinking per drinking day	3.43 (1.32)	0.93	9.75
Drinks per drinking day	4.75 (1.98)	1.40	10.67
Gambling days	5.32 (4.50)	1	27
Hours spent gambling per gambling day	2.08 (1.46)	0.02	6
Dollars spent gambling per gambling day[a]	42.51 (73.18)	0.50	451

Note. Drinking and gambling data were collected via behavior-specific timeline followback interviews; see *Interviewer-Administered Measures* section for a full description. Drinking data reflect estimates from the past 30 days whereas gambling data reflect estimates from the past 90 days.

[a]A single participant reported having wagered an average of $3000 per gambling day; thus, this variable was truncated to more meaningfully capture the central tendency and variability of the sample (see *Data Screening and Consolidation* section for further details). The median and mode of this variable were $20 and $10, respectively, with approximately 28% of the sample reporting they gambled $10 or less per gambling day. Nearly 46% of the sample reported gambling $10 or less per hour spent gambling.

Table 3

Summary of General Linear Model Predicting Total Number of Trials (N = 117)

Variable	***df***	***MS***	***F***	***p***	η_p^2	**Power**
Beverage condition (Beverage)	1	131.50	0.12	.735	.001	.063
Initial gambling outcome (Slot)	2	707.46	0.62	.541	.012	.151
Gender	1	4.37	0.00	.951	.000	.050
Gambling cognitions (Cog)	1	1247.12	1.09	.299	.011	.179
Impulsivity (Imp)	1	152.84	0.13	.716	.001	.065
Beverage × Slot	2	978.23	0.85	.429	.017	.193
Beverage × Gender	1	27.78	0.02	.877	.000	.053
Slot × Gender	2	3.28	0.00	.997	.000	.050
Beverage × Slot × Gender	2	318.84	0.28	.758	.005	.093
Beverage × Cog	1	342.84	0.30	.585	.003	.084
Beverage × Imp	1	463.18	0.41	.526	.004	.097
Error	101	1145.00				

Note. η_p^2= partial eta squared (effect size). Power = observed power to detect effect.

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Table 4

Summary of General Linear Model Predicting Average Bet Per Trial (N = 117)

Variable	***df***	***MS***	***F***	***p***	η_p^2	**Power**
Beverage condition (Beverage)	1	1.72	4.68	.033	.044	.573
Initial gambling outcome (Slot)	2	0.06	0.17	.847	.003	.075
Gender	1	1.10	2.99	.087	.029	.403
Gambling cognitions (Cog)	1	0.20	0.55	.458	.005	.114
Impulsivity (Imp)	1	0.02	0.05	.826	.000	.055
Beverage × Slot	2	0.41	1.11	.334	.021	.240
Beverage × Gender	1	0.20	0.56	.457	.005	.115
Slot × Gender	2	1.21	3.31	.041	.062	.616
Beverage × Slot × Gender	2	0.56	1.54	.219	.030	.320
Beverage × Cog	1	0.53	1.43	.234	.014	.220
Beverage × Imp	1	1.46	3.97	.049	.038	.506
Error	101	0.37				

Note. η_p^2= partial eta squared (effect size). Power = observed power to detect effect.