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The Combined Effects of Alcohol, Caffeine and Expectancies on Subjective Experience, Impulsivity and Risk-Taking

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Abstract

Caffeinated alcoholic beverage (CAB) consumption is a rapidly growing phenomenon among young adults and is associated with a variety of health-risk behaviors. The current study examined whether either caffeinated alcohol or the expectation of receiving caffeinated alcohol altered affective, cognitive and behavioral outcomes hypothesized to contribute to risk behavior. Young adult social drinkers (N=146) participated in a single session where they received alcohol (peak Breath Alcohol Content = .088 g/dL, SD = .019; equivalent to about 4 standard drinks) and were randomly assigned to one of four further conditions 1) no caffeine, no caffeine expectancy, 2) caffeine and caffeine expectancy, 3) no caffeine but caffeine expectancy, 4) caffeine but no caffeine expectancy. Participants' habitual CAB consumption was positively correlated with measures of impulsivity and risky behavior, independently of study drugs. Administration of caffeine (mean dose = 220 mg, SD = 38; equivalent to about 2.75 Red Bulls) in the study reduced subjective ratings of intoxication and reversed the decrease in desire to continue drinking, regardless of expectancy. Caffeine also reduced the effect of alcohol on inhibitory reaction time (faster incorrect responses). Participants not expecting caffeine were less attentive after alcohol, whereas participants expecting caffeine were not, regardless of caffeine administration. Alcohol decreased response accuracy in all participants except those who both expected and received caffeine. Findings suggest that CABs may elevate risk for continued drinking by reducing perceived intoxication, and by maintaining the desire to continue drinking. Simply expecting to consume caffeine may reduce the effects of alcohol on inattention, and either expecting or consuming caffeine may protect against other alcohol-related performance decrements. Caffeine, when combined with alcohol, has both beneficial and detrimental effects on mechanisms known to contribute to risky behavior.

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Keywords

Alcohol; Caffeine; Impulsivity; Risk-taking; Energy Drinks

Combining alcohol and caffeine has become a popular drinking practice, with estimates of use documented as high as 54% in college and medical students (Malinauskas, Aeby, Overton, & Carpenter-Aeby, 2007; Marczinski, 2011; O'Brien, McCoy, Rhodes, Wagoner & Wolfson, 2008; Oteri, Salvo, Caputi, & Calapai, 2007; Snipes & Benotsch, 2013). Alcohol mixed with energy drinks greatly appeals to underage and younger drinkers (Marczinski, 2011; Wells et al., 2013) and the beverage industry has capitalized on this spirited trend by aggressively marketing to teens and young adults (e.g., Ho, 2006; Howland & Rohsenow, 2013). Recently, however, there have been concerns about the potential public health consequences of this combination (e.g., Arria & O’Brien, 2011; Attwood, 2012; Howland, Rohsenow, Calise, Mackillop & Metrik, 2011; Howland & Rohsenow, 2013; Kaminer, 2010; Reissig, Strain, & Griffiths, 2009; Rosenhow & Howland, 2007; Weldy, 2010). As a result, the FDA sent warning letters to manufacturers that essentially halted the production and sale of pre-mixed caffeinated alcoholic beverages (CABs) (e.g., Blumenthal, Shurtleff, & Limtiaco, 2009; FDA, 2010); however, users continue to hand-mix energy drinks with alcohol (e.g., Red Bull and vodka, Jaeger Bomb). Thus, a typical CAB served in a bar or a house-party may contain more than three times the amount of caffeine the FDA allows in sodas (McCusker, Goldberg, & Cone, 2006; Reissig, et al., 2009). Despite mounting public health and safety concerns and subsequent efforts to regulate these products, few studies have actually evaluated the acute combined effects of alcohol and caffeine on indices of health-risk behavior. As such, there are extremely limited data to help inform public health initiatives to educate consumers about potential consequences of combining these substances.

A burgeoning literature indicates that CAB use is correlated with problematic alcohol use and negative alcohol-related consequences. For instance, in a large multi-site survey, college students who consumed alcohol mixed with energy drinks reported more alcohol-related risk behaviors (i.e., riding in a car with a driver under the influence, being hurt or injured, taking advantage of another student sexually, being taken advantage of sexually) compared to students who consumed alcohol alone (O'Brien, et al., 2008). Additionally, students who use caffeine-alcohol combinations report consuming more alcohol, and exhibit riskier drinking habits (e.g., binge drinking) than students who report only drinking alcohol (O’Brien et al, 2008; Velazquez, Poulos, Latimer & Pasch, 2012; Woolsey, Waigandt, & Beck, 2010) Moreover, hazardous drinkers are more likely than nonhazardous drinkers to use energy drinks in combination with alcohol (Berger, Fendrich, Chen, Arria, & Cisler, 2011) and CAB users are more likely to report intoxication prior to their most recent sexual encounter (Miller, 2012) and increased odds of engaging in high-risk sexual behaviors (Snipes & Benotsch, 2013) compared to non-CAB users. Finally, event-based analyses suggest that individuals consume more alcohol on occasions when they also use energy drinks (Peacock, Bruno & Martin, 2012; Price, Hilchey, Darredeau, Fulton, & Barrett, 2010; Thombs et al., 2010). Importantly, excessive drinking increases risk for a host of negative consequences including, but not limited to, sexual victimization, alcohol poisoning, and injury (e.g., Hingson, Heeren, Zakocs, Kopstein, & Wechsler, 2002). These correlational data raise the possibility of a synergistic effect whereby the addition of caffeine results in risk behavior that would otherwise not occur under alcohol alone.

Caffeine does not speed the clearance of alcohol (Ferreira, Mello, Pompeia & de Souza-Formigoni, 2006) though it does have the potential to reverse some of the performance-impairing effects of alcohol. CAB consumers are likely motivated by these expectations of caffeine-antagonism (e.g., Marczinski, 2011), which are frequently emphasized in energy drink advertisement campaigns (e.g., party longer and harder). Indeed, caffeine reverses alcohol-related performance impairment on numerous tests including reaction time, psychomotor speed, divided attention, and recall memory (e.g., Alford, Hamilton-Morris, & Verster, 2012; Azcona, Barbanoj, Torrent, & Jane, 1995; Drake, Roehrs, Turner, Scofield, & Roth, 2003; Franks, Hagedorn, Hensley, Hensley, & Starmer, 1975; Hasenfratz, Bunge, Dalpra, & Battig, 1993; Kerr, Sherwood, & Hindmarch, 1991; Roehrs, Greenwald & Roth, 2004; Rush, Higgins, Hughes, Bickel, & Wiegner, 1993). In one study (e.g., Oborne & Rogers, 1983), however, caffeine exacerbated the effects of alcohol on reaction time and several other studies reported no interactions at all across different outcomes (e.g., Attwood, Rogers, Ataya, Adams & Munafo, 2012; Ferreira, et al., 2006; Franks, et al., 1975; Howland, Rohsenow, Arnedt et al., 2011; Liguori & Robinson, 2001; Marczinski & Fillmore, 2003; Marczinski & Fillmore, 2006; Marczinski, Fillmore, Bardgett & Howard, 2011; Marczinski, Fillmore, Henges, Ramsey & Young, 2012a; Nuotto, Mattila, Seppala, & Konno, 1982). The reasons for the mixed findings are not clear, but may include variability in the doses of caffeine and alcohol, lack of control for caffeine withdrawal, small sample sizes and differences in experimental methodology (Fudin & Nicastro, 1988). Importantly, the inconsistencies in the evidence indicate that users cannot safely assume that consumption of caffeine will reverse the impairing effects of alcohol.

In addition to examining performance, several studies have investigated alcohol-caffeine interactions specifically in relation to decision-making and impulsivity. In two studies, caffeine reduced alcohol-induced slowing of response time but had no effect on inhibitory control as indexed by accuracy on a cued go/no-go task (Marczinski & Fillmore, 2003; Marczinski, et al., 2011). In another study, compared to alcohol alone, caffeine in combination with alcohol shortened decision time and N200 latency (orientation to a stimulus) on a choice reaction time task, but simultaneously reduced N500 area, an index of working memory (Martin & Garfield, 2006). The authors explained that whereas caffeine appeared to counteract alcohol-related slowing of decision time, it also functioned to impair working memory processes. Thus, caffeine may lessen alcohol-induced increases in reaction time, without improving accuracy compared to alcohol alone (i.e., "making bad decisions quicker").

Caffeinated alcohol may also engender risky behavior by reducing the bodily sensations associated with alcohol use (i.e., interoceptive cues), thus impairing judgments about possibly risky physical and cognitive states. For instance, an event based analysis revealed that drinking occasions involving energy drinks mixed with alcohol were associated with lower self-reported sedation and disinhibition and higher stimulation ratings compared to drinking occasions only involving alcohol (Peacock et al., 2012). Furthermore, compared to alcohol alone, caffeine together with alcohol produces lower subjective ratings of intoxication and higher ratings of stimulation (e.g., Marczinski & Fillmore, 2006; Marczinski, et al., 2011; Marczinski, et al., 2012a). Importantly though, despite these differences in subjective experience, caffeine did not improve accuracy of responses (i.e., inhibitory control on go/no-go task; dual task interference on psychological refractory period task). In another study, participants reported fewer symptoms of alcohol intoxication (e.g., headache, weakness, dry mouth, impairment in motor coordination) after combined alcohol and energy drink compared to alcohol alone, but they did not differ in motor coordination and visual reaction time (Ferreira, et al., 2006). Taken together, caffeinated alcohol may impair the perception of intoxication, without affecting objective performance.

With repeated experience with a substance, individuals develop expectancies or beliefs about its effects (Goldman, Brown, & Christiansen, 1987). Thus, these expectancies can then, in turn, influence future experiences with the drug. There is evidence that the effects of caffeine on mood, cognition and performance depend upon a person's expectations (Smith, 2002). For instance, an individual's performance and subjective experience can be influenced by the strength of their expectancies for caffeine (e.g., "caffeine will make me more alert"). Further, researchers have "implanted" expectations for caffeine to influence the effects of alcohol on performance and these expectations in turn, drove actual performance (Fillmore & Vogel-Sprott, 1995; Fillmore, Roach, & Rice, 2002). Hence, the expectation that caffeine will antagonize alcohol-induced impairment may also contribute to risky behavior.

The aim of the current study is to comprehensively characterize the effects of caffeinated alcohol and the expectation of receiving caffeinated alcohol on critical affective, cognitive and behavioral measures known to contribute to health-risk outcomes in young social drinkers. Based on previous evidence that caffeine counteracts some of the untoward effects of alcohol on performance (e.g., reaction time) and subjective experience (e.g., sedation), it is hypothesized that caffeine will attenuate the effect of alcohol on behavioral performance tasks, ratings of sedation, negative affect, driving ability and intoxication, and that it will increase ratings of stimulation, positive affect and desire to continue drinking. Next, compared to participants who receive only alcohol those who receive both caffeine and alcohol are expected to demonstrate more risky and impulsive behavior. Finally, participants expecting caffeine are hypothesized to demonstrate a profile of effects similar to that anticipated for participants who consumed both caffeine and alcohol, though to a lesser extent. In terms of subsidiary analyses, based on correlational findings showing that CAB consumption is positively associated with engagement in health-risk behaviors, it is hypothesized that CAB use will correlate with self-report measures of impulsivity, frequency of risky behavior and peer norms surrounding CAB use.

Method

Participants

The sample was comprised of 146 right-handed healthy men and women aged 21–30. Participants were recruited from the Chicago metropolitan area via online advertisements. They were screened to exclude individuals with significant psychiatric history, illicit substance use in the past 30 days, a score of 3 or higher on the Michigan Alcoholism Screening Test (SMAST; Selzer, Vinokur, & van Rooijen, 1975), never having used caffeine, weighing outside the specified range (males 120–200lbs, females 120–180 lbs), having medical conditions for which alcohol or caffeine use is contraindicated, or taking any medications that could affect performance or interact with alcohol or caffeine.

Design

A double-blind 2 (caffeine administration: caffeine, no caffeine) X 2 (caffeine instructions: told getting caffeine, told not getting caffeine) mixed design was employed. All participants received alcohol, and were randomly assigned to one of four caffeine conditions: 1) No caffeine, told not receiving caffeine (n = 37), 2) Caffeine, told receiving caffeine (n = 35), 3), No caffeine, but told receiving caffeine (n = 35) and 4) Caffeine but told not receiving caffeine (n = 39).

Measures

Alcohol, Caffeine and Caffeinated Alcohol Consumption—A modified Time Line Follow Back method (Sobell & Sobell, 1992) was used to assess consumption of caffeine, alcohol and caffeinated alcohol over the past 3 months. Participants provided estimates of how many units of each substance they consumed each day in a typical week in the last three months. Number of days and number of units were summed to yield a frequency and quantity score, respectively. For an extended description of caffeine consumption measurement see Heinz, Kassel and Smith (2009). Several additional items asked about drinking patterns in the past thirty days to assess for binge drinking and drunkenness. The Caffeine Dependence and Withdrawal Checklist (CDWC; see Heinz et al., 2009) was used to assess for problematic caffeine use. It employs DSM-IV-TR (American Psychiatric Association, 2000) criteria for psychoactive substance dependence modified to apply to caffeine (Hughes, Oliveto, Liguori, Carpenter, & Howard, 1998). Individuals were asked to endorse each criterion that had occurred at least once a month in the past 12 months. Endorsement of 3 or more criteria was required for participants to be considered “caffeine dependent” (Hughes, et al., 1998).

Impulsivity, Risk-taking and Peer Influences—The UPPS-P Impulsive Behavior Scale (Whiteside & Lynam, 2001; Cyders et al., 2007) is a 58- item measure of five different domains of impulsivity including sensation seeking, lacking of planning, lack of perseverance, negative urgency, positive urgency (e.g., acting rashly in a positive mood). Internal consistencies on each of the sub-scales ranged from .77 to .89. To assess past risk-behaviors, participants answered a series of single item queries (see Lejuez et al., 2002), about the frequency in which they engaged in unsafe sexual practices, driving under the influence, and infrequent seatbelt use. The Peer Influences on Drinking questionnaire (PID; see Bartholow & Heinz, 2006) asks participants to rate their friends’ alcohol involvement and perceptions of normative drinking patterns. In the present study, several questions were modified and added to assess peer influences on consumption of caffeinated alcohol.

Subjective Experience—The Subjective Intoxication Scale (SIS), which ranges from 1 (not at all intoxicated) to 10 (as intoxicated as I’ve ever been), was used to assess participants' perceived level of intoxication pre-drink, post-drink and at the end of the session. The 14-item Biphasic Alcohol Effects Scale (BAES; Martin, Earleywine, Musty, Perrine, & Swift, 1993) consists of two subscales, stimulation and sedation that assess the subjective effects of alcohol. The BAES was administered post-drink and at the end of the session, and had strong internal consistency (post-drink: Stimulation α = .85, Sedation α =. 93). Perceived ability to drive a car and desire to continue to drinking alcohol following drink administration were assessed with single items. The items included a visual analogue scale that ranged from 1 to 10 with opposing anchors labeled "could not drive at all," "could drive as I normally do" and "no desire at all," "strongly desire more alcohol," respectively. Finally, the 20-item Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) was used to assess positive and negative affect three times (pre-drink, post-drink, end of the session) to determine the effect of condition on mood (pre-drink: positive affect α = .87, negative affect α = .76).

Impulsivity and Risk-Taking Measures—The Cognitive Appraisal of Risky Events (CARE; Fromme, Katz, & Damico, 1997) assesses perceived risks, benefits and likely involvement with six domains of risky activities (sexual behavior, heavy drinking, illicit drug use, aggressive/illegal behaviors, academic/work behaviors and high risk sports). The CARE has been used with intoxicated participants (Fromme, et al., 1997) and has also been shown to correlate with subsequent risky behavior (Fromme, D'Amico, & Katz, 1999; Fromme, et al., 1997). For each of the subject areas, three composite scores are generated: likelihood of experiencing positive consequences, likelihood of experiencing negative consequences, and expected involvement in the activities in the next six months. Participants completed the CARE once, post-drink. In the current study, subscales for academic/work behaviors and high risk sports were excluded, and composite scores were summed across the different subject areas. Internal consistencies across the subscales ranged from .75 to .86 for likelihood, from .74 to .85 for positive perception and from .73 to .97 for negative perception.

Computerized Behavioral Tasks

Inattention may be one index of impulsivity (de Wit, 2009). It can be quantified by examining the positive skew in a distribution of reaction times (RT's) on a Simple Reaction Time Task (SRTT; Kane & Kay, 1992; Leth-Steensen, Elbaz, & Douglas, 2000). On the SRTT, participants are asked to respond as quickly as possible, via a key press on the computer keyboard with their dominant hand, to *'s presented on a computer screen. The task is comprised of three experimental blocks, each with 15 trials and response latencies are recorded to the nearest millisecond. The longest RT's are taken to indicate lapses of attention, which may reflect the allocation of attention elsewhere or the availability of fewer attentional resources (Kramer & Spinks, 1991). Attentional lapses can be quantified by subtracting the mode from the mean of the RT distribution (deviation from the mode; devmod; de Wit, 2009; Spencer et al., 2009). The greater the number of long RT's at the extreme of the distribution, the greater the DM. Thus the SRTT was used to assess attentional lapses (i.e., devmod) and available attentional processing capacity (response time) before and after drink administration.

The Stop Signal Task (SST; Logan, 1994) is one of the most commonly used measures of behavioral inhibition, a key dimension of impulsivity. The task is conducted as a choice reaction time paradigm (i.e., participants press one key if the target stimulus is a circle and another key if it is a square, as quickly as possible) and is comprised of 3 blocks of 64 trials. Participants are instructed to "stop" or withhold their response [after having received a "go" signal (i.e., + fixation sign) to make the response] upon hearing an audio tone blast (750 Hz, 75 msec). The primary outcome measure is the stop signal reaction time (see Verbruggen, Logan, & Stevens, 2008) or the amount of time following the presentation of a stop signal needed to inhibit a response that is already underway. Secondary outcome measures include mean reaction time on signal respond trials (no-go trials), in which the participant is supposed to inhibit their response (quicker reaction time indicates less hesitation when failing to inhibit a response) and percent of correct responses (hits) on no-signal trials (i.e., accuracy). The SST was administered pre and post-drink to examine the acute effects of alcohol and caffeine on behavioral inhibition.

The Balloon Analogue Risk Task (BART; Lejuez, et al., 2002) is designed to assess risk-taking behavior. Participants are presented with "balloons" on a screen and are given the opportunity to "pump" the balloon with a mouse click to earn money. On each trial, the amount of money earned increases with each pump until either, a) the balloon "pops" and the participant loses their earnings for that trial, or b) the participant decides to stop pumping the balloon and collects the accumulated earnings for that trial. Each balloon is programmed to randomly explode between 1 and 128 pumps. Participants completed 30 balloon trials with a 1.0 cent pay off per pump and could earn up to $12. The dependent variable, adjusted pumps, was the average number of pumps on trials in which the balloons that did not explode. The BART was administered pre and post-drink to examine the acute effects of alcohol and caffeine on risk-taking behavior.

Post-experimental questionnaire—At the end of the session, participants were asked: (1) if they thought they had consumed caffeine and alcohol (Y or N), (2) the amount of caffeine and/or alcohol they believed they had consumed (mg or oz) and (3) how pleasant the beverage tasted (1 to 4).

Procedure

After screening, participants were randomly assigned to one of the four experimental conditions. Participants in conditions 1 and 4 were informed that they would receive alcohol without caffeine and participants in conditions 2 and 3 were told that they would receive alcohol and caffeine. Participants in conditions 2 and 4 actually received caffeine and conditions 1 and 3 received placebo. All groups participated in a single, 3-hour session, conducted from approximately 11am to 2pm (participants dismissed when Breath Alcohol Content (BAC) = .03).

Participants were instructed to refrain from using alcohol or other drugs 24 hours prior to the experiment, fast for 4 hours prior to the experiment and to drink caffeine as they normally did up until 2 hours before the study. Upon arrival at the session, women provided urine samples for pregnancy testing (Pregnosticon Dri-Dot; Organon Diagnostics, West Orange, NJ; negative tests were required for participation), and all subjects provided a breath sample to ensure a BAC of zero (Data-Master infra-red breath alcohol detector, National Patent Analytical Systems, Inc., Mansfield, OH). After these tests they consumed a light snack and completed baseline questionnaires and computerized behavioral tasks. Participants then consumed a dose of alcohol, expected to produce BAC between 0.06%g/dL and 0.08%g/dL. The beverages were made using 100-proof Smirnoff vodka mixed with cranberry juice, and the doses were adjusted according to the subject's weight and gender (Sayette, Breslin, Wilson, & Rosenblum, 1994). For the groups receiving caffeine, anhydrous caffeine powder was added to the cranberry juice-alcohol solution, based on the subject's body weight and gender (5.0 mg/kg for women, up to a maximum of 250mg and 5.5 mg/kg for males up to a maximum of 300mg). The average doses administered to males and females were roughly equivalent to the caffeine content of 2.5 to 3 cans of Red Bull (80mg caffeine each), and within the range of doses consumed recreationally.

The beverage was administered to participants in three equal doses over 30 minutes. Fifteen minutes following consumption of the last dose, BAC (#2) was measured and subjects completed the SIS (#2), BAES (#1), PANAS (#2), the CARE and single items questions about perceived ability to drive and desire to drink more. Next, the same battery of computerized behavioral tasks was administered though the order was counterbalanced. At the end of the session, participants completed the same questionnaires (with the exception of the CARE), provided the final BAC (#3) and completed the post-experiment questionnaire.

Data analyses

The distributions of each variable were examined and outliers (i.e., values more than 3 standard deviations from the mean) were removed prior to analyses. Several variables were transformed to correct for skewed, non-normal distributions. The negative affect subscale of the PANAS was log transformed. On the SST, stop signal reaction time was square root transformed, mean reaction time on signal-respond trials was log transformed and mean percent of correct responses on no-signal, normal trials was first reflected (1+highest value – each participant's value) and then log transformed (and reflected again for interpretation). Finally, on the SRTT, reaction time and deviation from the mode (Devmod) were square root transformed.

Subsidiary analyses were performed first. We examined correlations between quantity and frequency of CAB consumption and self-report measures of impulsivity, frequency of engagement in risky behavior and peer norms and attitudes about drinking alcohol and caffeinated alcohol. Spearman Rho correlational analyses were performed with variables exhibiting non-normal distributions. In addition, we examined gender differences in recent patterns of caffeine, alcohol and caffeinated alcohol consumption.

To test the main hypotheses, 2 (pre vs post drink OR post-drink vs end of the session) by 2 (told or not told caffeine) by 2 (received caffeine or not) mixed design ANOVAs were conducted to assess pre and post-drink differences as well as post-drink and end of the session differences as a function of caffeine instruction and caffeine consumption. Because men tend to exhibit higher risk-taking than females (Byrnes, Miller, & Schafer, 1999) and because a meta-analysis suggested that men continue to pursue reward despite increasing risk on the BART (Cross, Copping, & Campbell, 2011), gender was entered as a covariate for the BART. For the CARE, two-way (instruction by consumption) ANOVA was conducted for each of the three ratings of risky behaviors (likelihood of engaging in the behavior, likelihood of positive and negative consequences). Based on previous findings (Fromme et al., 1997), gender was entered as a covariate in all models for the CARE as it was hypothesized to influence risk appraisal. Finally, in a very small number of sessions, random computer program glitches during the experiment did not permit administration of specific measures and tasks. Accordingly, some participants did not have complete data for all variables examined in the current study (i.e., data treated as missing).

Results

The sample consisted of 49% males, with a mean age of 24.1 (SD = 2.33), and was ethnically diverse (65% Caucasians, 16% African American, 14% Hispanic, 4% Asian/ Pacific Islander,1% other). Twenty-seven percent of the sample reported current cigarette use and among the smokers, 72% indicated they primarily smoked when drinking. Mean peak BAC for the sample was .088 (SD = .019); mean BAC post-drink was .076 (SD = .023; 15 minutes following drinking consumption) and .08 (SD = .017) at the end of the session; mean peak BAC did not differ as a function of gender. Average amount of caffeine administered to males was 245.47 mg (SD = 31.67; range = 190–300) and to females, 195.26 mg (SD = 25.15; range = 160–246). Forty-two percent of the sample met modified DSM-IV-TR criteria for caffeine dependence. Most (93%) reported binge drinking (i.e., consumed 4 (female) 5 (male) or more drinks in one sitting) one or more times in the past month and 79% indicated having been drunk at least once in the past month. In the past month, 59% of participants reported drinking alcohol 3–4 times a week or nearly every day.

The proportion of participants who believed they had received caffeine matched the group instructions (χ^2 (3) = 37.34, $p < .001$; the percent believing they had received caffeine in each of the four conditions were: 15% in the told no caffeine and received no caffeine group, 64% in the told caffeine and received caffeine group, 71% in the told caffeine and received no caffeine group and 19% in the told no caffeine and received caffeine group[1].

Subsidiary Analyses

Higher habitual CAB consumption was associated with less frequent seat belt use while driving/riding in a car in the past year (CAB quantity ρ=- .18, $p < .05$; frequency ρ=- .23, $p < .05$, respectively). Frequency of CAB consumption, but not quantity, was positively correlated with number of times driven when feeling “buzzed” or “drunk” in the past year (ρ= .17, $p < .05$). CAB use was not related to frequency of unprotected sex in the past 12 months. CAB use (quantity and frequency) was related to the tendency to act rashly when

[1]The proportion of participants who believed they had consumed caffeine in the experiment was higher among participants who were told they would receive caffeine (68%) compared to participants who were told they would *not* receive caffeine (17%; χ^2 (1) = 36.79, $p < .001$).The proportion of participants who believed they had consumed caffeine did not differ as a function of actual caffeine consumption (χ^2 (1) = .173, *ns*).Participants who were told they would receive caffeine had higher estimates of caffeine consumption (M = 105.07, SD = 99.13) than participants who were told they would not receive caffeine (M = 52.35, SD = 87.7; F(1, 131) = 10.51, $p < .001$, $\eta_p^2 = .07$).No effect of consuming caffeine and no interaction emerged for estimated amount of caffeine consumed.No effects of consumption or instruction and no interaction were found for how participants rated the taste (pleasantness) of their cocktails.

experiencing positive emotion (positive urgency) (ρ= .17, $p < .05$; ρ = .18, $p < .05$). In addition, quantity of CAB consumption was positively correlated with the lack of premeditation (i.e., non-planning) subscale score on the UPPS-P (ρ= .18, $p < .05$). Quantity and frequency of CAB consumption positively correlated with participants' estimated number of close friends who drank CABs (ρ= .21, $p < .05$; ρ = .21, $p < .05$, respectively) and ratings of their friends' approval of drinking CABs (ρ = .21, $p < .05$; ρ = .22, $p < .05$, respectively).

Number of drinking days in an average week in the three months prior to the study did not differ as a function of gender though males (mean = 4.08, SD = 1.83) demonstrated a higher average number of drinks per drinking day than females (mean = 3.17, SD = 1.31; $F(1, 141) = 11.59$, $p < .001$, $\eta_p^2 = .08$). Similarly, no gender difference emerged for number of days consumed caffeine (excluding caffeinated alcoholic beverages) in an average week in the last three months, but males (mean = 2.08, SD = 1.08) consumed more caffeinated beverages on caffeine consumption days than females (mean = 1.63, SD = .77; $F(1, 137) = 8.21$, $p < .01$, $\eta_p^2 = .06$). Finally, quantity and frequency of CAB use in an average week in the last three months did not differ as a function of gender. Table 1 presents descriptive statistics for caffeine, alcohol and caffeinated alcoholic beverage consumption for the sample as a whole, as well as information on peer norms and attitudes surrounding these beverages. Table 2 presents demographic variables and descriptive statistics for caffeine, alcohol and caffeinated alcoholic beverage consumption as well as smoking status as a function of group. Groups did not differ on any of these outcomes and thus demographic characteristics and substance use patterns were evenly distributed by the randomization procedure.

Experimental Measures: Subjective Experience

Subjective ratings of intoxication increased from pre to post-drink for the entire sample ($F(1, 138) = 1103.67$, $p < .001$, $\eta_p^2 = .89$). Caffeine decreased ratings of subjective intoxication (time by caffeine interaction ($F(1, 138) = 5.10$, $p < .05$, $\eta_p^2 = .03$)) such that post-drink, participants who received caffeine reported lower ratings of subjective intoxication than participants who did not ($F(1, 141) = 4.18$, $p < .05$, $\eta_p^2 = .03$). Subjective ratings of intoxication significantly decreased post-drink to the end of the session ($F(1, 133) = 9.31$, $p < .005$, $\eta_p^2 = .07$). Caffeine reduced ratings of intoxication ($F(1, 133) = 4.27$, $p < .05$, $\eta_p^2 = .03$) but caffeine instruction did not (Fig 1). That is, out of a possible rating of 10 (10 = "*as intoxicated as I've ever been*"), the difference in mean change in subjective intoxication from pre to post-drink among participants receiving caffeine (Mean (SD) = 4.11 (1.46)), and not receiving caffeine (Mean (SD) = 4.65 (1.66)) was approximately .5; the difference in ratings between groups at the end of the experiment was approximately .4.

Stimulation scores on the BAES decreased post-drink to the end of the session $F(1, 135) = 23.66$, $p < .001$, $\eta_p^2 = .15$) though no effects of group and no interactions emerged. Sedation subscale scores on the BAES did not significantly change from post-drink to the end of the session and no effect of group and no interactions were noted. Perceived ability to drive decreased from post-drink to the end of the session ($F(1, 137) = 7.52$, $p < .01$, $\eta_p^2 = .05$) but no effects of group and no interactions were observed.

Desire to continue drinking decreased from post-drink to the end of the session for the entire sample ($F(1, 134) = 19.63$, $p < .001$, $\eta_p^2 = .14$). A time (post-drink, end of the session) by caffeine consumption interaction ($F(1, 134) = 6.38$, $p < .05$, $\eta_p^2 = .05$) revealed that participants who did not consume caffeine had a significant reduction in desire to continue drinking from post-drink to the end of the session ($F(1, 67) = 20.74$, $p < .001$, $\eta_p^2 = .24$), but participants who consumed caffeine did not ($F(1, 69) = 2.86$, $p = .10$). Figure 2 illustrates desire to continue drinking at both time points as a function of caffeine consumption.

Positive affect ratings on the PANAS did not differ from pre to post drink or as a function of group. Positive affect decreased from post-drink to the end of the session ($F(1, 133) = 21.57$, $p < .001$, $\eta_p^2 = .14$). Pre-drink positive affect ratings were also significantly higher than positive affect ratings at the end of the session ($F(1, 136) = 20.79$, $p < .001$, $\eta_p^2 = .13$). No effects of group and no interactions were observed for positive affect from pre-drink to post-drink or from post-drink to the end of the session. Negative affect was not related to group condition or ingestion of the beverage, but declined at the end of the session relative to pre-drink ratings ($F(1, 121) = 5.04$, $p < .05$, $\eta_p^2 = .04$) .

Other Experimental Measures

Neither instruction nor caffeine consumption affected ratings of positive consequences, negative consequence and likelihood of engagement in risk behaviors described in the Cognitive Appraisal of Risky Events. However, overall, males reported they would be more likely to engage in risky behavior ($F(1, 133) = 15.41$, $p < .001$, $\eta_p^2 = .10$) and expect positive consequences ($F(1, 125) = 17.73$, $p < .01$, $\eta_p^2 = .12$) than females.

Reaction time on the SRTT significantly increased pre to post drink ($F(1, 123) = 19.7$, $p < .001$, $\eta_p^2 = .14$) but did not differ by group condition (instruction, caffeine). Although deviation from the reaction time mode did not differ from pre to post-drink overall, deviation from the mode (increased inattention) increased from pre to post-drink ($F(1, 66) = 4.60$, $p < .05$, $\eta_p^2 = .07$) in participants who were told they would not receive caffeine but not in participants who were told they would consume caffeine (F(1, 64 = .60, $p = .44$; time by instruction interaction $F(1, 128) = 4.32$, $p < .05$, $\eta_p^2 = .03$; Figure 3).

On the SST, neither instruction nor ingestion of caffeine affected stop signal reaction time, an index of ability to inhibit a potentiated response. Mean reaction time on signal-respond trials (trials where participants failed to inhibit their response) increased from pre to post drink ($F(1, 134) = 31.46$, $p < .001$, $\eta_p^2 = .19$). Participants who did receive caffeine demonstrated a smaller increase in response time post-drink on trials where inhibition of a response was unsuccessful ($F(1, 70) = 4.95$, $p < .05$, $\eta_p^2 = .07$) compared to participants who did not receive caffeine ($F(1, 66) = 34.46$, $p < .001$, $\eta_p^2 = .34$; time by consumption interaction $F(1, 134) = 5.17$, $p < .05$, $\eta_p^2 = .04$; Figure 4). Thus, consuming alcohol with caffeine was associated with a smaller post-drink increase in response time on trials where the response was to be inhibited (i.e., less hesitation to make the incorrect response), compared to consuming alcohol without caffeine.

Finally, mean percent of correct responses on no-signal, normal trials (hitting the appropriate key when presented with visual stimuli) decreased from pre to post-drink (F(1,

134) = 13.08, $p < .001$, $\eta_p^2 = .09$). A time by instruction by consumption group interaction emerged for mean percent of correct responses ($F(1, 134) = 4.64$, $p < .05$, $\eta_p^2 = .03$). Among participants who were informed they would not receive caffeine, mean percent of correct responses decreased from pre to post-drink ($F(1, 71) = 4.72$, $p < .05$, $\eta_p^2 = .06$) but no time by consumption interaction was observed. Among participants who were informed they would receive caffeine, percent of correct responses also decreased from pre to post-drink ($F(1, 63) = 9.53$, $p < .01$, $\eta_p^2 = .13$). However, a time by consumption interaction ($F(1, 63) = 7.0$, $p < .05$, $\eta_p^2 = .10$) indicated that mean percent of correct responses on normal trials significantly decreased from pre to post-drink for participants told they would receive caffeine but did not consume caffeine ($F(1, 32) = 16.01$, $p < .001$, $\eta_p^2 = .33$) but no such decrease was observed among participants who were told they would receive caffeine and consumed caffeine ($F(1, 31) = .10$, $p = .75$).

On the BART, average number of adjusted pumps on trials where the balloon did not explode increased from pre to post drink, indicating more risk taking following drink consumption ($F(1, 134) = 45.19$, $p < .001$, $\eta_p^2 = .25$). No effects of group emerged and no interactions were observed for number of adjusted pumps. Males evidenced a greater number of adjusted pumps than females ($F(1, 134) = 7.08$, $p < .01$, $\eta_p^2 = .04$).

Discussion

The current study represents the first attempt to comprehensively characterize the combined effects of alcohol and caffeine and expectancies for receiving caffeine on outcomes that pose potential public health implications. Several hypotheses were supported. First, caffeine decreased levels of perceived intoxication and prevented the within-session decline in desire to continue drinking. Second, alcohol decreased response accuracy in all participants except those who both expected and received caffeine, indicating an interaction between the pharmacological effects of the drug and expectancies. Third, caffeine reduced the effect of alcohol on inhibitory reaction time (faster incorrect responses). Additionally, participants who did not expect caffeine were less attentive (index of impulsivity) after alcohol, whereas participants who did expect caffeine did not exhibit this impairment, regardless of caffeine consumption.

The observation of lower subjective ratings of intoxication among participants who consumed caffeine and alcohol is consistent with some previous experimental research (Marczinski & Fillmore, 2006) and with survey data showing that students use alcohol with EDs so they could drink more and not feel as drunk (O'Brien, et al., 2008; Marczinski, 2011). However, other studies have not replicated this finding, (e.g, Alford et al., , 2012; Howland, Rohsenow, Arnedt et al., 2011; Marczinski, et al., 2012a; Marczinski, Fillmore, Henges, Ramsey & Young, 2012b), and it is unclear the extent to which the magnitude of these group differences (e.g., .5 on a scale of 1 −10) would render a meaningful change in real-world outcomes. Inconsistencies in the literature regarding the combined effects of alcohol and caffeine on subjective ratings of intoxication (e.g., Verster, Aufricht & Alford, 2012) highlight the complexity of the phenomenon – and may be attributed to differences in sample size and dose and types of caffeine and alcohol administered. For instance, the current study did not administer energy drinks, but instead used anhydrous caffeine powder to assess the combined effects of alcohol and caffeine on outcomes. Future studies are needed to replicate our findings using beverages that young social drinkers actually consume (e.g., Red Bull, Coke, Monster), so as to account for the effects of additional stimulants in these products (e.g., taurine, guarana, sugar derivatives; Heckman, Sherry, Mejia& Gonzalez, 2010) as well as product-specific expectancies. In addition, the current study employed a larger sample than has been used in previous studies and was thus statistically powered to detect a wider range of effects.

The lack of reduction in desire to continue drinking among participants who consumed alcohol and caffeine may suggest that caffeine enhances the priming effect of alcohol. This finding is in line with field research showing that individuals who consumed CABs were at three times greater risk of leaving the bar highly intoxicated than individuals who had consumed alcohol alone (Thombs et al., 2010). These data also complement experimental findings that participants receiving alcohol mixed with energy drink reported higher subjective ratings of “desire” for more alcohol over time compared to participants receiving only alcohol (Marczinski et al., 2012b). Of note, methodological developments in the field of behavioral economics have yielded valid and reliable measures (e.g., Alcohol Purchase Task; Murphy & MacKillop, 2006) of one’s demand for a substance (see Heinz, Lilje, Kassel, & de Wit, 2012). Quantification of what individuals are willing to spend in order to continue drinking may help better determine whether CABs increase desire to continue drinking more so than alcohol alone.

In terms of impulsivity, findings suggest that caffeine does not antagonize the effects of alcohol on inhibition and may even potentiate them. Indeed, no differences in inhibition were observed as a function of caffeine consumption and this is consistent with previous studies (Marczinski & Fillmore, 2003; Marczinski, et al., 2011). Next, regardless of expectancy, compared to participants who consumed caffeine, those who did not evidenced a greater increase in response time on trials where the response was unsuccessfully inhibited. This pattern indicates that caffeine consumption was associated with less hesitation when executing a response was that was supposed to have been suppressed (e.g., “making bad decisions faster”). However, given that overall error rates were not affected (i.e., stop signal reaction time), an alternative explanation might be that caffeine simply speeded reaction time on these trials. Finally, results suggest that the belief that caffeine has been consumed (and not actual caffeine consumption) may protect against lapses in attention that are associated with impulsive behavior.

Counter to stated hypotheses, neither caffeine consumption nor expectancy was associated with differences in risk perception or risky-behavior. Assessment of participants’ cognitive appraisals of risky events post-drink yielded no evidence of group effects, though males reported a higher likelihood of involvement in and positive consequences resulting from risky behaviors. Additionally, on the BART, participants evidenced an increase in risky performance pre to post-drink but these changes were not accounted for by caffeine consumption or expectancy. Interestingly, an events-based analysis showed that the odds of engaging in risky behavior were actually lower on drinking occasions involving alcohol mixed with energy drinks relative to occasions involving only alcohol (Peacock, et al., 2012); thus, one possibility is that the stimulating effects of caffeine may offset the untoward effects of alcohol on risky decision making. Consistent with previous research (Cross, et al., 2011), females earned less money than males on the BART which suggests that they were more likely than males to accept smaller earnings in the face of increasing risk. These findings, in combination with well documented gender differences in the literature for the effect of alcohol on propensity for aggressive and violent behavior (Giancola et al., 2009; Giancola & Zeichner, 1995) and sexual responses and decision-making (Nolen-Hoeksema, 2004), warrant further assessment of potential gender differences in vulnerability to CAB related harms.

Several other findings diverged from reported relations in the literature between caffeinated alcohol, subjective experience and performance. For instance, the lack of evidence for increased ratings of stimulation and decreased ratings of sedation from drinking is not in line with reports from similar studies (Attwood et al., 2012; Marczinski, et al., 2011; Marczinski, et al., 2012a) or with survey data showing that individuals' motivation to consume caffeine with alcohol includes increased happiness, euphoria and physical vigor (Ferreira, Mello, & Olivera, 2004). Additionally we observed no differences in perceived ability to drive as a function of group. Although intention is different from perceived ability, field research has shown that bar patrons who consumed CABs were four times more likely to express intentions of driving out of the bar district than patrons who had consumed only alcohol (Thombs et al., 2010). Finally, the addition of caffeine did not counteract the alcohol-related slowing of reaction time, which is somewhat inconsistent with previous studies (Kerr et al., 1991; Marczinski & Fillmore, 2003; Marczinski, et al., 2011), though caffeine coupled with the expectation of caffeine did counteract the effects of alcohol on a measure of accuracy. Taken together, findings lend mixed support to the notion that caffeine consumption, as well as the expectation of caffeine, antagonizes the untoward effects of alcohol on performance.

Despite several strengths, including use of a balanced placebo design for caffeine and multi-modal assessment of outcomes, limitations should be noted for the current study. Expectancies for the combined effects of caffeine and alcohol were not assessed. Individuals may hold expectancies unique to just caffeinated alcohol that cannot be captured with separate measures for each substance (e.g., I will feel less drunk, I can stay out drinking longer…when I consume alcohol with caffeine). Moreover, these expectancies for combined use of caffeine and alcohol may mediate (i.e., explain) the association between consumption of CABs and subsequent risky and impulsive behavior. Inclusion of the newly developed Caffeine plus Alcohol Combined Effects Questionnaire (MacKillop et al., 2012) in future studies, to assess strength of expectancies for CABs, would go a long way towards addressing this knowledge gap. Future research should also examine other candidate mediational factors that may reveal an indirect pathway between CAB consumption and health-risk behaviors (e.g., caffeine dependence; subjective indices of mood, arousal, perceived impairment under CABs). Finally, the CARE has demonstrated sensitivity to the acute effects of alcohol (e.g., lower perceived harm, Fromme, et al., 1997; Maisto, Carey, Carey, Gordon, & Schum, 2004; Testa, Livingston, & Collins, 2000) and future studies with caffeine and alcohol should assess within-subject (pre-post) changes in risk perception.

Much remains to be studied concerning the relation between caffeinated alcohol and health-risk behaviors. In the current study, quantity and frequency of caffeinated alcohol use positively correlated with several self-reported impulsivity subscales, frequency of engagement in various risk behaviors, and social norms surrounding CAB use. Such a pattern begs the question of whether individuals who choose to drink CABs are inherently more impulsive and risky [than individuals who opt not to] and thus are more likely to experience alcohol-related harms independent of the added effects of caffeine. As articulated by Howland and colleagues (2011), documented correlations in the literature among CAB use and risky behavior may be explained by a third-variable to which both outcomes are related (i.e., impulsivity). For instance energy drink (ED) users report higher impulsive sensation seeking scores than non ED users and are at increased risk for illicit substance use and alcohol dependence (Arria et al., 2010; Arria et al., 2011). However, even after controlling for risk-taking propensity, CAB users still demonstrate increased risk for alcohol-related harms compared to non-users (Brache & Stockwell, 2011). In the absence of sufficient experimental data to refute this claim, CAB use may be just an “epiphenomenon” of other related risk factors rather than a direct, causal factor of risky behavior (e.g., Verster et al., 2012). Researchers should test for a synergistic relationship whereby individuals higher in trait impulsivity demonstrate riskier behavior when consuming caffeinated alcohol versus alcohol alone.

Last, given the robust link between alcohol consumption and sexual risk-taking (e.g., Weinhardt & Carey, 2000) and aggressive behavior (see Heinz, Beck, Meyer-Lindenberg, Sterzer, & Heinz, 2011), it is important to determine if caffeinated alcohol differentially influences these outcomes. For example, if caffeine offsets alcohol-related decrements in reaction time but does not alter accuracy or inhibition, individuals may be more prone to react quickly and aggressively without first processing critical contextual details (e.g., intentionally versus accidentally being bumped into at a bar). These alcohol-related consequences, which transpire in interpersonal contexts, may be best studied using experimental paradigms that more closely simulate real-world circumstances or even outside the laboratory with ecological assessments and field studies.

In summary, consumption of caffeinated alcohol may elevate risk for continued drinking, reduce sensitivity to intoxication and decrease reaction time for inaccurate responses. Conversely, the expectation of caffeinated alcohol as well as consumption may reduce inattention, an index of impulsivity, and protect against some aspects of alcohol-related performance decrements. In all, the observed findings suggest that caffeine or the expectation of caffeine does not render a direct, uniform effect on impulsive and risky behavior under alcohol.

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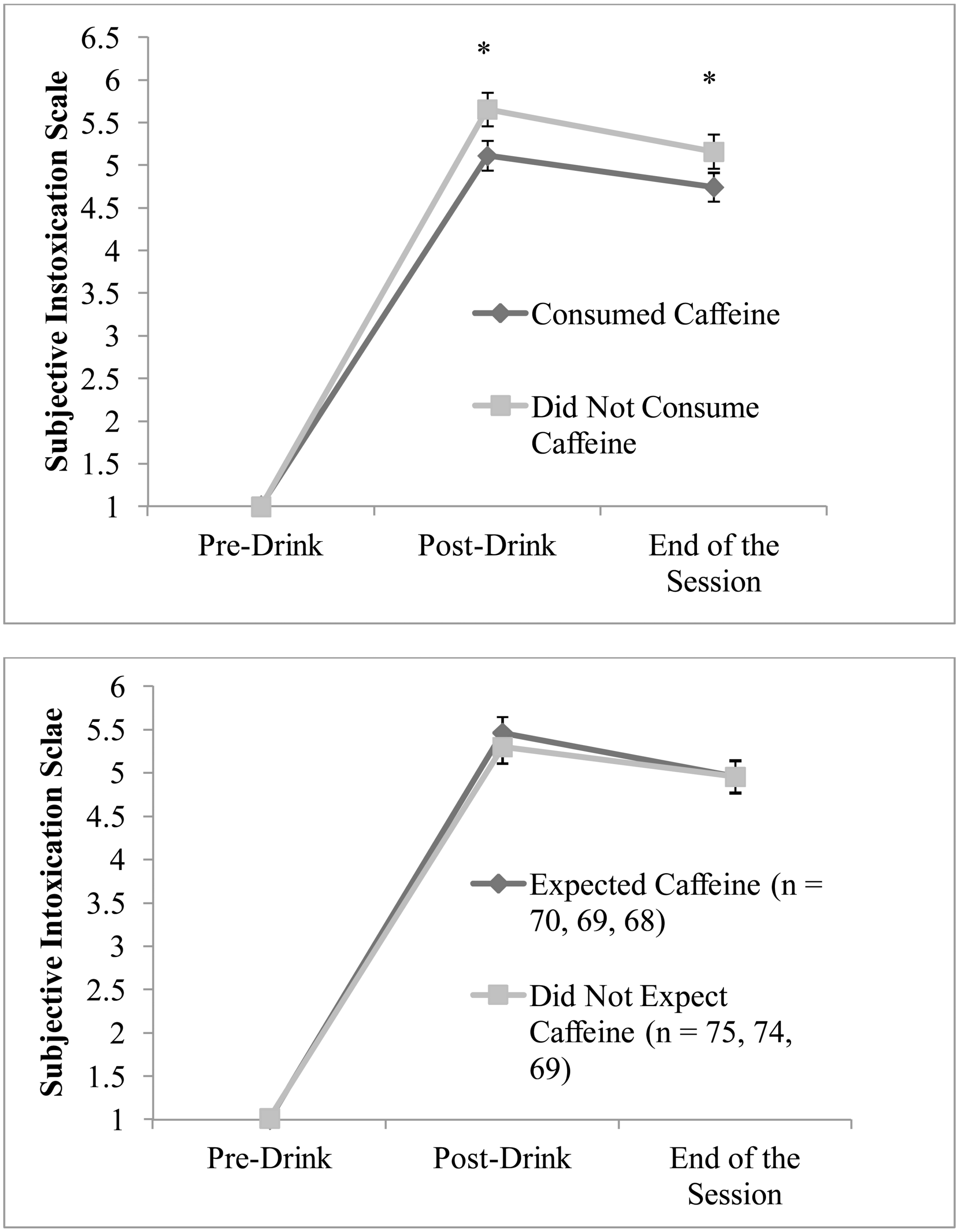

Figure 1.

Mean subjective rating of alcohol intoxication by time and caffeine consumption and by time and caffeine expectancy. Asterisks indicate statistically significant group differences ($p < .05$) in subjective intoxication. The Subjective Intoxication Scale ranges from 1 to 10 (10 = "*intoxicated as I've ever been*"). Error bars represent 1 standard error above and below the mean. For the caffeine consumption group, n = 74, 73, 69, at pre-drink, post-drink and end of the experiment, respectively. For the group not receiving caffeine, n = 71, 70, 68, at pre-drink, post-drink and end of the experiment, respectively.

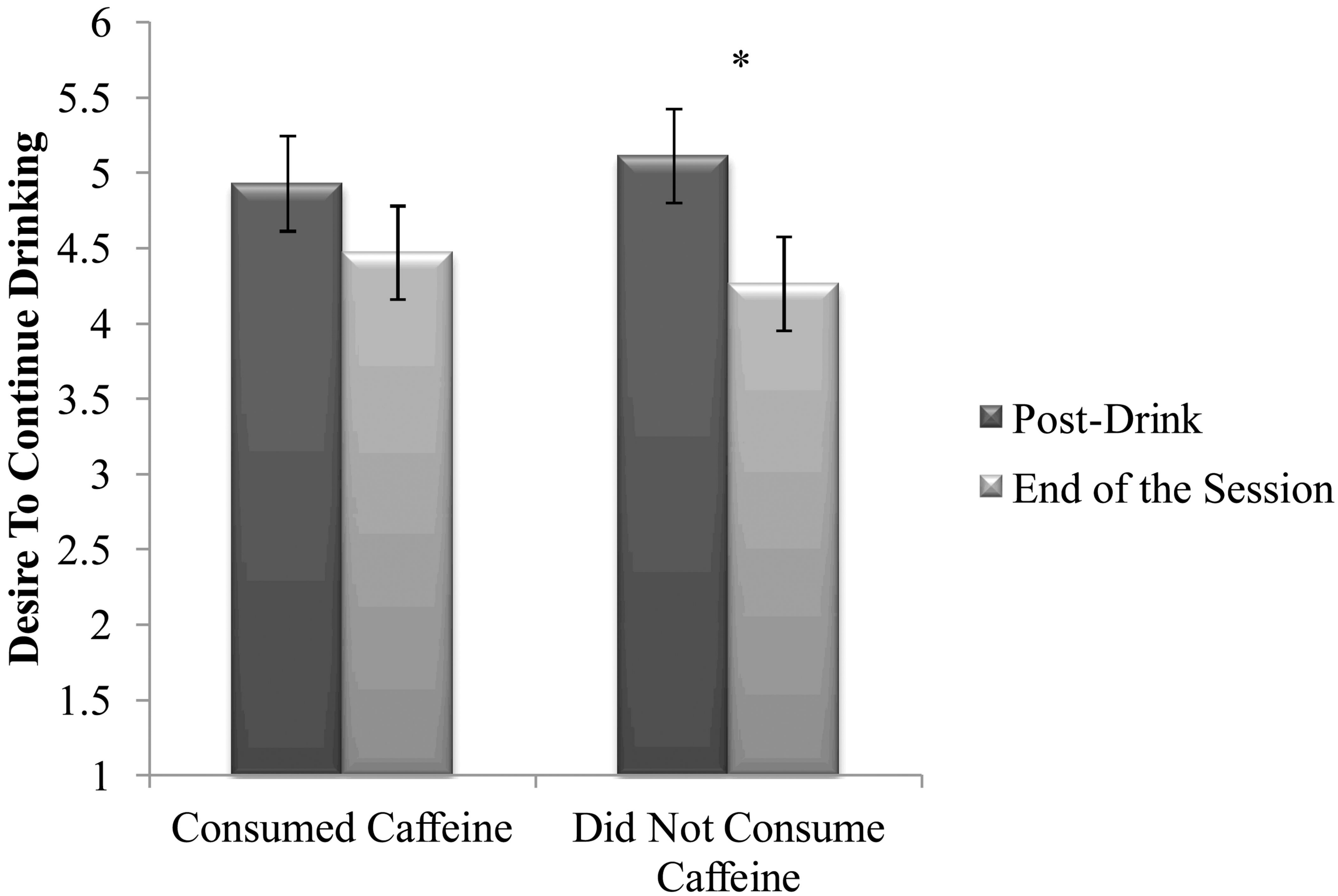

Figure 2.
Desire to continue drinking alcohol post-drink to the end of the session as a function of caffeine consumption. Asterisk indicates a statistically significant decrease ($p < .05$) in desire to continue drinking alcohol from post-drink to end of the session. The Desire to Continue Drinking Scale ranges from 1 to 10 (10 = "*strongly desire more alcohol*"). Error bars represent 1 standard error above and below the mean. For the caffeine consumption group, n = 73 and 70, at post-drink and end of the experiment, respectively. For the group not receiving caffeine, n = 70 and 68, at post-drink and end of the experiment, respectively.

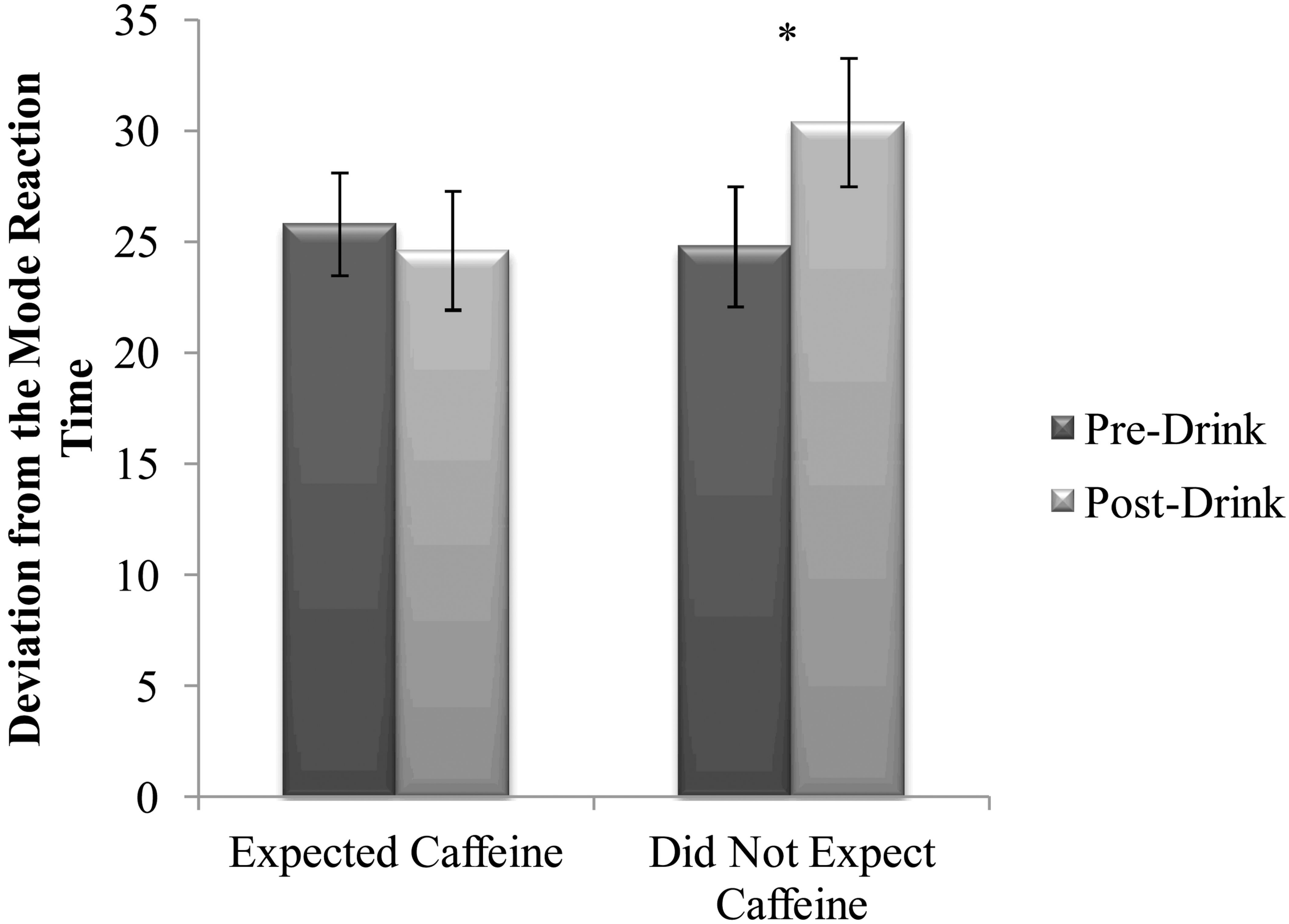

Figure 3.

Mean deviation from the mode reaction time on the Simple Reaction Time Test, before and after beverage consumption, by expectancy group. Asterisk indicates a statistically significant (p < .05) Increase in Deviation From the Mode, from pre to post-drink, which is an index of inattention and an element of impulsivity. Error bars represent 1 standard error above and below the mean. For the caffeine expectancy group, n = 67 and 67, at pre and post-drink, respectively. For the group with no caffeine expectancy, n = 74 and 68, at pre and post-drink, respectively.

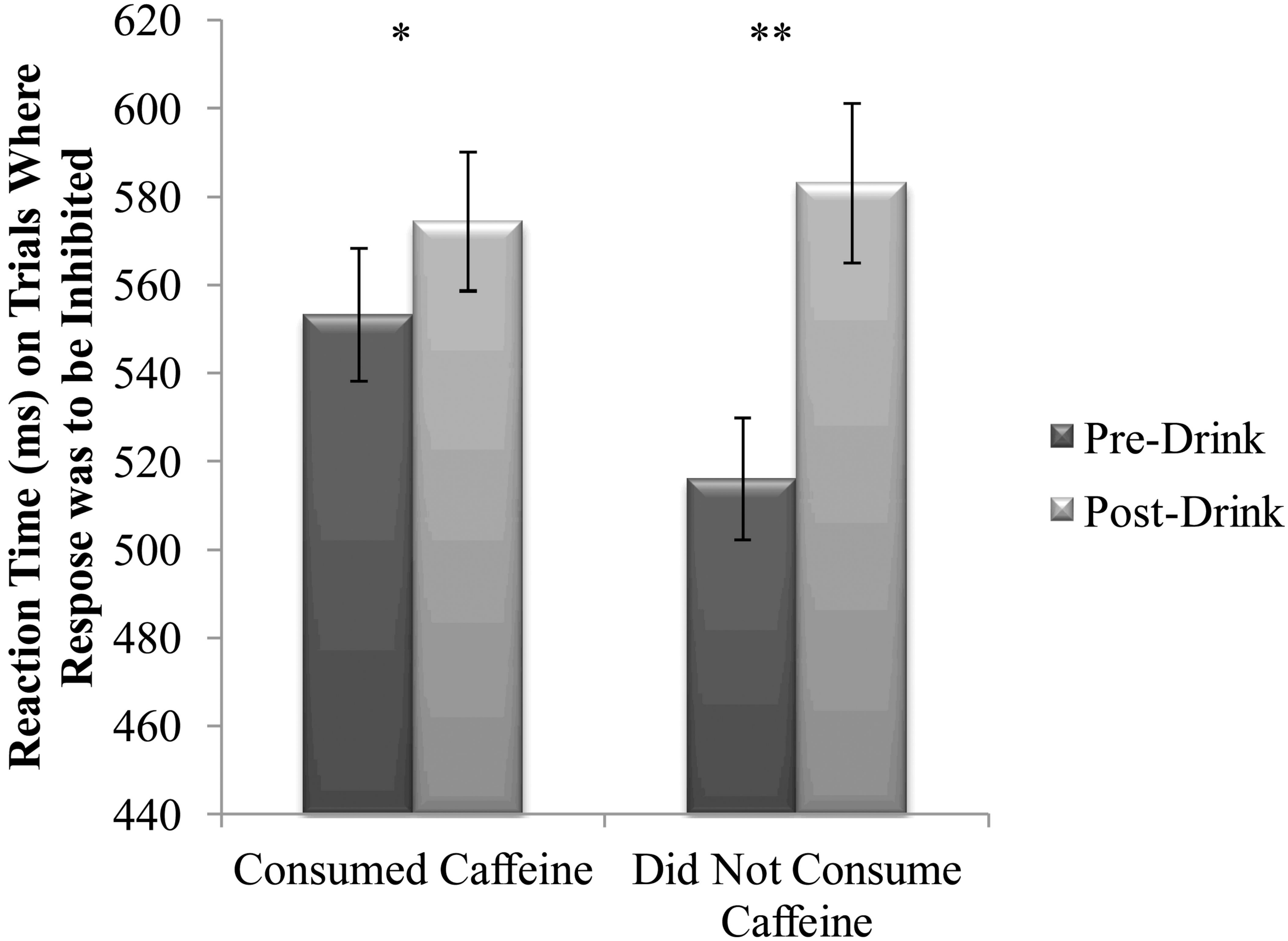

Figure 4.

Mean reaction time on stop signal trials in which participants failed to inhibit response, before and after beverage consumption in groups who did (n = 72, 71) or did not receive caffeine (n = 69, 69). Groups values pre-drink are not statistically different ($p = .07$). Error bars represent 1 standard error above and below the mean.

*$p < .05$; **$p < .01$

Table 1

Descriptive Statistics for Caffeine Alcohol and Caffeinated Alcoholic Beverage (CAB) Use and Peer Attitudes and Norms (N=146)

	Mean	SD
Number days consumed caffeinated beverages in an avg week in past 3 months**	5.44	2.04
Number caffeinated beverages consumed in an avg week in past 3 months **	10.86	8.01
Average number of caffeinated drinks consumed per drinking occasion**	1.86	0.96
How addicted are you to caffeine (1 not at all, 4 very addicted)	1.77	0.82
Number years been consuming caffeine at this quantity and frequency	5.89	4.12
Number of caffeine withdrawal symptoms experienced in past 12 months	1.43	1.59
Number days in an avg week in past 3 months consumed alcoholic beverages	3.97	1.64
Number alcoholic beverages consumed in an avg week in past 3 months	14.31	9.03
Average number of drinks consumed per drinking occasion in past 3 months	3.63	1.65
Number days in an avg week in past 3 months consumed CABs	1.91	1.98
Number CABs consumed in an avg week in past 3 months	3.18	4.19
Average number of CABs consumed per drinking occasion in past 3 months*	1.65	0.92
Max number of drinks had in one sitting in the past 30 days	7.24	3.34
Max number of CABs in one sitting in the past 30 days	1.7	1.74
	n	**%**
Number of days in the past 30 had a CAB		
I didn't drink a CAB in the past thirty days	50	34
About once a month	37	32
2 to 3 times a month	45	31
Once or twice a week or more	4	3
Drank a CAB at least once week on average in past 3 months	106	73
Had 4/5 (f/m) or more CABs in a single sitting one or more times in past 30 days	25	20
Peer Attitudes and Norms for CAB and Alcohol Consumption	**CABs**	**Alcohol**
How do most of your friends feel about drinking	**n (%)**	**n (%)**
Disapprove	8 (5)	0 (0)
Neither approve nor disapprove	55 (38)	17 (12)
Approve	62 (43)	69 (47)
Strongly approve	21 (14)	60 (41)
How many of your close friends drink	**CABs**	**Alcohol**
None	11 (7)	0 (0)
Some	62 (43)	1 (1)
Half	19 (13)	3 (2)
Most	31 (21)	35 (24)
Nearly all or all	23 (16)	107 (73)

Note.

[*] For participants who reported recent CAB use (n = 106).

[**] Independent of CAB use.

Table 2

Demographic Characteristics and Descriptive Statistics for Caffeine, Alcohol and Caffeinated Alcoholic Beverage Use Patterns as a Function of Experimental Group.

	Group 1, no caffeine and no expectancy	Group 2, caffeine and caffeine expectancy	Group 3, no caffeine and caffeine expectancy	Group 4, caffeine and no expectancy
	n = 37	**n = 35**	**n = 35**	**n = 39**
	Mean (SD)	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**
Age	24.27 (2.21)	24.03 (2.60)	24.03 (2.20)	24.08 (2.38)
Caffeine*				
Frequency	5.64 (2.07)	5.49 (1.96)	5.22 (2.17)	5.38 (2.02)
Quantity	1.85 (.84)	1.82 (.85)	2.09 (1.30)	1.69 (.81)
Alcohol				
Frequency	3.92 (1.64)	3.63 (1.65)	3.83 (1.44)	4.44 (1.76)
Quantity**	3.81 (1.61)	3.39 (1.54)	3.38 (1.68)	3.90 (1.76)
Caffeinated Alcoholic Beverages				
Frequency	1.81 (1.58)	2.03 (2.41)	1.60 (1.61)	2.18 (2.20)
Quantity***	1.66 (1.11)	1.66 (.94)	1.65 (.78)	1.63 (.92)
	n (%)	**n (%)**	**n (%)**	**n (%)**
Caffeine Dependent	10 (27)	19 (54)	16 (46)	16 (41)
Smoking	11 (30)	10 (29)	9 (26)	9 (23)
Female	19 (51)	18 (51)	18 (51)	19 (49)
Caucasian	23 (62)	25 (71)	22 (63)	25 (64)

Note. Frequency = number of days consumed in an average week in the past 3 months; Quantity = average number of beverages consumed per use day in an average week in the past 3 months.

* Caffeinated beverages could include coffee, tea, soda and energy drinks; mg of caffeine consumption varies across beverage types.

** Standard number of alcoholic drinks.

*** N = 106