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Effects of Acute Alcohol Tolerance on Perceptions of Danger and Willingness to Drive after Drinking

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Abstract

Rationale—Drinking and driving is associated with elevated rates of motor vehicle accidents and fatalities. Previous research suggests that alcohol impairs judgments about the dangers of risky behaviors; however, how alcohol affects driving-related judgments is less clear. Impairments have also been shown to differ across limbs of the blood alcohol concentration (BAC) curve, which is known as acute tolerance.

Objectives—Examine whether perceptions about the dangerousness of driving after drinking and willingness to drive differed across ascending and descending limbs of the BAC curve. Test whether reductions in perceived danger were associated with willingness to drive on the descending limb.

Methods—Fifty-six participants were randomly assigned to receive either a moderate dose of alcohol (peak BAC = 0.10 g%) or placebo. We assessed perceived dangerousness and willingness to drive at matched BACs (~0.067-0.068 g%) on the ascending and descending limbs.

Results—Both perceived danger and willingness to drive showed acute tolerance in the alcohol group. Participants judged driving to be significantly less dangerous and were more willing to drive on the descending limb compared to the ascending limb. The magnitude of change in perceived danger significantly predicted willingness to drive on the descending limb.

Conclusions—Decreased impairment associated with acute tolerance may lead individuals to underestimate the dangerousness of driving after drinking and in turn make poor decisions regarding driving. This study further emphasizes the descending limb as a period of increased risk and offers support for enhancing prevention efforts by targeting drivers at declining BAC levels.

Keywords

Drinking and driving; Perceived Danger; Alcohol Administration; Acute Tolerance; Descending Limb

Drinking and driving is a serious public health concern that contributes substantially to motor vehicle accidents and associated fatalities (NHTSA 2012). After years of substantial decline (Hingson and Winter 2003), the rate of alcohol-related fatal crashes in the U.S. has remained stable since the mid-90's (Yi et al. 2006). As such, the need for additional research

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on the determinants and consequences of drinking and driving remains high. In particular, research focused on the factors that contribute to the decisions to get behind the wheel after drinking has the potential to substantially inform prevention efforts.

The decision to drive after consuming alcohol is a complex one, reflecting the combination of a variety of situational and personal factors. In psychological models of health risk behavior, such as the theory of planned behavior (Ajzen 2011), the most immediate determinants of behavior are intentions, which, in turn, are influenced by more distal variables such as attitudes or normative beliefs. In the case of driving after drinking, one attitudinal factor that is a strong determinant of intention or willingness to drive (e.g., Beirness 1987) is individuals' appraisal of the dangers of drinking and driving (e.g., Grube and Voas 1996). Empirical studies have demonstrated that perceiving drinking and driving as more dangerous is associated with reduced odds of doing so (Grube and Voas 1996; McCarthy et al. 2007; Bingham et al. 2007; McCarthy and Pedersen 2009; Fairlie et al. 2010). Perceived risk of drinking and driving also uniquely predicts driving after drinking (Bingham et al. 2007), and has been found to mediate the influence of impulsive personality traits on drinking and driving (Treloar et al. 2012). Together, this research suggests that perceived danger is an important precursor to the intention to drive after drinking.

Laboratory studies have suggested that one mechanism by which alcohol intoxication promotes risky behaviors is by impairing judgments about the dangers of these behaviors. Previous research has primarily focused on factors contributing to risky sexual behavior while intoxicated (Fromme et al. 1997; Fromme et al. 1999; MacDonald et al. 2000; Maisto et al. 2002; Davis et al. 2007). However, relatively little research has examined the effects of alcohol on drinking-and-driving judgments. In an initial set of field experiments, intoxicated participants held more positive attitudes toward driving and reported greater willingness to drive than sober participants (MacDonald et al. 1995). Results from a subsequent laboratory alcohol administration study further indicated that drinking-and-driving perceptions assessed when intoxicated uniquely predicted drinking-and-driving behavior and intentions to drive (Morris et al. 2013).

The effects of alcohol on driving-related decisions may also differ between the ascending and descending limbs of the blood alcohol curve (e.g., Schweizer and Vogel-Sprott 2008; Cromer et al. 2010). This phenomenon—referred to as acute tolerance—suggests that the effects of alcohol are greater when assessed soon after alcohol consumption relative to when measured later, even if blood alcohol concentrations are similar at both time points. Importantly, while subjective intoxication shows acute tolerance, many of the cognitive and behavioral impairments produced by alcohol do not show a corresponding decrease (Fillmore et al. 2005; Schweizer and Vogel-Sprott 2008; Marczinski and Fillmore 2009; Cromer et al. 2010). The disconnect between perceived intoxication and behavioral performance may lead individuals to underestimate their level of impairment and, as a result, increase the likelihood of engaging in a variety of risky behaviors including driving.

Studying whether drinking-and-driving variables exhibit acute tolerance is highly relevant as the choice to drive after drinking often occurs at the end of a drinking episode when BAC levels are presumably declining. Roughly two-thirds of drunk driving-related fatalities

(Levine and Smialek 2000) and the majority of arrests for impaired driving (Jones 1990) occur on the descending limb. Furthermore, studies have found that simulated driving performance does not demonstrate acute tolerance, despite significant reductions in subjective intoxication and motor impairments across limbs (Marczinski and Fillmore 2009; Weafer and Fillmore 2012). It is largely unknown whether drinking-and-driving decisions exhibit acute tolerance. Marczinski and Fillmore (2009) found that participants felt less intoxicated and were more willing to drive on the descending limb compared to the ascending limb. Morris et al. (2013) subsequently found that perceptions of dangerousness of driving measured while intoxicated were uniquely associated with drinking-and-driving behavior, over and above these same perceptions assessed when sober. This study also found a significant decrease in the perceived dangerousness of driving after drinking from ascending to descending limbs. However, this study did not specifically match BAC on both limbs so it was unclear whether this reduction was indicative of acute tolerance. Also, this study used a within-subjects design without a placebo condition and, therefore, was unable to account for expectancy effects (see Goldman et al. 1999; Jones et al. 2001 for reviews).

Building on this research, the primary goal of the present study was to investigate whether perceived danger and willingness to drive after drinking exhibit acute tolerance. We assessed participants' perceptions about the dangerousness of driving after drinking and their willingness to drive on the ascending and descending limbs of the blood alcohol curve. Stemming from the finding that certain cognitive and behavioral variables may confer greater risk of driving on the descending limb (e.g., Weafer and Fillmore 2012), a secondary aim of this study was to investigate whether changes in perceived danger of driving predicted individuals' willingness to drive on the descending limb.

This study addresses the limitations of previous studies in two specific ways. First, this study included a placebo beverage group which allowed us to account for potential alcohol expectancy effects on acute tolerance. Second, although previous studies have examined acute tolerance for perceived danger or willingness to drive individually, no studies have tested whether increased willingness to drive can be attributed to reductions in the perceived dangers of doing so.

We hypothesized that alcohol would increase the perceived danger of driving and decrease the willingness to drive relative to the placebo group. We further predicted that participants who consumed alcohol would show a significant decline in perceived danger and report an increased willingness to drive on the descending limb compared to the ascending limb, reflecting acute tolerance. Finally, we predicted that individuals who showed a larger reduction in perceived danger would report a greater willingness to drive on the descending limb.

Materials and Methods

Participants

Sixty-six participants were recruited from a large, Midwestern university and its surrounding community via flyers and university informational emails. Potential participants were initially screened for eligibility via a telephone interview that assessed typical drinking habits and physical and mental health status. Participants had to report consuming five or more drinks on one occasion in the preceding six months. Individuals who self-reported a current or lifetime psychiatric disorder, substance abuse disorder, or head trauma were excluded. Additionally, individuals were excluded if they reported having a medical condition or taking a medication with which alcohol use is contraindicated. Women who were pregnant or nursing were excluded.

Two female participants were unable to participate due to positive pregnancy tests, one participant was excluded due to sickness following alcohol consumption, and three participants were excluded for not driving on a regular basis (i.e., not having access to a car or driving in the past month). Finally, four participants in the placebo beverage group did not believe that they had received alcohol during the session and were consequently excluded from all analyses. The final sample of 56 participants (26 females) ranged in age from 21 to 33 years old ($M = 22.61$, $SD = 2.81$). The majority were Caucasian ($n = 38$), with five African American, one Asian, one American Indian, seven multi-racial participants, and one Other response (three participants did not report race).

Measures

Demographics—Demographic information such as age, sex, race, accessibility to a car, and past month driving activity was assessed with a self-report questionnaire.

Alcohol use and drinking-and-driving behavior—Past month alcohol use was assessed using two questions adapted from the Monitoring the Future project (Johnston et al. 2011). Participants were asked to report the number of occasions they consumed alcohol and the number of drinks they typically consumed on drinking days in the past 30 days. Participants also reported how many times they drove after consuming three drinks in a two-hour time frame in the past year.

Perceptions of dangerousness of driving after drinking—Participants reported their perceptions concerning the dangerousness of driving after drinking (e.g., Grube and Voas 1996). Sober perceptions of the dangerousness of driving after drinking were assessed by asking participants how dangerous it would be to drive after hypothetically consuming three drinks within a two-hour time frame. Participants completed similar ratings after beverage consumption, but the prompt was reframed to refer to their present state (i.e., “How dangerous do you feel it is for you to drive right now?”). In both cases, participants responded using a 4-point Likert scale with the following response options: (1) “not at all”, (2) “a little”, (3) “somewhat”, and (4) “extremely”.

Willingness to drive—Willingness to drive was assessed using a dichotomous item asking whether the participant would drive right now (1 = yes; 0 = no) (Beirness 1987; Morris et al. 2013).

Breath alcohol concentration—Breath alcohol concentration (BrAC) was assessed using a FST-Alco-Sensor breathalyzer device (Intoximeters, Inc.; St. Louis, MO). Following consumption, BrAC samples were collected at five-minute intervals to allow for accurate matching of BrAC for the ascending and descending limb assessments.

Subjective intoxication—Participants rated their level of subjective intoxication via a single item that asked, "How intoxicated do you feel right now?" Responses ranged from 1 ("Not drunk at all") to 10 ("More drunk than I've ever been").

Procedure

This study employed a two-group between-subjects design in which participants were randomly assigned to either an alcohol ($n = 28$) or placebo ($n = 28$) beverage condition. Of note, an additional 36 participants were assigned to a no-beverage control condition. However, because participants in the control group knew that their drinks contained no alcohol, they reported nearly 100% willingness to drive and very low perceived danger at both time points. As such, these participants were excluded from analysis due to lack of variability in their responses. Test sessions began at 11:00 AM and were conducted in a neutral laboratory setting. Participants were tested individually by two research assistants: one was blind to beverage condition and interacted with the participant; the other assigned the participant to a condition, prepared the beverages, and collected BrAC readings. Participants were instructed to abstain from drugs and alcohol for 24 hours prior to the session. At the start of the session, participants provided informed consent, signed an affidavit confirming abstention, and verified pre-session sobriety (i.e., BrAC = 0.00 g%). Female participants completed a hormonal pregnancy test. Participants then completed questionnaires on a desktop computer that assessed demographic and drinking information, as well as other individual differences variables not relevant to the current study. Sober perceptions of dangerousness were assessed at this time.

Beverage administration—Upon completion of the individual differences assessment, participants were randomly assigned to the alcohol or placebo group. Following established procedures for examining acute tolerance in the laboratory (e.g., Fillmore et al., 2005; Marczinski & Fillmore, 2009), the alcohol group expected to receive alcohol and consumed 190-proof pure grain alcohol mixed with orange juice in a 1:3 ratio. The specific alcohol dose was calculated based on participants' total body water and time for consumption. Estimates of total body water were generated using age, sex, height and weight (Curtin and Fairchild 2003). The dose administered was calculated to produce a peak BrAC of 0.10 g% at one hour following the onset of drinking. The placebo group also expected to receive alcohol, but their beverage consisted of orange juice with a small volume of alcohol (6 mL) floated on top. The total volume of the placebo beverage was equivalent to the total volume of the alcoholic beverage had the participant been assigned to the alcohol group. For both groups, the beverages were divided equally into two glasses. Participants consumed each glass in one minute, with a five minute break between glasses.

Post-consumption testing—Breath alcohol concentration readings were assessed at five minute intervals following the consumption period. For the alcohol group, readings were tracked until a BrAC of approximately 0.060 g% was achieved. At this point, participants completed an assessment that comprised subjective intoxication, perceived dangerousness, and willingness to drive. Following the completion of this assessment, BrAC recordings resumed at five minute intervals until a comparable BrAC (~0.060 g%) was achieved on the descending limb. Participants were again administered the subjective intoxication, perceived dangerousness, and willingness to drive assessments. For the placebo group, the timing of the first and second assessments was matched to the timing in the alcohol group, based on participant sex and weight.

Debriefing and departure—To verify the efficacy of the placebo manipulation, participants were asked whether they believed they received alcohol during the session and were asked to estimate how many standard drinks they received. Participants were then given a thorough debriefing, including disclosure of alcohol vs. placebo group status. Following completion of the study, participants in the alcohol group were given a light meal and remained in the laboratory until their BrAC descended below 0.020 g% (NIAAA 2005). Participants in the placebo group were permitted to leave following the conclusion of the study since their BrAC was 0.000 g%. Participants were paid $12/hour for their participation and were transported home via a prepaid taxi or friend. All procedures were in accordance with the 1964 Declaration of Helsinki and were approved by the University of Missouri Institutional Review Board.

Data Analysis

SPSS Version 21 (IBM Corp.; Armonk, NY) and STATA Version 12 (STATA Corp.; College Station, TX) were used to conduct all analyses. Prior to analyses, data were screened for the presence of outliers (e.g., ± 3 *SD* from the mean). One outlier was identified for drinking frequency; this value was recoded as 1 unit higher than the closest non-outlying value (Tabachnick and Fidell 2001). No other outliers were present in the data. Independent samples *t*-tests and Pearson chi-square tests were used to examine differences between groups at baseline. Preliminary analyses were conducted to verify the established parameters of acute tolerance. Specifically, a 2 (sex: male, female) × 2 (limb: ascending, descending) mixed factorial analysis of variance (ANOVA) was conducted for BrAC in the alcohol group. A 2 (group: alcohol, placebo) × 2 (sex: male, female) × 2 (limb: ascending, descending) mixed factorial ANOVA was conducted to examine change in subjective intoxication.

The presence of acute tolerance to alcohol's effects on perceived danger was tested using a 2 (group: alcohol, placebo) × 2 (sex: male, female) × 2 (limb: ascending, descending) mixed factorial analysis of covariance (ANCOVA). Drinking quantity and frequency were included as covariates. Planned comparisons were conducted to examine change in perceived danger within each group. We also examined whether the change in participants' willingness to drive (0 = no; 1 = yes) from the ascending to descending limb was moderated by beverage group using generalized estimating equations (GEE). GEE is appropriate when there is repeated assessment of a dichotomous dependent variable. Main and interaction effects for both limb (0 = ascending limb) and beverage group (0 = placebo) were simultaneously entered into the model. A binomial family with a logit link function and exchangeable correlation structure was specified to obtain odds ratios (OR) of willingness to drive for each predictor. Larger ORs indicated increased odds of willingness to drive. Planned comparisons were also conducted to examine the change across limbs in the proportion of participants willing to drive within each group. Finally, we examined whether the change in perceived danger across limbs predicted willingness to drive on the descending limb. In this case, ORs were calculated using a hierarchical logistic regression model to test the association between the change in perceived danger and willingness to drive (0 = no; 1 = yes) on the descending limb. Sex, drinking frequency, drinking quantity, and ascending limb willingness to drive ratings were entered simultaneously on the first step. The danger difference score was then entered on the second step. Larger ORs indicated increased odds of willingness to drive for every unit of greater decrease in perceived danger. Likelihood ratio χ^2 difference tests (G^2) were used to examine the predictive information gained from inclusion of the predictors at each step.

Results

Descriptive Statistics

Participant demographics and alcohol use measures for each group are presented in Table 1. Chi-square tests and independent samples *t*-tests indicated no significant group differences in demographics or alcohol use variables (*p*s > .11), although the effect sizes for sex and drinking quantity comparisons were moderate to large (sex: Cramer's $V = .22$; drinking quantity: Cohen's $d = .46$). As such, these variables were included as covariates in subsequent analyses. On average, participants reported drinking on ten occasions during the past month and consumed four drinks per occasion. There were no significant differences between males and females with respect to drinking frequency or quantity (*p*s > .79). Approximately 43% ($n = 23$) of the sample reported driving after consuming three alcoholic drinks within two hours over the past year ($M = 11.30$, $SD = 16.9$ occasions). Males and females were equally likely to report driving after drinking in the past year ($p = .75$), as were participants in the alcohol and placebo groups ($p = .93$). There were also no significant differences between groups on sober ratings of dangerousness of driving after hypothetical consumption of three drinks ($p = .85$). For the manipulation check, participants in the alcohol group reported consuming a greater number of alcoholic drinks ($M = 3.46$, $SD = 1.48$) compared the placebo group ($M = 2.00$, $SD = 0.77$), $t(52) = 4.61$, $p < .001$, $d = 1.30$. Across all participants, the average time elapsed from the end of beverage consumption to the ascending and descending limb assessments was 30.83 ($SD = 16.14$) minutes and 124.30 ($SD = 40.21$) minutes, respectively. Finally, perceived danger and willingness to drive variables were significantly correlated on both the ascending and descending limb assessments, *r*s = .74-.78, *p*s < .0001.

Breath Alcohol Concentration and Subjective Intoxication

Breath alcohol concentration levels and subjective intoxication ratings were examined to confirm the previously established parameters of acute tolerance (e.g., Cromer et al. 2010). For BrAC, there were no significant main effects of limb, $F(1, 26) = 2.73$, $p = .11$, $\eta_p^2 = .10$, or sex, $F(1,26) = 1.77$, $p = .20$, $\eta_p^2 = .06$. The limb × sex interaction was similarly non-significant, $F(1,26) = 0.86$, $p = .36$, $\eta_p^2 = .03$. Across participants, the average BrAC was 0.068 g% ($SD = 0.009$) for the ascending limb and 0.067 g% ($SD = 0.010$) for the descending limb. No detectable BrACs were observed in the placebo group.

Mean subjective intoxication ratings for the ascending and descending limbs, respectively, were 3.93 ($SD = 1.54$) and 2.68 ($SD = 2.11$) for the alcohol group and 1.96 ($SD = 1.11$) and

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1.39 (*SD* = 0.69) for the placebo group. The group × sex × limb ANOVA revealed significant main effects of limb, $F(1,50) = 6.91$, $p < .01$, $\eta_p^2 = .12$, and group, $F(1,50) = 15.99$, $p < .001$, $\eta_p^2 = .24$, that were qualified by a significant limb × group interaction, $F(1,50) = 6.59$, $p < .05$, $\eta_p^2 = .16$. Post hoc tests indicated that the decrease in subjective intoxication was significant in both groups (*p*s < .01), but the effect size of this difference was larger in the alcohol group ($\eta_p^2 = .43$) compared to the placebo group ($\eta_p^2 = .12$).

Effects of Limb on Perceived Danger

Fig. 1 depicts the mean ratings of perceived danger on the ascending and descending limbs of the BrAC curve for alcohol and placebo groups. Results from the mixed factorial ANCOVA revealed a significant main effect of group, $F(1,50) = 32.60$, $p < .001$, $\eta_p^2 = .40$, and a significant limb × group interaction on perceptions of dangerousness, $F(1,50) = 4.20$, $p < .05$, $\eta_p^2 = .08$. The main effect of limb was not statistically significant, $F(1,50) = 2.31$, $p = .14$, $\eta_p^2 = .04$, nor were any main or interactive effects of sex (*p*s > .45). On average, participants who received alcohol rated driving as significantly more dangerous than those who expected alcohol but did not receive any. With regard to the significant limb × group interaction, post hoc tests revealed that both alcohol and placebo groups rated driving as significantly less dangerous on the descending limb compared to ascending limb (*p*s < .05), reflecting acute tolerance, the effect size of this difference was larger for participants in the alcohol group ($\eta_p^2 = .32$) compared to the placebo group ($\eta_p^2 = .08$).

Effects of Limb on Willingness to Drive after Drinking

Fig. 2 depicts the percentage of participants in the alcohol and placebo groups who were willing to drive on the ascending and descending limb. In both groups, males and females were equally likely to report willingness to drive at both time points (*p*s > .76). Results of the GEE analysis indicated significant effects of both limb (OR = 6.63, 95% CI: 2.59, 17.02, Wald's $\chi^2 = 3.94$, $p < .001$) and group (OR = 13.90, 95% CI: 3.78, 51.19, Wald's $\chi^2 = 3.96$, $p < .001$). The Limb × Group interaction was marginally significant (OR = 0.30, 95% CI: 0.08, 1.20, Wald's χ2 = 1.70, $p = .089$). Planned comparisons indicated that for participants who received alcohol, the percentage of individuals who were willing to drive was significantly higher on the descending compared to the ascending limb ($\chi^2 = 15.50$, $p < .001$). On the descending limb, roughly 60% of the alcohol participants were willing to drive compared to only 20% on the ascending limb. No significant change in willingness to drive was evident in the placebo group ($\chi^2 = 1.80$, $p = .18$).

Predicting Willingness to Drive on Descending Limb

We also examined whether willingness to drive on the descending limb was predicted by change in perceived danger across limbs. For the alcohol group, sex, drinking frequency, drinking quantity, and ascending limb willingness to drive were not significantly associated with descending limb willingness to drive in the first step of the logistic regression model (*p*s > .20). At the second step, the decrease in perceived danger across limbs significantly predicted willingness to drive on the descending limb, OR = 11.28, 95% CI: 1.57, 80.77, Wald's $\chi^2 = 2.41$, $p = .02$; step $G^2 = 14.03$, $p < .001$. When the same analysis was conducted for the placebo group, change in perceived danger across limbs was not a significant predictor of willingness to drive on the descending limb, OR = 0.64, 95% CI: 0.09, 4.45, Wald's $\chi^2 = -0.45$, $p = .66$; step $G^2 = 0.19$, $p = .66$.

Discussion

Although alcohol intoxication is associated with a range of risky behaviors, the mechanisms by which alcohol increases the likelihood of engaging in these behaviors is less clear. Prior research has suggested one mechanism is that intoxication alters perceptions about the risks associated with specific behaviors (Fromme et al. 1997; Fromme et al. 1999). The present study tested the effect of alcohol on driving-related perceptions and intentions. Our findings replicate and extend prior research in several ways. First, this study extends the previous findings of Morris et al. (2013) by using a protocol designed to test for acute tolerance while also accounting for expectancy effects. The present results increase confidence in the conclusion that reductions in perceived danger across limbs are indicative of acute tolerance. Second, we found that willingness to drive increased substantially on the descending limb, which replicates the findings of Marczinski and Fillmore (2009). Most importantly, to our knowledge, this is the first study to report that individuals' intentions to drive on the descending limb are attributed, in part, to reductions in the perceived danger of driving across limbs.

The demonstration of the presence of acute tolerance for driving judgments and intentions is of particular concern for impaired driving decisions. Some aspects of alcohol-induced impairment do not exhibit acute tolerance, and remain impaired on the descending limb, including simulated driving ability (Fillmore et al. 2005; Schweizer and Vogel-Sprott 2008; Weafer and Fillmore 2012). These findings suggest a problematic asymmetry – perceptions of the danger of driving recover on the descending limb, while driving ability does not. Thus, inaccurate risk appraisals combined with protracted driving impairments could have particularly serious consequences for decisions to drive after drinking.

The present study also has potentially important implications for drinking-and-driving prevention efforts. Drinking-and-driving researchers have recently emphasized the need for novel intervention programs (Fell and Voas 2013). While the majority of existing prevention efforts target individuals when sober, previous work has emphasized the additional need for in-the-moment strategies to intervene when individuals are intoxicated (e.g., Morris et al. 2013). As noted, most drinking-and-driving arrests (Jones 1990) and fatal accicdents (Levine and Smialek 2000) occur while individuals are on the descending limb, in part because transportation decisions may be more likely later in a drinking session for logistical reasons. However, our results also suggest that individuals who experience greater effects of acute tolerance on attitudes concerning drinking and driving are more likely to be willing to drive on the descending limb. One direction for future research is to examine not only whether in-the-moment interventions can help reduce drinking-and-driving decisions, but whether there interventions are best implemented on the descending limb. The use of salient inhibitory cues in drinking contexts has been found to effectively reduce the likelihood of risky behaviors (e.g., unsafe sexual activities, excessive alcohol use), presumably by increasing awareness of the potential dangers of such behaviors (MacDonald et al. 2000; Dal Cin et al. 2006; Kleinjan et al. 2012). For example, MacDonald et al. (2000) found that individuals had lower intentions to engage in risky sexual activities when given an "AIDS Kills" hand stamp compared to a "Safe Sex" stamp. Similar inhibitory messages focused on impaired driving could be delivered via text messages or cell phone alerts during a drinking episode to remind individuals of the dangerousness of driving after drinking. Examining the feasibility and effectiveness of in-the-moment interventions for intoxicated individuals is an important future direction for research.

The present results should be considered in the context of the study's limitations. The sample was drawn from one geographic location, and the majority of participants were young adults and Caucasian. It is important to note that the rates of drinking and driving are highest in this age range (NHTSA 2012); however, our findings may not generalize to more diverse populations. The sample size was also modest which may have constrained statistical power, particularly for the tests of moderation by sex. Participants were also tested in a laboratory setting, which is atypical compared to natural drinking environments. The alcohol administration protocol included a relatively strong beverage and short consumption time period, which is not representative of typical consumption patterns for social drinkers and may have produced an atypically fast rate of BrAC increase. Faster rate of ascent in BrAC has been shown to produce greater feelings of subjective intoxication and psychomotor impairment on the ascending limb (Martin and Earleywine 1990; Fillmore and Vogel-Sprott 1998). It is possible that the alcohol dosing protocol in the present study may have contributed to greater acute tolerance than is typical in the real world. If this is the case, the impact of acute tolerance in the present study may be exaggerated. Future studies are necessary to determine the extent to which rate of change in BrAC influences the magnitude of acute tolerance. Also of note, while this study included a placebo condition to account for expectancy effects, it is difficult to interpret differences between alcohol and placebo conditions as solely attributable to pharmacological effects. As in many studies (see Testa et al. 2006), placebo participants believed they had received alcohol, but they estimated that they received a lower dose than in the alcohol group. In addition, although no differences were observed between experimental groups or across gender on past year drinking and driving, the assessment of past year drinking and driving frequency was not adjusted for participant characteristics (e.g., sex, weight). As such, it is possible that BAC levels for this amount of alcohol may have differed across participants. Finally, the willingness to drive assessment relied on self-report and we cannot be certain whether participants would have actually driven. For ethical reasons, assessing actual driving decisions after drinking is not possible in a laboratory study. Therefore, an important goal for future studies is to develop more objective laboratory analogues of risky driving decisions, as in the case of alcohol-related aggression and other behaviors (e.g., Taylor and Gammon 1975).

This study focused on perceived danger of driving, as prior research has indicated that these perceptions are both a predictor of drinking-and-driving decisions (Grube and Voas 1996; McCarthy et al. 2007; Bingham et al. 2007; McCarthy and Pedersen 2009; Fairlie et al. 2010) and a focus of many drinking-and-driving interventions (Piquero and Paternoster 1998; Shults et al. 2001). An important direction for future laboratory research is to disentangle the factors that contribute to the observed changes in perceived danger across limbs of the BrAC curve. One possibility is that reduced subjective intoxication and/or recovery of motor control (e.g., Weafer and Fillmore 2012) on the descending limb result in reduced perceptions of the danger of driving. A related goal for future research is to examine the effects of acute tolerance on other factors that may contribute to decisions to drive, including positive expectancies (e.g., McCarthy et al. 2006). Finally, future studies would benefit from further investigating acute tolerance in the context of individual differences variables related to drinking patterns (e.g., heavy drinkers vs. light drinkers) and prior history of legal problems related to drunk driving.

In summary, the present study implicates perceptions of danger as a potential mechanism for increased willingness to drive after drinking. Individuals' in-the-moment appraisals of the dangers of driving showed a robust decrease from the ascending to the descending limb, despite similar BrAC levels at each time point. These results provide clear evidence of acute tolerance for judgments about specific risky behaviors. More broadly, these findings add to the growing literature implicating the descending limb of the BrAC curve as a period of increased liability for poor decisions that may result in potentially severe consequences for the individual and society.

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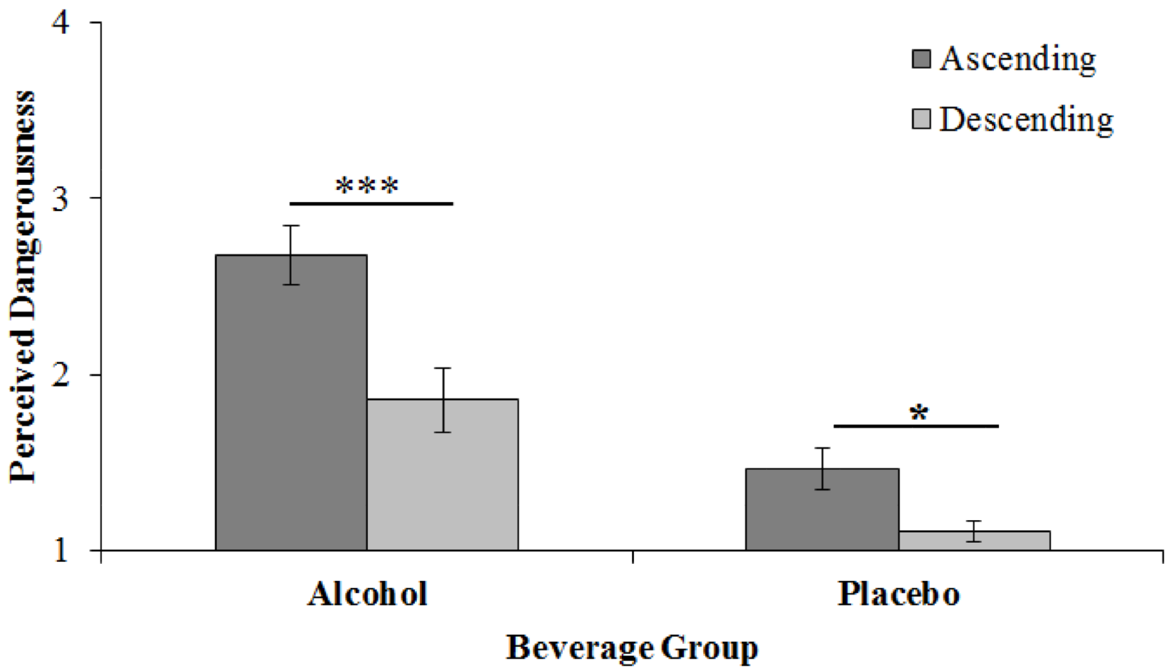

Fig. 1. Differences in Perceptions of Danger of Driving across Ascending and Descending Limbs

Means for perceived danger of driving after drinking for alcohol and placebo beverage groups on the ascending (dark gray bars) and descending (light gray bars) limbs of the breath alcohol concentration curve. Larger values on the vertical axis are associated with greater perceived danger of driving after drinking (1 = "not at all dangerous" 2 = "a little dangerous" 3 = "somewhat dangerous" 4 = "extremely dangerous"). Error bars reflect standard error of the mean. *Note:* **$p < .01$; ***$p < .001$.

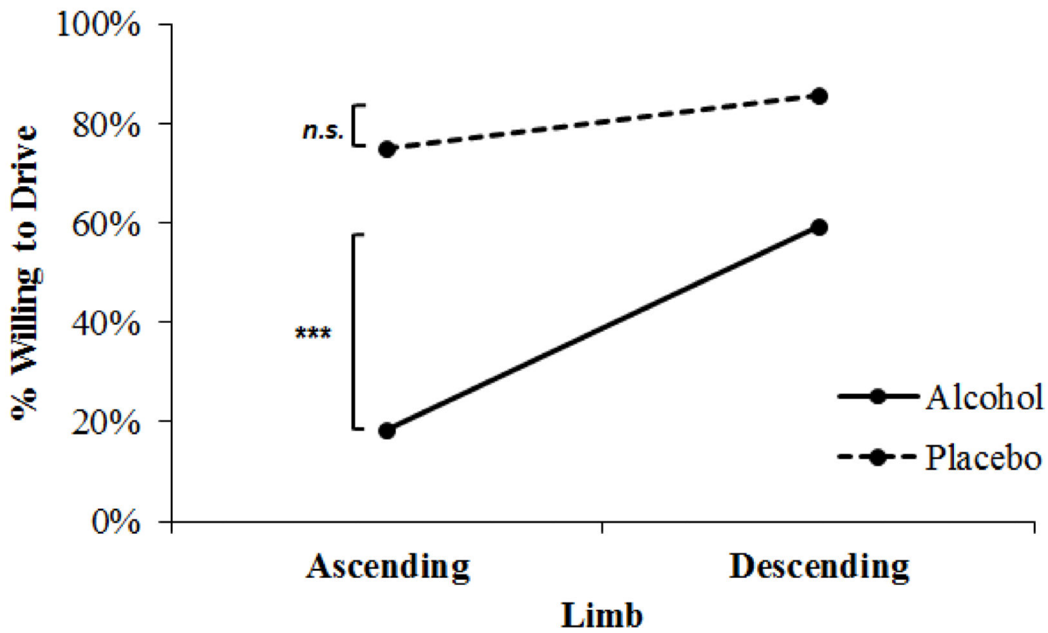

Fig. 2. Willingness to Drive across Ascending and Descending Limbs

Percentage of participants who reported willingness to drive on ascending and descending limbs of the breath alcohol concentration curve. Solid line depicts individuals in the alcohol group; dashed line depicts individuals in the placebo group. *Note:* ***$p < .001$.

Table 1

Sample Characteristics by Beverage Group

	Group				
	Alcohol (n = 28)		Placebo (n = 28)		
	M	*SD*	*M*	*SD*	*p*
Age	22.60	3.10	22.60	2.50	.99[a]
Females (%)	64%		43%		.11[b]
Caucasian (%)	71%		72%		.83[b]
Drinking Occasions	9.50	5.83	9.64	5.69	.93[a]
Drinking Quantity	4.61	4.14	3.25	1.73	.12[a]
Sober Perception of Danger	2.73	0.73	2.69	0.76	.85[a]

Note.

Drinking occasions reflect number of drinking days in last 30 days. Drinking quantity reflects typical number of drinks consumed per occasion in last 30 days. Sober perception of danger indicates perceived dangerousness of driving after hypothetically consuming three alcoholic drinks in a two-hour period

[a] Independent samples *t*-test;

[b] Pearson χ^2 test.