# Drinking-and-Driving–Related Cognitions Mediate the Relationship Between Alcohol Demand and Alcohol-Impaired Driving

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**ABSTRACT. Objective:** Elevated behavioral economic demand for alcohol has been shown to be associated with drinking and driving in college students. The present study sought to clarify the underlying mechanisms of this relationship by examining whether drinking-and-driving–related cognitions (e.g., attitudes, perceptions, and normative beliefs) mediate the association between alcohol demand and drinking and driving. **Method:** A total of 134 young adult social drinkers completed an alcohol purchase task and measures of perceived dangerousness of drinking and driving, normative beliefs about drinking and driving, and perceived driving limit (i.e., perceived number of drinks one could consume and still drive safely). The frequency of drinking and driving in the past year was assessed via self-report. **Results:** Individuals who reported drinking and driving exhibited greater alcohol demand (intensity, $O_{max}$, and elasticity) compared with those who did not engage in drinking and driving. Increased demand was also correlated with more favorable drinking-and-driving cognitions. Indirect effects tests revealed that perceived driving limit partially mediated the relationship between alcohol demand and drinking-and-driving behavior, even after accounting for drinking level, sex, and delay discounting. **Conclusions:** These findings provide further support for the utility of behavioral economic theory in understanding drinking-and-driving behavior. In particular, they provide evidence for one mechanism—drinking-and-driving–related cognitions—by which alcohol demand influences drinking and driving. Additional research using longitudinal and experimental designs is required to confirm this model and to identify other potential mediators. (*J. Stud. Alcohol Drugs, 77,* 656–660, 2016)

SEVERAL INDIVIDUAL DIFFERENCE FACTORS have been linked to engagement in drinking and driving, including favorable attitudes toward drinking and driving (McCarthy et al., 2007; McCarthy & Pedersen, 2009), knowledge of drinking-and-driving laws (Sloan et al., 2014), and impulsivity (Rossow, 2008; Sloan & Eldred, 2015; Sloan et al., 2014; Treloar et al., 2012). Although this research has advanced our understanding of risk factors for drinking and driving, there is a need for more integrative models specifying the determinants of drinking and driving in order to ultimately improve interventions. To this end, research in behavioral economics has begun to explore whether indices of decision-making, such as delay discounting (Rossow, 2008; Sloan et al., 2014), are related to drinking and driving. Two recent studies (Teeters & Murphy, 2015; Teeters et al., 2014) demonstrated that the behavioral economic index of alcohol demand, which reflects the incentive value of alcohol, is elevated in college student drinkers who reported drinking and driving.

In a separate line of research, cognitions pertaining to drinking and driving—including attitudes, normative beliefs, and perceived driving limits—have been shown to be strong determinants of drinking and driving. For instance, individuals are more likely to engage in drinking and driving if they perceive drinking and driving as less dangerous (Amlung et al., 2014; Bingham et al., 2007; Morris et al., 2014), believe that their peers are more accepting of drinking and driving (Bingham et al., 2007; LaBrie et al., 2012), or have higher perceived alcohol limits for driving safely (Gulliver & Begg, 2004; Royal, 2003). Theoretical models of risk behavior such as the Theory of Planned Behavior (Ajzen, 1991), and models specific to alcohol-related behaviors such as the Acquired Preparedness Model (Corbin et al., 2011; Settles et al., 2014), posit that these factors reflect a common pathway by which distal risk factors (e.g., impulsivity) converge to influence engagement in specific behaviors, including drinking and driving (LaBrie et al., 2012; Treloar et al., 2012).

The present study tested a similar hypothesis—that the influence of a distal risk factor from the behavioral economics domain (elevated alcohol demand) on drinking and driving is attributable in part to more favorable drinking-and-driving–

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related cognitions. In doing so, this study tests a model integrating risk factors from distinct perspectives—behavioral economic and social cognitive—in the prediction of drinking and driving. We hypothesized that individuals who engage in drinking and driving would exhibit higher alcohol demand, replicating prior research, and that one or more drinking-and-driving–related cognitions will partially mediate this association.

## Method

### *Participants*

Participants were 147 adults from a large midwestern university and surrounding community. Eligibility criteria included 21–35 years of age and reporting consumption of five or more drinks on one occasion within the previous 6 months. Because participants were drawn from an alcohol administration study (Amlung et al., 2015), exclusion criteria included pregnancy; body mass index > 30 kg/m$^2$; medications that contraindicated alcohol consumption; or any medical, psychiatric, or substance use disorders. Twelve participants were excluded for not having a valid driver's license or driving less than monthly, and one participant was excluded because of noncompliance (final $N = 134$).

### *Measures*

*Alcohol use.* The quantity and frequency of alcohol use in the past month was assessed using the items from the National Institute on Alcohol Abuse and Alcoholism (NIAAA) Task Force on Recommended Alcohol Questions (NIAAA, 2003).

*Drinking-and-driving behavior.* An open-ended item asked how many times participants drove after consuming three drinks within 2 hours in the last year. Participants were subsequently dichotomized into "drinking drivers" (i.e., at least one drinking-and-driving episode) and "nondrinking drivers" (i.e., zero drinking-and-driving episodes).

*Alcohol purchase task.* Alcohol demand was assessed via a hypothetical alcohol purchase task (APT) in which participants reported how many standard drinks they would consume at 21 prices (free–$30/drink), presented in sequential order (Murphy & MacKillop, 2006). The APT was prefaced by standard instructions (e.g., typical drinking situation, no stockpiling of drinks). Four demand indices were generated: intensity (number of drinks at free price), breakpoint (price that suppressed consumption to zero), $O_{max}$ (maximum expenditure value; Murphy & MacKillop, 2006), and elasticity ($\alpha$), which was derived using the exponential equation in Hursh and Silberberg (2008). Elasticity values for two participants were omitted because of poor model fit ($R^2 \leq 0.30$). Elasticity values were multiplied by 1,000 because of digit limits in Mplus.

*Drinking-and-driving cognitions.* Perceived dangerousness of drinking and driving was assessed by asking how dangerous participants thought it would be to drive within 2 hours of consuming three drinks (Grube & Voas, 1996). Responses ranged from 1 (*not at all dangerous*) to 4 (*very dangerous*). Normative beliefs were assessed by asking participants how many of their three closest friends disapproved of drinking and driving and how many would refuse to ride with a driver who had been drinking (Grube & Voas, 1996). Perceived personal limit was assessed by asking how many drinks participants believed they could consume and still drive safely within 2 hours of drinking (Gulliver & Begg, 2004; Royal, 2003).

*Delay discounting.* Delay discounting was assessed to control for the effect of impulsivity on drinking and driving (Rossow, 2008; Sloan et al., 2014; Teeters & Murphy, 2015). An overall discounting rate ($k$) was estimated using the 27-item Monetary Choice Questionnaire (Kirby et al., 1999).

*Demographics.* Self-reported demographic information included age, sex, race, ethnicity, and income.

*Estimated blood alcohol concentration.* Estimated blood alcohol concentration following consumption of three drinks in 2 hours (i.e., same quantity and time as the drinking-and-driving items) was calculated for each participant using an equation that takes into account sex, weight, number of drinks, time, and estimated metabolism rate (Matthews & Miller, 1979).

### *Procedure*

Data were collected during a baseline assessment before beverage administration (see Amlung et al., 2015). Participants were asked to abstain from the use of alcohol or other drugs for 24 hours before their appointment. Participants provided written informed consent, and a breath alcohol analysis test verified sobriety. Participants were compensated $12/hour. All procedures were approved by the University of Missouri Institutional Review Board.

### *Data analysis*

Outlying values ($Z$s > 3.29) were Winsorized to one unit greater than the next nonoutlier value (Tabachnick & Fidell, 2001). Elasticity was normalized using a logarithmic transformation. Differences in demand and drinking-and-driving cognitions between drinking drivers and nondrinking drivers were examined using analyses of covariance, controlling for sex, drinking quantity, and delay discounting. Only demand indices with significant bivariate correlations with the drinking-and-driving cognitions and cognitions with significant correlations with drinking-and-driving behavior were included in mediation analyses (MacKinnon et al., 2002). Indirect effects tests using the product of coefficients method were conducted in Mplus Version 7 (Muthén & Muthén, 2011) us-

Table 1. Indirect effect estimates for tests of mediation through drinking-and-driving cognitions

| Variable | *b* | (*SE*) | OR | [95% CI] | *z* |
|---|---|---|---|---|---|
| Intensity | | | | | |
| Perceived danger | 0.04 | (0.03) | 1.04 | [0.99, 1.10] | 1.50 |
| Perceived personal limit | 0.23 | (0.08) | 1.25 | [1.07, 1.44] | 2.69** |
| Normative beliefs | 0.03 | (0.02) | 1.03 | [0.99, 1.07] | 1.45 |
| $O_{max}$ | | | | | |
| Perceived personal limit | 0.07 | (0.03) | 1.07 | [1.01, 1.14] | 2.00* |
| Elasticity | | | | | |
| Perceived personal limit | -0.002 | (0.001) | 0.998 | [0.996, 1.00] | 2.00* |

*Notes:* OR = odds ratio; CI = confidence interval. The elasticity parameter is scaled negatively such that smaller values reflect greater insensitivity to escalating costs (greater demand).
*$p < .05$; **$p < .01$.

ing procedures that accounted for the dichotomous outcome variable (Muthén, 2011). Standard errors for the indirect effects were computed using the multivariate delta method, and confidence limits were obtained using bias-corrected bootstrap resampling (MacKinnon et al., 2004). Mediation models included direct effects of sex, drinking quantity, and delay discounting on drinking-and-driving behavior.

## Results

### *Descriptive statistics*

Drinking drivers were more likely to be male, $\chi^2(1, 134) = 10.92$, $p < .001$, but the groups did not differ in terms of age or drinking behavior (*p*s > .05). The mean estimated blood alcohol concentration for three drinks in 2 hours was .047% (*SD* = .022).

### *Comparisons of drinking versus nondrinking drivers*

Compared with nondrinking drivers, drinking drivers reported significantly greater intensity, *M* (*SD*): drinking drivers = 9.40 (4.39), nondrinking drivers = 6.69 (3.29); greater $O_{max,}$ drinking drivers = 16.90 (9.01), nondrinking drivers = 12.86 (6.23); and lower elasticity, drinking drivers = 0.01 (0.01), nondrinking drivers = 0.02 (0.01); (*p*s < .05). Breakpoint did not differ between groups ($p = .11$). Drinking drivers reported lower perceived dangerousness, drinking drivers = 2.66 (0.63), nondrinking drivers = 3.35 (0.68); more positive normative beliefs, drinking drivers = 1.68 (0.85), nondrinking drivers = 2.38 (0.70); and higher perceived personal limit, drinking drivers = 3.73 (2.75), nondrinking drivers = 1.91 (1.12); ($p < .001$).

### *Bivariate associations*

Drinking-and-driving behavior was correlated with all demand indices (*r*s = .17–.34, *p*s < .05) and drinking-and-driving cognitions (*r*s = .41–.47, *p*s < .001). Significant correlations were also found between intensity and perceived danger ($r = -.23$, $p < .01$); intensity, $O_{max}$, and elasticity with perceived personal limit (*r*s = .21–.41, *p*s<.05); and intensity with normative beliefs ($r = -.19$, $p < .05$).

### *Mediation analyses*

Indirect effects from intensity through perceived danger, perceived personal limit, and normative beliefs to drinking-and-driving behavior were examined in separate mediation models. Indirect effects were also examined for $O_{max}$ and elasticity through perceived personal limit. Results of the indirect effects tests are presented in Table 1. Perceived personal limit partially mediated the effects of each demand index on drinking and driving. Indirect paths from intensity through normative beliefs and perceived dangerousness to drinking-and-driving behavior were not significant.

## Discussion

Behavioral economics is increasingly being applied to better understand engagement in alcohol-related negative behaviors such as drinking and driving (Sloan et al., 2014; Teeters & Murphy, 2015; Teeters et al., 2014). Although prior research has reported that individuals who drink and drive exhibit elevated alcohol demand (Teeters & Murphy, 2015; Teeters et al., 2014), these studies did not explore potential mechanisms linking the distal risk factor of demand to drinking-and-driving behavior itself. By integrating a multifaceted assessment of drinking-and-driving–related cognitions with an assessment of alcohol demand, the present study provides the first data on one potential intervening variable connecting demand and drinking and driving. We found that individuals with higher levels of demand are more likely to perceive driving to be safe after consuming a greater amount of alcohol, and in turn to drive after drinking. Our results are consistent with partial mediation, suggesting that elevated demand confers unique risk for drinking and driving, independent of the drinking-and-driving–related cognitions we examined. More generally, these findings are consistent with the broader literature suggesting that cognitive factors serve to connect distal risk factors to engagement in risky behaviors such as

drinking and driving (e.g., LaBrie et al., 2012; Treloar et al., 2012).

The finding that drinking drivers have greater perceived safe driving limits is consistent with the limited number of studies in this area (Gulliver & Begg, 2004; Royal, 2003). These findings suggest that perceived limits may provide unique insights into risk for drinking and driving and warrant further attention as potential targets for interventions. For instance, to reduce drinking-and-driving behaviors among individuals who exhibit elevated demand, it may be important to address perceptions of perceived personal limit when designing novel interventions for drinking and driving (Teeters et al., 2015). Unlike other drinking-and-driving–specific cognitions, little is known about how perceived personal limit changes over time and on what information individuals base these perceptions. Although the present study controlled for recent drinking, future research is needed to determine how recent drinking and level of tolerance influences perceived safe driving limit. Longitudinal studies are required to examine how these perceptions may change as a function of experience with drinking, driving, or their combination.

This study has a number of limitations. The cross-sectional design limits our ability to test the temporal directionality of the mediation model. Although models controlled for sex, drinking, and impulsivity, there may be other factors not accounted for in our analyses. Our sample size was relatively modest, and participants were primarily young adults from a single geographic region. Furthermore, participants were tested when sober, despite the fact that drinking-and-driving decisions are typically made when intoxicated. Finally, the APT was hypothetical, although prior research has reported close correspondence between hypothetical and actual-reward APTs (e.g., Amlung et al., 2012).

In summary, this study provides preliminary evidence for how alcohol demand, a behavioral economic index of alcohol motivation, might influence a specific alcohol-related negative behavior, driving after drinking. Results suggest that demand might influence drinking-and-driving risk by altering the perceived safety of driving after a set number of drinks. Further research, using both longitudinal and experimental designs, is needed to support this mechanism and test other requirements of mediation. Prospective studies can establish whether alcohol demand influences the development of and change in perceived personal limit. Experimental studies can be used to test whether changes in alcohol demand—for example, in response to acute intoxication (Amlung et al., 2015)—produce changes in perceived personal limit. More broadly, given that several studies have now found significant associations of delay discounting and demand with drinking and driving (Rossow, 2008; Sloan et al., 2014; Teeters & Murphy, 2015; Teeters et al., 2014), an important goal for future research is to develop an integrated model incorporating behavioral economic indices with other well-established risk factors for drinking and driving, including cognitive factors.

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