

# Acute disinhibiting effects of alcohol as a factor in risky driving behavior

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## Abstract

Automobile crash reports show that up to 40% of fatal crashes in the United States involve alcohol and that younger drivers are over-represented. Alcohol use among young drivers is associated with impulsive and risky driving behaviors, such as speeding, which could contribute to their over-representation in alcohol-related crash statistics. Recent laboratory studies show that alcohol increases impulsive behaviors by impairing the drinker's ability to inhibit inappropriate actions and that this effect can be exacerbated in conflict situations where the expression and inhibition of behavior are equally motivating. The present study tested the hypothesis that this response conflict might also intensify the disruptive effects of alcohol on driving performance. Fourteen subjects performed a simulated driving and a cued go/no-go task that measured their inhibitory control. Conflict was motivated in these tasks by providing equal monetary incentives for slow, careful behavior (e.g., slow driving, inhibiting impulses) and for quick, abrupt behavior (fast driving, disinhibition). Subjects were tested under two alcohol doses (0.65 g/kg and a placebo) that were administered twice: when conflict was present and when conflict was absent. Alcohol interacted with conflict to impair inhibitory control and to increase risky and impaired driving behavior on the drive task. Also, individuals whose inhibitory control was most impaired by alcohol displayed the poorest driving performance under the drug. The study demonstrates potentially serious disruptions to driving performance as a function of alcohol intoxication and response conflict, and points to inhibitory control as an important underlying mechanism.

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## 1. Introduction

Automobile crash reports have shown that up to 40% of fatal crashes in the United States involve alcohol and that younger drivers are over-represented among these alcohol-related crashes (Evans, 2004). During the year 2002, over 17,000 motor vehicle fatalities in the United States involved alcohol, representing an average of one alcohol-related fatality every 30 min (National Highway Traffic Safety Administration, 2002). Younger drivers constitute a higher percentage of alcohol-related crashes than any other age group. Drivers under 20 years have a 5-fold average risk of alcohol-related crashes compared with drivers over age 30 (e.g., Keall et al., 2004). There is considerable interest in identifying possible factors that could account for this over-representation and much of this research effort has hinged on the assumption that younger drivers are typically at a greater

risk because they are less experienced in terms of their driving ability and in terms of their exposure to alcohol (e.g., Harrison and Fillmore, 2005).

Although younger individuals might be less experienced drivers, they also possess certain personality traits that distinguished them from older individuals. It is well documented that younger individuals are characterized by greater levels of impulsivity, leading to increased risk-taking and sensation-seeking (for a review, see Dahl, 2004). Indeed, some research suggests that these personality characteristics might also confer increased risk for alcohol-related accidents in this population. Survey-based studies of alcoholic and non-alcoholic drivers found individuals who scored high on measures of impulsivity, sensation-seeking, and aggression also reported past histories of alcohol-related accidents, DUIs, and other traffic violations (for reviews see Donovan et al., 1983; Miller and Windle, 1990). These data have led to interactional hypotheses which argue that the impairing effects of alcohol on driving performance might be exacerbated by certain personality characteristics of the driver, such as impulsivity (e.g., Beirness, 1993; Jonah et al., 2001;

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McMillen et al., 1989). Although rarely tested empirically, such hypotheses have considerable intuitive appeal as these drivers would be expected to take greater risks while driving, such as speeding and passing cars, all of which could increase accident risk, especially while under the behaviorally impairing effects of alcohol.

During the past decade, laboratory studies have provided considerable support for the notion that alcohol can actually promote impulsive actions by impairing basic inhibitory mechanisms that normally serve to suppress inappropriate behavior. Stop-signal and cued go/no-go tasks are reaction time tasks used to model behavioral control as the ability to quickly activate a response to a go-signal and suddenly inhibit a response when a stop-signal occurs (Logan, 1994; Logan and Cowan, 1984; Miller et al., 1991). Studies using these tasks have found that alcohol impairs the ability to inhibit behavior (e.g., de Wit et al., 2000; Fillmore and Vogel-Sprott, 2000; Marczinski and Fillmore, 2003; Mulvihill et al., 1997). Evidence for the reliable impairing effects on inhibitory control in this research is particularly noteworthy given the comparatively mild alcohol doses administered (e.g., 0.45–0.65 g/kg) and the relatively simple nature of the inhibitory response tested. Moreover, the findings are important because they identify a basic inhibitory mechanism that is impaired by alcohol which could contribute to the display of impulsive, aggressive, and other socially inappropriate behaviors under the drug (Fillmore, 2003, 2007; Jentsch and Taylor, 1999).

Laboratory studies also suggest that the disinhibiting effects of alcohol are most pronounced when the inhibition of a response is in conflict with a strong instigation to display the response (Conger, 1956; Curtin and Fairchild, 2003; Fillmore and Vogel-Sprott, 2000). Such conflict is present in situations where there are equal reinforcers or punishments for the expression and inhibition of a behavior. For example, Fillmore and Vogel-Sprott (2000) studied alcohol effects on inhibitory control and found that alcohol only disinhibited responding in situations where displaying a response was as equally motivating as inhibiting the response (i.e., conflicting reinforcement). A meta-analysis of studies of alcohol effects on a variety of social and interpersonal measures (e.g., aggression, risk-taking, sexual behaviors) also found that the disinhibiting effect of the drug was most pronounced when there was some conflicting motivational consequence (e.g., money) for inhibiting and for displaying the response (Steele and Southwick, 1985). In sum, there appears to be a consistent body of laboratory evidence to suggest that the risk of disinhibited, impulsive behavior under alcohol is greatest in conflict situations in which displaying a response is as equaling motivating as inhibiting the response.

Studies of conflict as a mediator of alcohol-induced disinhibition have considerable ecological relevance to behaviors outside the laboratory where conflicting behaviors are often reinforced. For example, response conflict is commonplace in many situations in which people drive automobiles. Being late and in a hurry to drive somewhere is a familiar example of a conflict for many drivers. There is a strong instigation to speed in order to arrive on time and avoid possible punishment for being late for work or some other important engagement. Con-

flicting with this tendency is the incentive to avoid speeding and risky driving behaviors as these behaviors could result in traffic citations or personal injury (e.g., Aarts and van Schagen, 2006; Blows et al., 2005). There are other factors that can instigate speeding and risky driving behaviors as well. “Joy riding” is an example among younger drivers where peer approval from passengers likely plays a role in motivating speeding and risky driving behaviors of the driver (Simons-Morton et al., 2005). However, at the same time, such behaviors are in conflict with the ever-present threat of traffic citation or personal injury.

Despite such obvious examples of conflict in driving behavior, there have been no experimental investigations to test the hypothesis that such conflict might interact with alcohol to intensify the impaired and impulsive driving behaviors normally associated with the drug. The present study tested this hypothesis by examining the degree to which alcohol and response conflict interacted to increase impaired and risky driving behaviors. Specifically, the study sought to determine which aspects of driving behavior are disrupted by alcohol in the conflict situation. In particular, it was hypothesized that conflict and alcohol would interact to exacerbate impulsive, risk-taking characteristics of driving behavior, such as speeding, accelerating, and running red lights.

In addition, given the considerable empirical support for the notion that alcohol promotes impulsive actions by impairing basic inhibitory mechanisms, the study also assessed impairment of drivers’ inhibitory control as a co-occurring and perhaps a contributing factor that underlies the display of risky, impulsive driving behavior. Thus, in addition to the driving test, subjects also performed a cued go/no-go task to assess the degree to which alcohol and response conflict interacted to specifically impair their inhibitory control.

## 2. Method

### 2.1. Participants

Fourteen adults (7 women and 7 men) between the ages of 21 and 30 years (mean age = 23.5 years, S.D. = 3.2) participated in this study. In terms of racial makeup, the sample identified themselves as being Caucasian ( $n = 11$ ), African-American ( $n = 1$ ), Hispanic ( $n = 1$ ), or reported no specific racial group ( $n = 1$ ). Volunteers completed questionnaires that provided demographic information, drinking habits, other drug use, and physical and mental health status. The health questionnaires gathered information about the volunteers’ histories of serious physical disease, current physical disease, impaired cardiovascular functioning, chronic obstructive pulmonary disease, seizure, head trauma, CNS tumors, or past histories of psychiatric disorder, (i.e., Axis I, DSM IV). Individuals with a self-reported psychiatric disorder, substance abuse disorder, head trauma, or other CNS injury were excluded from the study. Substance use disorders were assessed using the Structured Clinical Interview for DSM-IV (SCID-IV) and volunteers were excluded if their current use met dependence/withdrawal criteria. As an additional screen for alcohol dependence, volunteers with a score of 5 or higher on the Short-Michigan Alcoholism Screening Test (S-MAST) (Seltzer et al., 1975) were also excluded from the study.

No participant reported the use of any psychoactive prescription medication and recent use of amphetamines (including methylphenidate), barbiturates, benzodiazepines, cocaine, opiates, and tetrahydrocannabinol was assessed by means of urine analysis. Any volunteer who tested positive for the presence of any of these drugs was excluded from participation. No female volunteers who were pregnant or breast-feeding participated in the research, as determined by self-report and urine human chorionic gonadotrophin levels. All participants held a

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