Self-regulation and Simulated Driving Performance of DUI Offenders in Sober and Intoxicated States

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Abstract

Background
Alcohol-related traffic injuries and fatalities continue to be a major public health problem, prompting the need for research aimed at identifying characteristics of DUI drivers in efforts to improve treatment and prevention. Although DUI offenders report traits of impulsivity, suggesting poor inhibitory control and heightened reward sensitivity, the specific cognitive characteristics underlying such behavioral dysregulation have not been systematically studied in the laboratory.

Aims
The purpose of the research was to directly evaluate driving performance and levels of inhibitory control in DUI offenders to test hypotheses that these high-risk drivers display deficits in mechanisms of self-regulation and display heightened sensitivity to the impairing effects of alcohol on their inhibitory control and their driving performance.

Methods
Study 1 compared DUI offenders (n = 43) to control drivers with no history of DUI (n = 33). Subjects performed laboratory tasks that included a measure of inhibitory control (i.e., go no-go task) and simulated driving performance. Group differences in task performance were examined. In Study 2 DUI offenders (n = 12) were compared to controls (n = 12) on their inhibitory control and driving performance following a dose of 0.65 g/kg alcohol and a placebo.

Results
DUI offenders displayed poorer driving performance compared with controls on measures of driving performance that were indicative of impulsive/reckless driving (e.g., speeding, running red lights). Moreover, poor inhibitory control predicted increased speeding and running red lights in DUI offenders, but not in controls. With respect to alcohol effects, DUI offenders displayed greater impairment of driving performance following alcohol compared with controls. Alcohol also impaired inhibitory control.

Discussion and Conclusions
The findings are important because they identify deficits in driving performance among DUI offenders that could be consequences of heightened impulsivity in this population, especially in...
response to alcohol. Understanding the specific behavioral outcomes associated with impulsivity among DUI offenders could contribute importantly to our understanding of the factors underlying their decisions to drink and drive.

Introduction

Driving records show that DUI offenders commit more moving violations, such as speeding, and are involved in more accidents compared with the general population (Bishop, 2011). Personality inventories of DUI drivers reliably show high levels of impulsivity and sensation-seeking (Hubicka et al., 2010). Together, these lines of evidence suggest that DUI drivers can be characterized by patterns of impulsive action and risk-taking that are evident in driving behavior. Impulsivity reflects an imbalance in these countervailing mechanisms due to poor behavioral inhibition and/or heightened reward-seeking. (Fillmore & Weafer, 2011). Work in our laboratory has shown that deficient inhibitory control can contribute to reckless driving in a driving simulator (Fillmore et al., 2008). Drivers with poor inhibitory control are more likely to speed, run red lights, and display poorer driving precision.

Impulsivity might also result in increased sensitivity to the impairing effects of alcohol on driving performance. Survey-based studies find that individuals who score high on measures of impulsivity report histories of alcohol-related accidents (Miller & Windle, 1990). Such evidence has led many to hypothesize that the impairing effects of alcohol on driving performance might be exacerbated by poor impulse control (e.g., Jonah et al., 2001).

Despite numerous studies showing that DUI offenders self-report traits of impulsivity, the specific cognitive characteristics underlying such behavioral dysregulation have not been systematically studied in the laboratory. Nor has research examined how such characteristics might promote poor driving performance in this population, particularly under the influence of alcohol. The purpose of this research was to directly evaluate driving performance and levels of inhibitory control in DUI offenders to test hypotheses that these high-risk drivers display deficits in impulse control and heightened sensitivity to the impairing effects of alcohol on their inhibitory control and their driving performance. Study 1 compared DUI offenders to control drivers with no history of DUI. Subjects performed laboratory tasks that included a measure of inhibitory control (i.e., go no-go task), and simulated driving performance. Study 2 examined the acute effects of alcohol on driving performance and inhibitory control of DUI offenders and controls.

Study 1: Analyses of Driving Performance and Inhibitory Control

Subjects
Subjects were 76 adults between the ages of 21 and 40 years. Forty-three subjects were DUI offenders (31 men and 12 women) and 33 subjects were non-offender, control subjects (19 men and 14 women). DUI subjects had to have at least one DUI offense in the past 5 years. Control
subjects had no history of any arrests/convictions for DUI. All subjects completed a comprehensive driving history questionnaire that included measures of driving experience (e.g., years driving, weekly distance driven), as well as reports of license revocations, traffic violations, and DUI offenses. DUI convictions were also verified by state district court records. All subjects held a valid driver’s license for at least 5 years and drove on a regular (i.e., weekly) basis. Subjects were recruited by newspaper, websites, and community bulletins that invited individuals to participate in studies of driving skill and behavioral effects of alcohol. Some advertisements specifically targeted adults with previous DUI offenses. All subjects were current consumers of alcohol. Their typical quantity and frequency of drinking was measured. The University of Kentucky Medical Institutional Review Board approved the study, and subjects received $50 for their participation.

**Apparatus and Materials**

**Simulated Driving Task** A computerized driving simulation task was used to measure driving performance (STISIM Drive, Systems Technology Inc., Hawthorne, CA). In a small test room, subjects sat in front of the computer display that presented the driving simulation. The driver was placed in the cab of the vehicle, providing a view of the roadway and dashboard instruments. Drivers controlled the vehicle by moving a steering wheel and manipulating accelerator and brake pedals. The task required subjects to drive 6 miles in a traffic-laden, urban setting. Drivers were instructed to obey all traffic and speed limit signs. The test yields several measures of driving performance. Two primary measures of driving precision are deviation of lateral lane position and rate of steering maneuvers. Poorer driver precision is indicated by greater deviation of lane position accompanied by faster steering maneuvers. Measures of “risky driving” were also examined, such as speeding and failures to completely stop at red lights (i.e., stopping failures).

**Cued Go/No-go Task** Subjects’ inhibitory control was measured by the cued go/no-go task. This reaction time task requires subjects to respond quickly to go targets and inhibit responses to no-go targets. Response inhibition is measured by the proportion of no-go targets in which subjects fail to inhibit a response (p-inhibition failures).

**Procedure**

Subjects attended a single test session. They completed background and screening measures and were familiarized with the driving simulator and go/no-go task. After screening and familiarization, subjects performed the tasks.

**Results**

There was no significant group difference in age (p > .05). The mean ages of DUI offenders and controls were 26.1 (SD = 5.1) and 27.0 (SD = 6.2) years, respectively. There were also no significant differences in driving experience (ps > .05). The sample had been driving for a mean of 11.1 years (SD = 21.1) and drove an average of 5.3 days per week (SD = 2.2). With regard to
drinking habits, DUI offenders reported consuming more drinks per occasion than controls ($p = .043$). DUI offenders reported a mean of 5.1 drinks (SD = 2.5) and controls reported 4.0 drinks (SD = 2.2). There was no group difference in drinking frequency ($p > .05$). On average the sample drank 2.5 times per week (SD = 1.8).

Analyses of driving performance showed that DUI offenders displayed significantly poorer driving performance compared with controls on multiple measures of driving performance. Compared with controls, DUI offenders drove faster, had more stopping failures at red lights, and showed greater deviation within their lane. Mean driving performance measures for each group are reported in Table 1. There was no significant group difference in inhibitory control ($p > .05$). However, correlational analyses showed that poor inhibitory control predicted increased speeding and running red lights in DUI offenders ($ps < 0.05$), but not in controls ($ps > 0.60$).

<table>
<thead>
<tr>
<th></th>
<th>Controls</th>
<th></th>
<th>DUI Offenders</th>
<th></th>
<th>T</th>
<th>P</th>
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<tbody>
<tr>
<td>Speed</td>
<td>39.95 (5.96)</td>
<td>44.12 (8.54)</td>
<td>2.51</td>
<td>0.01</td>
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<tr>
<td>LPSD</td>
<td>0.93 (0.22)</td>
<td>1.37 (1.20)</td>
<td>2.37</td>
<td>0.02</td>
<td></td>
<td></td>
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<tr>
<td>Stop failures</td>
<td>0.52 (0.80)</td>
<td>0.93 (1.01)</td>
<td>2.01</td>
<td>0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finish time</td>
<td>537.97 (84.61)</td>
<td>495.39 (93.12)</td>
<td>2.08</td>
<td>0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inhibition fails</td>
<td>0.035 (0.042)</td>
<td>0.047 (0.065)</td>
<td>0.91</td>
<td>0.36</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table 1. Speed = average driving speed (mph); LPSD = lane position standard deviation (feet); Stop failures = number failures to completely stop at red lights; Finish time = time to complete drive (seconds); Inhibition fails = proportion of inhibition fails to no-go targets.*

**Study 2: Effects of Alcohol on Driving Performance**

*Subjects*

Subjects were 12 DUI offenders (9 men and 3 women) and 12 controls (4 men and 8 women). As in Study 1, subjects completed background measures on driving and alcohol use and general demographics. Volunteers were excluded if their current alcohol use met dependence/withdrawal criteria as determined by the *Structured Clinical Interview for DSM-IV (SCID-IV)*. All participants were at least 21 years old, and women who were pregnant or breast-feeding, as determined both by self-report and urine sample, were not allowed to participate.

*Procedure*

Subjects attended a familiarization session during which they completed background information and practiced the go/no-go task and a simulated driving test that emphasized driving precision and vigilance. The test required subjects to drive 15 miles in a rural setting comprised of a winding road and occasional hills. Driving measures included within-lane deviation (LPSD), rate
of steering movement (mean per second degree change in steering wheel), and center lane and road edge line crossings.

All subjects were tested under two doses of alcohol: 0.0 g/kg (placebo) and 0.65 g/kg. Each dose was administered on a separate test session (i.e., test day), and dose order was counterbalanced across subjects and groups. The dose produces an average peak BAC of 80 mg/100 ml at approximately 70 min. The placebo consisted of a volume of carbonated mix that matched the total volume of the 0.65 g/kg alcohol drink. Testing on the driving test and cued go/no-go task began at 20 min after drinking and was completed 55 min after drinking. Subjects also completed visual-analogue scales to assess subjective effects (e.g., self-estimates of BAC, perceived intoxication, ability and willingness to drive) at regular intervals during the descending phase of the BAC curve at: 70, 115, 160, 205, and 250 min post drinking.

**Results**

There were no significant group differences in age, driving experience, or drinking habits (ps > .05). The groups did not differ in BAC following alcohol administration (ps > .05). The mean (SD) BAC in mg/100 ml at each time interval was: 20 min = 47.0 (16.4), 40 min = 60.1 (13.5), 60 min = 60.1 (10.7), 70 min = 68.9 (10.3), 115 min = 54.3 (10.5), 160 min = 42.6 (9.6), 205 min = 32.5 (10.0), and 250 min = 21.1 (10.3).

The primary measures of driving performance were steering rate, LPSD, and line crossings. A 2 (group) X 2 (dose) ANOVA of drivers’ steering rate scores obtained a significant group X dose interaction, F(1,22) = 5.8, p = .024. Figure 1 plots the interaction. The figure shows that DUI offenders and controls displayed similar steering rates when tested under placebo (i.e., 0 g/kg alcohol). However, when tested under 0.65 g/kg alcohol, DUI offenders displayed an increased steering rate compared with controls.

![Figure 1. Mean steering rate in deg/sec following 0.0 g/kg and 0.65 g/kg alcohol for DUI and control drivers.](image)

Analysis of LPSD scores obtained a significant main effect of dose, F(1,22) = 9.1, p = .006. LPSD increased under alcohol (1.15 feet, SD = 0.48) compared with placebo (0.96 feet, SD = 0.32). Although the sample showed more crossings under alcohol (mean = 15.4, SD = 25.0) than
placebo (mean = 9.4, SD = 2.6), the main effect of dose did not attain statistical significance, F(1,22) = 3.5, p = .073. Analysis of subjects’ p-inhibition failure scores on the cued go/no-go task obtained a significant main effect of dose, F(1,22) = 9.1, p = .006. The proportion of inhibition failures increased under alcohol (0.145, SD = 0.14) compared with placebo (0.07, SD = 0.10).

Analyses of subjective effects showed that, under alcohol, DUI offenders reported a greater ability and willingness to drive, and lower self-estimated BACs compared with controls (ps < .05).

**Discussion and Conclusions**

The results show that, in the sober state, DUI offenders drove faster, had more failures to stop at red lights, and showed greater deviation within their lane. Moreover, this reckless driving behavior was related to the DUI offenders’ poor inhibitory control. With regard to alcohol effects, DUI offenders displayed a greater increase in steering rate compared with controls that was indicative of abrupt, quick steering maneuvers. Also under alcohol, DUI offenders estimated their BAC to be lower than controls and perceived themselves as more able and willing to drive than controls. Taken together, the findings suggest that DUI offenders have heightened sensitivity to the behaviorally disruptive effects of alcohol on their driving performance that might be due in part to poor inhibitory control. At the same time, DUI offenders appear to have reduced self-perceptions of such impairments. The findings highlight how reduced inhibitory control coupled with poor self-evaluation could underlie risky decisions to drive after drinking.

**References**


**Acknowledgement**

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