Drug and Alcohol Dependence 117 (2011) 31–37

Contents lists available at ScienceDirect

Drug and Alcohol Dependence

journal homepage: www.elsevier.com/locate/drugalcdep

Alcohol and distraction interact to impair driving performance

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ARTICLE INFO

Article history:
Received 10 September 2010
Received in revised form 8 January 2011
Accepted 9 January 2011
Available online 28 January 2011

Key words:
Alcohol
Distraction
Divided attention
Driving

ABSTRACT

Background: Recognition of the risks associated with alcohol intoxication and driver distraction has led to a wealth of simulated driving research aimed at studying the adverse effects of each of these factors. Research on driving has moved beyond the individual, separate examination of these factors to the examination of potential interactions between alcohol intoxication and driver distraction. In many driving situations, distractions are commonplace and might have little or no disruptive influence on primary driving functions. Yet, such distractions might become disruptive to a driver who is intoxicated.
Methods: The present study examined the interactive impairing effects of alcohol intoxication and driver distraction on simulated driving performance in 40 young adult drivers using a divided attention task as a distracter activity. The interactive influence of alcohol and distraction was tested by having drivers perform the driving task under four different conditions: 0.65 g/kg alcohol; 0.65 g/kg alcohol + divided attention; placebo; and placebo + divided attention.
Results: As hypothesized, divided attention had no impairing effect on driving performance in sober drivers. However, under alcohol, divided attention exacerbated the impairing effects of alcohol on driving precision.
Conclusions: Alcohol and distraction continue to be appropriate targets for research into ways to reduce the rates of driving-related fatalities and injuries. Greater consideration of how alcohol and distraction interact to impair aspects of driving performance can further efforts to create prevention and intervention measures to protect drivers, particularly young adults.

1. Introduction

Research examining how alcohol impairs driving performance is an important step in the process of preventing future crashes. In the United States, an average of one alcohol-related fatality occurs every 30 min (NHTSA, 2002). Automobile crash reports have shown that up to 40% of fatal crashes in the United States involve alcohol (Evans, 2004). As blood alcohol levels increase, the likelihood of a fatal traffic crash also increases (Zador et al., 2000). Younger drivers constitute a higher percentage of alcohol-related crashes than any other age group. Drivers under 20 years of age have a 5-fold increase in average risk of alcohol-related crash when compared with drivers over age 30 (Keall et al., 2004). Understandably, considerable research interest has been devoted to 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 (Harrison and Fillmore, 2005a).

The ever-increasing demands on drivers' attention have also become a focus in driving research. Drivers are often required to divide their attention between tasks associated with driving, such as maintaining lane position and speed, and other tasks, such as engaging with passengers and adjusting dashboard instruments. Of particular concern is the growing number of "technology-based" distractions in the automobile (e.g., cell phone, GPS, and entertainment systems) that compete for driver attention. Such distractions have become one of the main factors leading to traffic crashes (Dingus et al., 2006; Klauer et al., 2006; Lam, 2002).

Recognition of the risks associated with alcohol intoxication and driver distraction has led to a wealth of simulated driving research aimed at studying the adverse effects of each of these factors. Moreover, in recent years driving researchers have moved beyond the individual, separate examinations of these factors to the examination of potential interactions between alcohol intoxication and driver distraction. The examination of such interactions is the purpose of the present study.

Much of the current interest in studying the combined influence of alcohol intoxication and driver distraction is fueled by the ecological relevance of examining the two factors jointly. Alcohol

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doi:10.1016/j.drugalcdep.2011.01.002

intoxication and driver distraction, separately, are well known factors in car crashes, but also likely co-occur frequently (Brewer and Sandow, 1980). There is also empirical justification for examining the joint effects of alcohol intoxication and distraction on driver performance. Laboratory research has shown that alcohol-induced impairment of simple laboratory tasks can be intensified when the subjects are distracted by a secondary task. Indeed, decades of laboratory studies have shown that among the most sensitive measures of alcohol-induced impairment are tasks that involve divided attention (Fillmore, 2007; Holloway, 1995; Moskowitz and Robinson, 1988). These tasks assess the ability to attend to multiple stimuli, some that are relevant to task goals and some that are irrelevant. Performance in divided attention situations is considered highly vulnerable to the disruptive influence of alcohol and reviews of alcohol studies report some of the lowest threshold blood alcohol concentrations (BACs) for statistical evidence of impairment. For example, Moskowitz and Robinson (1988) found that over half of the studies they reviewed reported impairment on divided attention tasks at BACs below 50 mg/100 ml, with some studies finding impairment as low as 20 mg/100 ml.

Theories to account for this vulnerability center on the assumption that alcohol might reduce the capacity to process information (Fillmore, 2003; Steele and Josephs, 1990). In general, these theories assert that information processing is constrained much like a "bottleneck" in which only one process can be completed at any one time (Pashler, 1994). With respect to alcohol, the theory suggests that alcohol reduces the capacity to process information so that information beyond the capacity limit cannot be processed effectively, leading to slowed or inaccurate responses (Fillmore and Van Selst, 2002; Fillmore et al., 2002). Divided attention tasks are especially vulnerable in this regard because their increased task demands already limit available capacity, making it more likely that task demands will exceed capacity when further constrained by alcohol, and also because the ability to switch attention on divided attention tasks is impaired by alcohol (Holloway, 1995; Moskowitz and Fiorentino, 2000).

With respect to driving performance, some researchers have recently examined the joint influence of alcohol and divided attention in simulated driving scenarios and have shown that the impairing effects of alcohol can be intensified when the driver is required to divide attention among distractor tasks while driving (Rakauskas et al., 2008; Verster et al., 2009). In these studies, the divided attention tasks required volunteers to manipulate vehicular controls in response to visual instructions within the vehicle, to participate in a verbal cognitive test battery (Rakauskas et al., 2008) or to press buttons in response to changes in peripheral visual stimuli (Verster et al., 2009). In these studies it was shown that alcohol and distraction each individually impaired driving performance and that such impairment was increased substantially when alcohol and divided attention were combined.

To date, evidence that divided attention exacerbates the impairing effects of alcohol has been based on highly distracting divided attention tasks that have direct impairing effects on driving performance, even in sober drivers. In line with dual process models of cognition (Shiffrin and Dumais, 1981; Shiffrin and Schneider, 1977), driving researchers have long recognized that aspects of driving can be classified on the basis of reflecting either automatic or controlled modes of cognitive processing (Michon, 1985; Salvucci, 2006). Behaviors governed by automatic processes tend to be well learned actions that require little conscious effort and can be conducted in parallel with other activities. By contrast, controlled actions are effortful, demand greater cognitive resources, and are often disrupted by a secondary activity (Shiffrin and Dumais, 1981). In the context of driving, the ability to maintain lane position by executing minor steering adjustments is often considered to reflect automatic processes, whereas overtaking other vehicles is considered to entail controlled, conscious action on the part of the driver (Michon, 1985).

Such a distinction between automatic and controlled aspects of driving is important when considering the potential disruptive influence of a distraction. In many driving situations, distractions are commonplace and have little or no disruptive influence on the driving performance of sober drivers because they do not disrupt the lower-level, automatic processes. Some aspects of driving routinely require both controlled and automatic aspects of driving. Such situations include attending to changes in traffic conditions while maintaining a steady lane position, adjusting vehicular dials while slowing in response to traffic signals, and being observant of pedestrians who might enter the road while maintaining a safe following distance behind other cars. Sober drivers typically do not exhibit any degradation of impairment on automatic aspects of driving when such distractions are included. Yet, these distractions might become disruptive to a driver who is intoxicated. With reduced information processing capacity from alcohol intoxication (Fillmore, 2003; Steele and Josephs, 1990), it is possible that even automatic aspects of driving could be impaired by distraction. Therefore, it is important to determine if such distractions that alone, are benign, could nonetheless function to exacerbate the behavioral impairment in an intoxicated driver.

The purpose of the present investigation was to examine the interactive impairing effects of alcohol intoxication and driver distraction on simulated driving performance in young adult men and women, using a divided attention task as a distracter activity that does not degrade the driving performance of sober drivers. The interactive influence of alcohol and distraction was tested by having drivers perform the driving task under four different conditions: alcohol; alcohol + divided attention; placebo, and placebo + divided attention. In this study the hypothesis was tested that the disruptive effects of divided attention would be only observed in intoxicated drivers and not in sober drivers. The study used a driving simulation that measured critical aspects of driving precision (e.g., swerving) and indicators of reckless driving behaviors, such as failures to stop at red lights. Speeding was examined as a possible mechanism for the interactive impairment of alcohol and distraction. Past work suggests that the disinhibiting effects of alcohol could exacerbate impairment because drivers are less likely to attempt to compensate for their impairment (Fillmore et al., 2008). One manner in which drivers could compensate for distraction is by reducing their speed, and some research shows that under alcohol, drivers fail to slow down during distracting events (Allen et al., 2009). Therefore, the present study employed a driving scenario that encouraged speeding to determine the extent to which intoxicated drivers might speed despite the presence of distracters. To encourage speeding all drivers were provided monetary reinforcement for their rapid completion of the simulated driving test.

2. Methods

2.1. Participants

Forty (20 women and 20 men) volunteers between the ages of 21 and 35 years (mean age = 24.0 years, SD = 3.8) participated in this study. Volunteers completed questionnaires that provided demographic information, drinking habits, and physical and mental health status. Individuals with a self-reported psychiatric disorder, substance abuse disorder, head trauma, or other CNS injury were excluded from the study. Volunteers with a score of 5 or higher on the short-Michigan alcoholism screening test (S-MAST) (Selzer et al., 1975) were excluded from the study. The racial makeup of the sample was Caucasian ($n = 32$), African-American ($n = 5$), Asian ($n = 1$), and other ($n = 2$).