The Effects of Heavy Drinking and Socio-Economic Status on Sober Driving Behavior

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Background: Drinking and driving is a primary cause of traffic fatalities and it has been suggested that heavy drinkers comprise a major portion of those drivers involved in drinking and driving accidents. Although several experimental studies have investigated the driving behavior of social drinkers or the general population under the influence of alcohol, few studies have focused on a comparison of sober driving behavior between heavy and social drinkers. In addition, these studies have not taken other potentially influential factors into account such as socio-economic status.

Methods: A driving simulator study was conducted with a 2×2 factorial design (heavy vs. social drinker; low vs. high income). Sixty-four participants who were not under the influence of alcohol or drugs were asked to operate a driving simulator following traffic rules. Multiple aspects of participants’ driving behavior were measured in a sober driving situation. To control the potential effects of confounding factors, factors (e.g., age, gender etc.) that were significantly correlated the driving behavior were all entered into the MANOVA as covariates.

Results: Significant interaction effects were found between effects of heavy drinking and income levels. Analyses indicated that heavy drinkers—indeed of their income levels—exhibited more speeding exceedances and longer speeding duration than those of social drinkers with a high income. Individuals characterized as social drinkers with a low income also exhibited more speeding behaviors.

Conclusions: Cognitive deficits and problems in vehicle control resulting from chronic alcohol consumption may impact heavy drinkers’ ability to perform adequately, even in a sober driving

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situation. In addition, social drinkers with a low income were more prone to make unsafe choices compared to social drinkers with a high income.

Key words: Heavy Drinker, Alcohol Abuse, Driving Behavior, Experiment, Driving Simulator.

1. Introduction

Drinking and driving is a major cause of traffic accidents and fatalities. The National Highway Traffic Safety Administration (NHTSA) considers a driver to be alcohol impaired when his/her blood alcohol concentration (BAC) is 0.08 gram per deciliter (g/dl) or higher. In 2007, there were 12,998 fatalities in alcohol-impaired driving crashes, accounting for 32 percent of the total motor vehicle traffic fatalities in the United States (NHTSA, 2007).

More importantly, the majority of such driving accidents or fatalities was caused by individuals with a BAC level of 0.08 or greater. For example, in 2007 12,068 (84%) of the 14,447 drivers with a BAC of 0.01 or higher who were involved in fatal crashes had BAC levels at or above 0.08, and 7,974 (55%) had BAC levels at or above 0.15. The most frequently recorded BAC level among drinking drivers in fatal crashes was 0.16 (NHTSA, 2007). A similar conclusion was reached by Simpson and Mayhew (1991), where almost two-thirds of alcohol-involved fatally injured drivers (AIFID) had BACs in excess of 0.15. Zador (1991) also reported that drivers with BACs in excess of 0.15 were 300-600 times more likely to be fatally injured in a crash compared with drivers who had not been drinking. In general, a BAC level of 0.08 or greater corresponds to 5 drinks in a 2 hr period for men and 4 drinks in a 2 hr period for women, although clearly there is variability due to factors such as body mass, age, and recent drug and food ingestion (Jackson, 2008). As a result, heavy alcohol consumption appears to play an especially prominent role in injuries resulting from motor vehicle accidents in the United States (Arias, et al., 2003).

Accordingly, Simpson and Mayhew (1991) have advanced a hypothesis that there is a “Hard Core” of drinking drivers, called heavy drinkers, who do not fit a social drinker profile. In research on alcoholism, heavy drinkers are typically defined as individuals who consume 5 or more drinks per occasion in the past month (Room, 1972). Since then, the 5+ threshold has been proposed as a standard measure for heavy episodic drinking in general population alcohol surveys (Midanik, 1999). More recently a gender-specific threshold (5 or more drinks for men; 4 or more drinks for women) has also been widely adopted (Wechsler, et al., 1994, 1995; Wechsler
These heavy drinkers are mainly composed of problem drinkers, many of which meet criteria for alcohol dependence and exhibit abnormal driving behaviors, which in turn, may represent a threat to public safety (Kramer, 1986). Statistical data from NHTSA revealed that people with a BAC level of 0.08 or above in fatal crashes were eight times more likely to have a prior conviction for driving while impaired (DWI) than were drivers with no alcohol (a BAC level of 0.00). Kennedy et al., (1996) also concluded that alcohol-involved fatally-injured drivers (AIFIDs) with high BACs were more likely to have histories of DWI convictions and license suspensions than AIFIDs with low BACs.

Much of the existing research on alcohol-related driving has primarily focused on the effects of alcohol on the driving behavior of social drinker (e.g., Arbuckle, et al., 1994; Muraven, et al., 2002; Fillmore & Vogel-Sprott, 2000; Marczinski et al., 2008) or general population (e.g., Bjerver & Goldberg, 1950; Laurell, 1977; Brookhuis & de Waard, 1993). Typically, researchers have employed alcohol administration techniques on social drinkers or individuals from the general population and examined the effects on driving performance. As a result, the heavy drinker population that has a relatively high risk of drinking and driving has not received much attention in transportation research. Although several studies in the addictions literature have explored the characteristics of heavy drinkers in general (e.g., their drinking patterns) with various surveys and questionnaires (e.g., McGuire, 1982; Mayou & Bryant, 1995; Kennedy et al., 1996), few experimental studies have been conducted to measure heavy drinkers’ characteristics in operating a vehicle in sober driving situations.

A recent related study by Marczinski and colleagues (2008) examined both acute alcohol and placebo effects on simulated driving performance as well as subjective ratings of intoxication and driving ability in binge and non-binge drinkers. Interestingly, they reported that the driving performance of the binge and non-binge drinkers did not differ on any aspect of driving performance with either acute alcohol or placebo administration. They have extended this line of research to examine other factors such as acute tolerance (Marczinski & Fillmore, 2009). Given these recent findings with regard to binge drinking, an important aspect to consider is the college student sample in these studies, an important population for the study of binge drinking effects. However, most participants in these studies are young and likely have shorter drinking histories, less driving experience, and different drinking motivations than older individuals in the community. In fact, these studies took great care to exclude individuals that
might meet criteria for alcohol dependence due to the potentially confounding effects that heavy drinking might have on driving performance. Although this line of work addresses significant factors associated with binge drinking and driving while under the acute influence of alcohol in college students, it does not necessarily speak to potential effects of heavy drinking on driving behavior, including sober driving situations.

Previous research in the addictions literature has indicated that individuals with alcohol dependence and/or a pattern of heavy drinking exhibit a number of cognitive deficits (e.g., visuospatial perception, processing speed and efficiency, attention; Moselhy, et al., 2001; Oscar-Berman, 1993; Oscar-Berman & Hutner, 1993; Sullivan & Pfefferbaum, 2005) and problems in inhibitory control (e.g., Thayer, et al., 2006) that may affect driving performance. Sullivan and Pfefferbaum (2005) have suggested that chronic and excessive consumption of alcohol results in degradation of frontocerebellar circuitry affecting widespread brain regions and contributing to alcoholism’s salient, enduring, and debilitating cognitive and motor deficits. While the potential for driving under the influence is high for heavy drinkers, it is also possible that deficits in neurocognitive processing may impact their ability to perform adequately even in sober driving situations.

Another factor that is gaining attention with regard to alcohol use and related behaviors, such as driving under the influence, is socio-economic status (SES). SES is a multidimensional construct reflecting particular strata in society and is comprised of several socioeconomic characteristics (Oakes & Rossi, 2003). Income (either personal or household income) is one major socioeconomic characteristic often examined in research on alcoholism (e.g., Khan, 1998; Casswell, et al., 2003; Spijkerman, et al., 2008). Epidemiological evidence indicates a positive relation between income and the prevalence of alcohol abuse in the general population, but an inverse relation between income and alcohol dependence. Casswell, et al., (2003) also reported that frequency of drinking was influenced by income with the higher income respondents drinking more often, an effect that was persistent over time.

A few studies have been conducted examining the relation between income and driving behavior, although the literature is equivocal. For example, several investigators have reported that unsafe driving behaviors, such as speeding, driving after drinking and not use seat belt, are characteristic of a core group of low income drivers (Shinar, 1993; Haaga, 1986; Helsing & Comstock, 1977; NHTSA, 2000). Yet, other studies reported a negative relationship between
income and safe driving behavior (Traynor, 1993; Golias & Karlaftis, 2001; Shinar et al., 2001). For example, Golias and Karlaftis (2001) found that higher income led, in general, to less law-abiding driver behaviors. One possible explanation for this heterogeneity of findings is the self-report measure of driving behavior and lack of empirical evidence on the effect of income on driving behavior. Although self-reports are widely recognized as a valuable methodology in the social sciences, they are vulnerable to a number of biases that can lead to both under- and over-reporting (Corbett, 2001). In addition, self-reported behavior measures are potentially vulnerable to self-presentational biases such as self-deception and the tendency to give favorable self-descriptions (e.g. Lindeman & Verkasalo, 1994; Paulhus, 2002).

Although separate lines of research exist on driving behavior and its relation to either SES/income or alcohol consumption, it is not clear how income might influence or interact with drinking patterns (e.g., heavy vs. social drinking) to influence driving behavior. Thus, the purpose of this study is to examine how drinking history (heavy vs. social drinkers) might interact with income and affect driving variables during sober performance of a driving simulation task.

2. Methods

2.1 Recruitment procedures

Participants were recruited via newspaper and radio advertisements for participation in a study of driving behavior. Interested participants contacted an experimenter who explained the study and administered a brief set of screening questions over the phone to determine eligibility. This brief phone screen included questions regarding medical history, driving behavior and drinking patterns.

Inclusion criteria for all participants included: age 22-45 years, English speaking, valid US driver license, and driven within the past 6 months. A number of strict exclusion criteria were used in the study to limit potential confounds on the behavioral/cognitive aspects of driving performance. Exclusion criteria included a history of seizures, neurosurgery, head injury with a loss of consciousness > 10 minutes, mental retardation, report of serious psychiatric disorder (i.e. schizophrenia or bipolar disorder), or serious medical disorders (e.g. neurological disorders,
HIV/AIDS, etc.), drug dependence (excluding nicotine), and current use of psychoactive medications.

2.2 Participants

Sixty-four participants in the Western New York area (25 males and 39 females) took part in the laboratory session which involved a driving simulator. Two subjects (1 male and 1 female) were eliminated from the analysis due to incomplete questionnaire data, resulting in a sample of 62 subjects whose average age was 30.6 years (SD = 7.94) and average education level was 14.8 years (range from 12 to 18 years, SD = 1.92). The sample was 71% Caucasian and Non-Hispanic, 19.4% African-American and Non-Hispanic, 4.8% Hispanic, and 4.8% Other.

2.3 Self-Report Measures

All participants were asked to complete the following self-report measures on site before engaging in the driving task.

1) Demographic Questionnaire - This questionnaire was designed to capture information about subjects’ demographic situation, such as age, gender, education level and estimated annual household income.

2) Driving history survey - This measure contained questions regarding driving history such as estimated annual mileage, the year a US driver license was first issued and prior crash or violation history as well as information on the participant’s vehicle such as horsepower.

3) Alcohol Use Timeline Followback (TLFB; Sobell & Sobell 1992, 1995) - The timeline followback is a specialized interviewing procedure which uses a daily calendar method to gather retrospective reports of quantity and frequency of daily drinking for the period prior to assessment. Alcohol use is recorded in terms of the number of standard drinks consumed. The TLFB was administered to each participant to document alcohol consumption for the prior 30 days. The timeline permits derivation of drinking-related dimensions such as drinking days (DD) and heavy drinking days (HDD). The reliability and validity of the measure have been consistently demonstrated among alcohol dependent individuals (e.g., Sobell & Sobell 1992, 1995).
4) State Trait Anger Expression Inventory-2 (STAXI-2, Spielberger, 1999) - provided an assessment of trait anger. The portion of the STAXI used in the current study (part 3) assessed four components: anger expression-in (AX/In), anger expression-out (AX/Out), anger control-in (AC/In), and anger control-out (AC/Out). These items are scored by participants’ responses to statements on a four point scale (Almost Never [1], Sometimes [2], Often [3], Almost Always [4]). The anger expression index (AX/Index) provided an overall estimate of the person’s tendencies to express anger either outwardly toward other people, or inwardly toward herself. It is based on the person’s responses to the AX/In, AX/Out, AC/In, and AC/Out items and a higher score indicates greater anger expression or less anger control.

2.4 Experimental design

A 2×2 factorial design (heavy vs. social drinker; low vs. high income) was used to examine differences related to the types of drinkers and income levels. Participants who consumed 5 or more drinks (for male) or 4 or more drinks (for female) in at least one occasion in the past month were regarded as heavy drinkers (Wechsler, et al., 1994, 1995; Wechsler & Austin, 1998). Social drinkers were those individuals that consumed 4 or fewer drinks (for male) or 3 or fewer drinks (for female) per occasion in the past month. As a result, participants were categorized into two groups: Heavy Drinkers (n = 42) and Social Drinkers (n = 22).

All participants were asked to estimate their total household income last year before taxes including wages, pensions, and interest or dividends on savings and investments. Because some individuals may have access to resources provided by the household income, but may not have a personal income, household or family income was used in present study. The Department of Agriculture, U.S. General Service Administration defines low-income as between 50 and 80 percent of the area median income (AMI). In this study, the criterion was calculated by multiplying the median annual household income (around $30,000 in 2007) by 65% (average boundary between 50 and 80 percent). Accordingly, an approximate cut-off income of 20,000 dollars was used to categorize 64 participants into two groups: low income group (less than or equal to 20,000 US dollars, n = 23) and high income group (greater than 20,000 US dollars, n = 41).

2.5 Apparatus
The driving task was completed using a STISIM® driving simulator (STISIMDRIVE M100K) (See Figure 1). The STISIM simulator was installed on a Dell Workstation (Precision 490, Dual Core Intel Xeon Processor 5130 2GHz) with a 256MB PCIe×16 nVidia graphic card, Sound Blaster® X-Fi™ system, and Dell A225 Stereo System. The driving scenario was presented on a 27-inch LCD with 1920×1200 pixels resolution. The driving simulator also included a Logitech Momo® steering wheel with force feedback and a gas and a brake pedal.

2.6 Experimental procedure

Upon arrival, participants were asked to sign a consent document. Both urine and breath samples were collected and tested for recent alcohol/drug use. Urinalysis for benzodiazepines, opiates, amphetamine, cocaine, and cannabis were performed immediately. Any participant who tested positive for alcohol or drugs was not allowed to participate in the study that day (n=4), but was rescheduled for a different test date.

After filling out a set of questionnaires, all participants completed a Practice Block for the driving task. This session allowed them to become familiar with the driving simulator controls including steering wheel, speedometer, brake and gas pedal. Participants were required to drive the simulator for a one-mile distance with normal road events so that they could manipulate the simulator smoothly and become familiar with the different road events. For example, when a participant approached a road barrier in the right lane, s/he had to enter the left lane to pass the barrier and then return to the right lane as soon as possible to avoid any approaching vehicles in the left lane.

Next, participants completed the Test Block, a two-lane (in each direction) local environment with normal road events. Four types of driving events were included:

Pedestrians crossing the road. Two types of pedestrians were designed: target and non-target. Initially, pedestrians were displayed 2 feet from either the left or right roadway edge line.
When the driver was within 200 feet of the pedestrian, the pedestrian (target) began to cross the road at a constant speed of 2 feet per second. To reduce learning effects, stationary pedestrians (non-target) were also displayed with an exact ratio of 1:3 (target vs. non-target).

**Barriers in the road.** Target and non-target barriers were used. Target barriers were placed in the middle of the right lane and appeared 600 feet ahead of the driver. Participants had to change from one lane to another and avoid any approaching vehicles when they passed the barriers. Non-target barriers were placed on either side of the road with an exact ratio of 1:3 (target vs. non-target).

**Intersections with traffic lights.** Two types of traffic lights were included: target and non-target. Target traffic lights turned from green to yellow when the driver was within 200 feet of the intersection. The light then stayed yellow for a total of 2 seconds at which time it turned to red. Non-target traffic lights remained green and occurred 3 times as often as target traffic lights. **Speed limit sign.** Speed limit signs with different speed limits (ranging from 20 to 60) were displayed 1000 feet in front of the driver. Participants were instructed to adjust their speed and follow the speed limit throughout the task.

Each type of event occurred 15 times in the Test Block and was randomly distributed throughout the block without overlapping. Participants were asked to operate the driving simulator and follow the traffic laws as if they were driving a real vehicle on the road.

### 2.7 Measurement

Several behavioral measures from the driving simulator Test Block were examined: frequency of accidents, frequency of running a red light, speeding frequency and duration of speeding.

**Accidents.** Three types of accidents could occur during the driving simulation. First, pedestrian-related accidents included instances where drivers did not respond quickly enough and hit a pedestrian who was crossing the road. Next, vehicle-related accidents dealt with any collision with a vehicle on the road. The last type of accident was barrier-related accidents which specified how many times drivers hit a barrier either in the middle or on either side of the road. **Running a red light.** This reflected the number of times drivers crossed the limited line for a traffic light while the traffic light was red. **Speeding frequency.** This indicated the number of times a vehicle’s speed exceeded the posted speed limit.


2.8 Data Analysis

Analysis of variance (ANOVA) was used to examine potential group differences in demographic factors (e.g., age, education) and driving history. Chi square analyses were used for categorical variables such as gender and ethnicity. Pearson correlations were performed to investigate the bivariate relations between self-report variables and behavioral variables from the driving task. A multivariate analysis of variance (MANOVA) was then conducted with the driving behavior variables serving as dependent variables and drinking group (heavy vs. social) and income levels (high vs. low) serving as between-subjects factors. In addition, those factors significantly correlated with the dependent variables were entered as covariates in the MANOVA (e.g., age, gender, number of years since obtaining a driver’s license etc.). Significance testing was set for an alpha level of .05. Finally, for significant interactions, planned contrasts were used to compare the four groups on the driving behavior variables. These four groups were heavy drinker with high income (HH), heavy drinker with low income (HL), social drinker with high income (SH) and social drinker with low income (SL). This approach was chosen given the prior literature on heavy drinking effects on cognitive functioning and the equivocal literature on income and driving to ensure that the comparisons for each group were represented (Field, 2009). Three hypotheses were stated as follow: 1) \( H_0 : 3\mu_{SH} = \mu_{HL} + \mu_{HI} + \mu_{SL} \) (Contrast 1); 2) \( H_0 : 2\mu_{SL} = \mu_{HI} + \mu_{HL} \) (Contrast 2); 3) \( H_0 : \mu_{HI} = \mu_{HL} \) (Contrast 3).

3. Results

3.1 Descriptive statistics

One-way ANOVAs were conducted comparing the drinking and income groups on demographic variables, driving history and drinking history (Table 1). There was significant difference between high and low income group for age, \( F(1, 60) = 16.411, p < 0.01 \); level of education, \( F(1, 60) = 4.992, p < 0.05 \); year license, \( F(1, 60) = 18.035, p < 0.01 \); annual mileage, \( F(1, 60) = 20.505, p < 0.01 \); horsepower, \( F(1, 60) = 12.989, p < 0.01 \) and  

STAXI anger expression index, \( F(1, 60) = 6.172, p < 0.05 \). It was indicated that high income group tended to be older, have a low level of educational achievement, experienced driver, drive a
vehicle with a higher horsepower and have a higher score on the anger/expression index. Moreover, no significant differences between high and low income groups were observed for gender, ethnicity or any drinking history variable.

On the other hand, there were significant differences between heavy and social drinkers in terms of ethnicity, (Pearson $\chi^2(1) = 33.334, p < 0.01$), indicating that a greater proportion of heavy drinkers were Caucasian as compared to the social drinker group. Compared with social drinkers, heavy drinkers reported more heavy drinking days, ($F(1, 60) = 22.372, p < 0.01$); more drinking days, ($F(1, 60) = 12.77, p < 0.01$), consuming a greater number of drinks per drinking day, ($F(1, 60) = 35.632, p < 0.01$), and consuming a greater total number of drinks in the prior month, ($F(1, 60) = 13.856, p < 0.01$). Additionally, there were no significant differences between heavy and social drinkers for age, gender, education level, STAXI anger/expression index or any driving history variable.

<Insert Table 1. Means and standard deviations for demographic and self-report measures and driving performance variables>

3. 2 Bivariate correlations

Pearson correlation coefficients (Table 2) were calculated between variables derived from the self-report measures and simulation driving behaviors. The six driving behavior variables were speeding frequency, duration of speeding, frequency of running a red light, frequency of hitting a pedestrian, frequency of hitting a barrier and frequency of colliding with a vehicle.

<Insert Table 2. Pearson correlation coefficients>
3.2.1 Speeding frequency

For speeding frequency, there were significant negative correlations with age and number of years since driving license was obtained. This indicates that young drivers and those who had a driver’s license for a shorter time tended to exceed the speed limit more often.

3.2.2 Duration of speeding

Similarly, young drivers and those who had a driver’s license for a shorter time sped for a longer duration. There were also significant negative correlations with gender and marital status for this measure indicating that drivers who are male and single tended to exceed the speed limit for longer time. In addition, the anger expression index was positively correlated with duration of speeding, indicating that drivers with higher anger expression scores tended to speed for longer periods of time.

3.2.3 Frequency of running a red light

Young drivers and those who had a driver’s license for a shorter time ran red lights more frequently. Significant negative correlations were also observed between gender, marital status and this variable indicating that drivers who are male and single run red lights more frequently. In addition, there is a positive correlation between the anger expression index score and frequency of running a red light.

3.2.4 Frequency of hitting a pedestrian and others

Five variables were significantly negatively correlated with frequency of hitting a pedestrian. Single and young drivers, as well as those who had a driver’s license for a shorter time exhibited more instances of hitting a pedestrian. Moreover, people who reported lower annual mileage and a vehicle with lower horsepower exhibited more instances of hitting a pedestrian.

3.3 MANOVA

In the third step of data analysis, a MANOVA was conducted with the types of drinkers and income levels as between-subjects factors and four of the driving behavioral variables serving as dependent variables: speeding frequency, duration of speeding, frequency of running a red light and frequency of hitting a pedestrian. Frequency of hitting a barrier and colliding with another
vehicle were dropped from further analysis as they were not strongly correlated with the effects of drinking or income. In addition, age, gender, number of years since obtaining a driver’s license, current marital status, the STAXI Anger Expression Index score, reported annual mileage, and vehicle horsepower were all entered into the MANOVA as covariates to control the potential effects of these confounding factors. The overall MANOVA was significant (Wilks’ \( \lambda = 0.821, p < 0.05 \)). Follow-up comparisons for each dependent variable are discussed below.

### 3.3.1 Speeding frequency

A significant types of drinkers × income levels interaction was revealed for speeding frequency (Figure 2), \( (F(1, 51) = 6.522, p < 0.05) \). Planned contrasts indicated that social drinkers with high income had significantly fewer speeding exceedances, compared to those in the other three groups, \( (t(58) = -2.366, p < 0.05) \). In other words, heavy drinkers, independent of their income levels, exhibited more speeding exceedances than social drinkers with high income. No significant difference was found between heavy drinkers with high income and those with low income \( (t(58) = 0.139, p = 0.89) \). There were no significant difference among heavy drinkers with high income, heavy drinkers with low income and social drinkers with low income, \( (t(58) = 0.214, p = 0.83) \).

<Insert Figure 2. A significant interaction between types of drinkers and income levels on speeding frequency>

There were no significant main effects for speeding frequency for types of drinkers or income levels.

### 3.3.2 Duration of Speeding

The interaction effect of types of drinkers × income levels for duration of speeding was significant, \( (F(1, 51) = 7.897, p < 0.01) \) (Figure 3). Planned contrasts indicated that social drinkers with high income, significantly sped for a shorter time period than those in the other three groups, \( (t(58) = -2.366, p < 0.05) \). In other words, heavy drinkers, independent
of their income levels, exhibited longer speeding duration than social drinkers with high income. However, no significant difference was shown between heavy drinkers with high income and those with low income (Contrast 3; \( t(58) = 0.927, \ p = 0.36 \)). There were no significant difference among heavy drinkers with high income, heavy drinkers with low income and social drinkers with low income, (Contrast 2; \( t(58) = -0.175, \ p = 0.86 \)).

<Insert Figure 3. A significant interaction between types of drinkers and income levels on duration of speeding >

There were no significant main effects for types of drinkers or income levels on duration of speeding. No significant effects were observed for frequency of running a red light or frequency of hitting a pedestrian.

4. Discussion

The current study found that even when sober, heavy drinkers exhibited more speeding exceedances and longer speeding duration than those of social drinkers with high income. In addition, individuals characterized as social drinkers with low income also exhibited more speeding behaviors as compared to social drinkers with high income. Possible explanations for this effect include cognitive deficits and problems in vehicle control resulting from chronic alcohol consumption and the negative relationship between income and unsafe driving behaviors.

A growing number of longitudinal neuropsychological studies reported that individuals with a pattern of heavy drinking exhibit a number of cognitive deficits and problems in inhibitory control. It is likely that these deficits may impact drivers’ ability to perform a driving task. Sullivan & Pfefferbaum (2005) proposed a central role for degradation of frontocerebellar neuronal nodes and connecting circuitry affecting widespread brain regions and contributing to the cognitive deficits (such as visuospatial impairment and executive dysfunction). Typically,
cognitive deficits resulting from chronic heavy drinking include impaired working memory, judgment disability, response disinhibition, poor insight, reduced motivation, and attentional deficits (Parsons et al., 1987; Oscar-Berman & Hutner, 1993; Moselhy et al., 2001; Nixon et al., 2002; Sullivan, 2000; Thayer, et al., 2006). Based on the current findings, it is possible that such deficits in neurocognitive processing may have impacted participants’ ability to perform adequately, even in a sober driving situation (to inhibit or prevent speeding of the car). Moreover, chronic alcohol consumption has been associated with a lack of impulse control (Rubio et al., 2008), which may be related to a decrease in focused attention and a greater disregard for future consequences (e.g., risk perception).

Although we anticipated that income levels may influence driving behavior, the interaction with types of drinkers is a unique finding. It has been well established that higher income is associated with healthier behavior choices, such as health food purchasing, regular physician visits and medical cares (Kenkel, 1991; Mechanic, 1978; Yung et al., 1984; Rosner et al., 1988). Individuals with a higher income seem to be more aware of the consequences of their behavior, and therefore more prone to make healthier choices. Particularly, previous research in the driving literature revealed that there was a negative relationship between income and unsafe driving behaviors, such as speeding, driving after drinking, and not using a seat belt (Shinar, 1993; Haaga, 1986; Helsing & Comstock, 1977; NHTSA, 2000). In the current study, social drinkers with a high income exhibited fewer speed exceedances and sped for a shorter time, indicating a positive effect of income levels on the safe driving behavior, consistent with the aforementioned findings. However, heavy drinkers in the high income group engaged in more speeding behavior, likely due to the predominant effect of the heavy drinking pattern.

The effect of income on the driving behavior is equivocal and some researcher argued that higher income led to unsafe driving behaviors (Traynor, 1993; Golas & Karlafitis, 2001; Shinar et al., 2001). For example, Traynor (1993) found that high income was related to increased safety-enhancing purchases, such as anti-lock brakes. Although the usage of such advanced safety devices may decrease the likelihood that an accident will result in severe injury or fatality, at the same time it may lead to increased assertiveness and decreased risk perception, encouraging the prevalence of unsafe driving behaviors. Several possible explanations could be applied for this inconsistent finding. First, there is very little empirical evidence (such as real road or simulator study) on the relation between income and driving performance variables. Self-
report measure of driving behaviors derived from questionnaires or surveys are vulnerable to a number of biases that can lead to both under- and over-reporting (Corbett, 2001; Lindeman & Verkasalo, 1994; Paulhus, 2002). Second, income is not an independent indicator of driving behaviors and correlated with a number of factors, such as region, culture, occupation, etc. For example, low income defined in one area might be classified as moderate or even high income in another area. As a result, the classification of income might be different and result in inconsistent findings in relation to the effect of income on driving behaviors.

In practice, this study has value for reducing the risk of alcohol-related traffic crashes. First, several driving behavioral variables, such as speeding related measures (speeding frequency and duration of speeding) might be helpful to identify those most at risk for alcohol abuse and aggressive driving. Kennedy et al. (1996) found that there were no driving variables in their study that differentiated heavy and light drinkers, indicating that heavy drinking was the primary factor that distinguished the groups. In other words, under the influence of alcohol, heavy drinkers did not have obviously significant difference of driving behavior than social drinkers. Similar conclusion was reached by Marczinski et al (2008), where binge and nonbinge drinkers did not differ on any aspect of driving performance in either alcohol or placebo condition. In this study, however, it is suggested that speeding related measures might serve as important considerations related to drinking even in a sober driving situation.

Second, the interaction of types of drinkers and income levels may help to identify individuals at higher risk for hazardous driving behaviors. These findings may have implications for determining appropriate treatment, intervention, and rehabilitation options for individuals with a history of drinking and driving. Namely, it may be important to take into account both the offender’s drinking history and socioeconomic status in the course of rehabilitation and driver educational achievement in order to effectively reduce the risk of alcohol-related traffic crashes.

Despite these intriguing findings, it is necessary to consider the limitations of this study to be addressed in future work. For example, the study was conducted using a driving simulator, which may produce different risk perception for subjects compared with real-road driving. Real road tests may be needed in future studies to validate these findings. Despite the small sample size the observed power (β) for the types of drinkers × income levels interaction was 0.8 in the current study, but future studies may benefit from a larger sample size. Future studies should also consider other internal and external factors that might influence driving behavior such as
impulsivity and the availability of safety-enhancing features on the participants’ own vehicles. Furthermore, it may be useful to determine whether history of drinking and income levels have an impact on driving behavior while under the acute influence of alcohol as well. Finally, in addition to experimental research methods, computational modeling approaches could also be used to capture the effects of alcohol on human perceptual, cognitive and motor control functions (Wu, et al., 2007-2008). In sum, the current study reinforces prior evidence suggesting that heavy drinkers represent a special group of interest with regard to dangerous driving behaviors and also highlights the importance of considering other factors that might help identify at-risk drivers, such as the potential interaction between drinking and SES status. Future studies are necessary to better define the factors that are most important with regard to rehabilitation and prevention.

Acknowledgement

We appreciate the support from Interdisciplinary Research & Development Fund (IRDF) UB2020 from SUNY-Buffalo for this study (Award Number 35905).

References


**Figure legends**

Figure 1. STISIM Driving Simulator

Figure 2. A significant interaction between types of drinkers and income levels on speeding frequency

Figure 3. A significant interaction between types of drinkers and income levels on duration of speeding

**Table legends**

Table 1. Means and standard deviations for demographic and self-report measures and driving performance variables

Table 2. Pearson correlation coefficients