Alcohol and the Perception of Speed

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Abstract
Alcohol-affected drivers, and specifically young alcohol-affected driver, are over represented in road accidents in New South Wales. This single-blind study assessed the effects of a moderate dose of alcohol on inexperienced and mature drivers’ reaction times, perception of vehicle speed, awareness, and ability to perform complex driving manoeuvres such as overtaking. Participants (20 males and 20 females) were required to consume an amount of alcohol sufficient to reach a target blood alcohol concentration (BAC) of 0.080 g dL$^{-1}$, and undertook two experimental sessions on the STISIM Drive$^{©}$ Driving Simulator at 30, 60 and 90 minutes. Comparisons were made between performances at target BACs of 0.000 g dL$^{-1}$ (placebo condition) and 0.080 g dL$^{-1}$, as well as between the performances of young and mature drivers.

Introduction
A large number of preventative measures have been adopted in order to curb the stagnantly high incidence of road accidents in the state of New South Wales (NSW), Australia. These include a lowered suburban speed limit (from 60 km/h to 50 km/h), restrictive ages and criteria for potential licence holders, speed cameras, random breath test sites, and education campaigns on the dangers of drink-driving. Nevertheless, speeding and alcohol currently remain the two highest contributors to casualty road crashes in NSW, at 16% and 39% respectively (1). Furthermore, while young drivers (aged 17–20 years) comprised only 5% of the driving population in NSW in 2000, they were involved in 14% of all crashes.

Driving a motor vehicle is a complex task. It is a learned skill that coordinates focus, perception, decision-making, and motor control. After the consumption of alcohol, however, driving performance has been shown to deteriorate via, among other factors, increases in speed variability, lateral lane position variability, reaction time and steering responsiveness (2, 3). Although extensive research has been conducted in the field of alcohol and general driving performance, predominantly psychomotor performance, little attention has been focused on the specific cognitive skills involved in driving a motor vehicle. To date, only one study has investigated the effects of alcohol on a driver’s perception of speed (4), and no significant effect of alcohol was found. This finding, however, was attributed to the relative ease of the task, because there is a consensus that the more demanding the task, the more likely will there be measurable impairment of performance after moderate doses of ethanol (5). Therefore, insight
into the relationship between moderate to high doses of alcohol, speed perception and crash risk, is critically lacking.

Exploration of the influence of age on speed perception, both under the influence of alcohol and in a sober state, has also been relatively neglected. It has been found, however, that young drivers, in particular, are over-represented in overtaking accidents and have a higher rate of accidents involving alcohol (6). This is often attributed to faulty choices of timing and speed rather than a lack of vehicle control skills. It is unclear, however, whether such inappropriate gap acceptance is due to risk-taking, a misperception of arrival time, or both. Another factor that could also contribute to such misjudgements is a decrease in the driver’s state of arousal. That is, drivers that detect hazards slower than others could react impulsively and without due safety. This study was designed to explore the ways in which gap-acceptance and perception are affected by alcohol, and how this influence differs between young and mature drivers. Considering that the perception of risk is reduced after alcohol (7) and is more prominent in young drivers (8), it would appear that alcohol-affected drivers and, in particular, alcohol-affected young drivers, would be more likely to misjudge safe gaps in traffic. These findings hold significant importance in developing training strategies for the specific areas of deficit in performing complex driving manoeuvres such as overtaking, as well as identifying and educating the public on the precise limitations of alcohol consumption on the ability to safely drive.

Methods

Participants
Following ethics approval from The University of Sydney Human Ethics Committee, 40 healthy volunteers (twenty male, twenty female; age ranges 18 to 21 years and 25 to 40 years), who were not first-time drinkers of alcohol, were recruited for this study. Participants were told to abstain from consuming alcohol for at least 24 hours prior to testing, and to eat at least 2 hours before testing commenced. They were instructed not to drive on either of the testing days. Participants were offered out-of-pocket expenses, up to A$40, for their involvement in the study. A$20 was guaranteed for the two 2 hour simulator sessions (one with alcohol and one with a placebo), however, if the participant did not crash (collide with other vehicles, run off the road, etc.) in either session, they received an additional A$20 as an incentive to drive as safely as possible. For every crash in which they were involved, they lost A$5 from this additional A$20 payment.

Driving simulator
This project used a STISIM Drive© driving simulator located at The University of Sydney. The simulator includes a full car cabin fitted with a steering wheel, speedometer, accelerator and brake pedals (Figure 2). Computer generated visual images project onto three screens resulting in a 135° field of view (Figure 1). The STISIM Drive© driving simulator provides a completely flexible experimental environment where a variety of scenes can be constructed (e.g. straight and curved roads, approaching vehicles and pedestrians) to interact with the participant’s vehicle.
Experimental conditions
Using a mixed design, participants were given two sessions on the driving simulator, once after alcohol (BAC = 0.08 g dL\(^{-1}\)), and once after a placebo beverage (BAC = 0.00 g dL\(^{-1}\)).

Alcohol administration
Before each session, participants drank an orange juice beverage. They were not informed which alcohol treatment they had received. For the alcohol condition, alcohol (0.7 g kg\(^{-1}\)) was administered orally as a 1:3 solution of vodka (37% v/v) diluted with orange juice. The dose was adjusted for bodyweight and gender. The placebo beverage comprised of an equivalent amount of orange juice with 5ml of vodka floated on the surface to provide olfactory masking (9). Participants were allowed 20 minutes to consume the beverage.

Experimental tasks
The experimental design aimed to explore how participants performed overtaking manoeuvres. This was examined in terms of the tasks involved in performing these manoeuvres:

1. Detection time.
   Participants were required to press the horn button as soon as they detected an approaching vehicle. These vehicles were programmed to enter the opposing lane by either appearing from parked positions on the roadside, from behind buildings, or from a distance but obstructed by trees. This was designed to measure the level of awareness/alertness of the participants at the different experimental times and conditions.

2. Time-to-collision/contact estimations.
   Approaching vehicles disappeared at specific distances away from the participants’ vehicles. Participant were required to estimate when the approaching vehicles would have met their vehicle, bonnet to bonnet, if it had not disappeared. At this point, participants were instructed to press the horn button. This task provided a measure of the participants’ perception of speed, time and distance.

   Participants were presented with a scenario in which there was a vehicle ahead of theirs, travelling in the same direction, with an approaching vehicle in the next lane. While the
participant was driving at a set speed, he/she was required to activate the horn when it was considered that it was no longer safe to overtake the vehicle ahead. That is, before the approaching vehicle became too close for a safe overtaking manoeuvre to be attempted. This measured the participants’ perception of the adequate safety margins required in potentially dangerous situations.

4. Gap acceptance measured through performing the manoeuvres.
   Participants were required to perform overtaking manoeuvres, as soon as they deemed it to be safe, across a succession of approaching vehicles. The gaps between the approaching vehicles became progressively larger. This task provided a measure of the participants’ perception of, and willingness to take, risks.

5. Self-rating of driving performance.
   Participants were required to complete a questionnaire in which they were asked to compare their driving performance in the simulator with their general driving performance on road, as well as to compare their personal driving performance with that of others in their age group. This was intended to provide some measure of the participants’ self-assessment and decision-making ability, particularly while under the influence of alcohol.

All four tasks were performed on the driving simulator at 30, 60 and 90 minutes after they attained each of the two target BACs (0.000 and 0.080 g dL⁻¹). The complexity of the driving environment, in terms of the curvature of the road, intersections, other traffic, pedestrians, and roadside buildings, was kept constant throughout the sessions.

Experimental procedure
Participants attended the laboratory on two occasions, on two separate days, separated by a two-week period. The aims and procedures were carefully explained to the participants and their informed consent was obtained. They were breath-analysed to ensure that they were alcohol-free, and were then given a practice drive (approximately 5 min) on the simulator prior to their first session. Participants then received either the alcohol or placebo treatment according to a counterbalanced design, and consumed the beverage at a constant rate over a 20 min period, under close supervision. After finishing their drinks, participants waited 10 min before being instructed to wash their mouths with tepid water. Following this, the simulator session began in which participants underwent two drives, each approximately 5 min in duration, at 30, 60 and 90 min. They were breath-analysed prior to each drive. The total session time, over both days, was approximately 4 hours.

Collection and Analysis of Data
The Alco Sensor III (St Louis, Mo.) was used to measure breath alcohol at intervals throughout the experiment, beginning 30 min after drinking had finished to avoid contamination of the breath sample by residual mouth alcohol. The instrument employs a blood : breath factor of 2100 : 1, and readings were corrected to the true mean blood : breath of 2285 : 1. Previous studies have shown a correlation in excess of 97% between BACs determined from breath and directly from venous blood (10). Participants were not told which alcohol treatment they had received.
Results and Discussion

Experimentation will be complete by the end of June and the results presented at the conference in August. Nevertheless, it is hypothesised that young drivers will display relatively poorer driving skills than mature drivers and, across all participants unaffected by alcohol, there will be a general underestimation of time-to-collision. This translates to relatively cautious margins of safety and is consistent with preliminary research conducted at The University of Sydney. In contrast, however, alcohol-affected drivers will underestimate time to a lesser degree, as will young drivers both affected by alcohol and not. This corresponds to alcohol-induced increases in aggression and risk-taking. A number of factors including driving experience, predisposition as sensation seekers, gender and alcohol tolerance, are all expected to influence the results. For this reason, it is impossible to predict exactly what trends will be observed, yet the results may provide important information in gauging how such factors are weighted in driving performance.

References


