INTRODUCTION

Alcohol has been shown to influence the performance of a variety of skilled activities, but most researchers have been concerned with the deleterious effects of alcohol on driving or driving related performance. Such a concentration of research interest is understandable when it is recognised that road accidents are now the main cause of death in the 21–40 year age group in motorised communities, and alcohol has been shown to be implicated in at least 50 per cent of all serious crashes.

Car driving is a complex skill which includes a number of separable components, but few attempts have been made to investigate the influence of alcohol on particular aspects of driving performance.

Re-analysis of data collected in an earlier study of the effects of alcohol on driving, carried out by the School of Psychology, University of New South Wales,1,2 revealed that non-traffic driving performance could be described in terms of two major factors or dimensions, a judgment/accuracy factor, and a handling/stability factor.

The first factor is concerned with accuracy of car placement and judgment of speed and distance. The second has to do with the ability of the driver to maintain directional control, and to keep the vehicle stable under conditions of cornering stress and marginal tyre adhesion.

The handling-stability factor in driving performance has received little attention from researchers up to the present time. Nevertheless, the changing pattern of road deaths following the widespread use of seat belts, suggests that the relevance of a study of car handling skills is likely to become increasingly recognised.

Vazey and Holt in New South Wales have reported an investigation of 125 car crashes in which people died despite wearing seat belts.3 The study revealed that:

(a) Seventy per cent of the crashes occurred outside areas with a 60 km/h speed limit;
(b) Only eight per cent of the crashes involved a collision at an intersection;
(c) Approximately one-third of the crashes occurred on wet roads;
(d) In 54 per cent of the cases the car collided with a roadside object, or another vehicle, in the vicinity of a corner;
(e) In at least 70 per cent of the cases the car was off course and essentially out of control at the time of the crash.

It is apparent that, whatever the preceding circumstances, most of the drivers entered the area of high 'g' forces, and/or loss of tyre adhesion and were unable to maintain control of their vehicles. In other words, the car handling skills of the drivers were not equal to the demands of the situation that confronted them in the immediate pre-crash period. The BAC's of drivers of the case vehicles are not known, but the sample included a large number of single vehicle crashes (46%), and previous work has shown that alcohol is strongly involved in single vehicle deaths.

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In the School of Psychology, University of New South Wales, we are engaged in a series of field studies designed to elucidate the nature and acquisition of car handling skills. As part of these studies we have begun an investigation of the effects of alcohol on response to a car handling task.

BASIC APPROACH

Apparatus

The equipment used in the experiments permits the experimenter to impose a perturbation in the cornering behaviour of an experimental vehicle by means of a remote control system, and to control the visual and non-visual information available to the driver. The vehicle is an extensively modified 1973 Volkswagen 1500. A system of agricultural spray nozzles enables a mixture of detergent and water to be directed onto the contact patches of the treadless rear tyres.

Given that the car is cornering at a speed sufficient to generate substantial tyre side forces, operation of the nozzle system produces an immediate reduction in rear wheel adhesion to the point where the tail of the vehicle moves well out of line, and substantial over-steer is induced.

If the driver fails to compensate by appropriate steering input, the car proceeds to a 180° spin whilst remaining within the road limits.

The Driving Task

The basic task the driver is required to perform is to negotiate a hairpin corner on Warwick Farm Car Racing Circuit, at a constant speed of 50 km/h, whilst maintaining a course in the centre of the road. It is emphasised that smooth accurate performance is required, and that when a handling perturbation is introduced, the task is to maintain as far as possible the required path and speed of the vehicle.

Performance Measures

Driving performance is assessed by the following measures which are recorded within a four second period from the onset of the handling perturbation:
(a) Steering Reaction Time: The interval between perturbation onset and the initiation of corrective input.
(b) Maximum Steering Input: The maximum steering lock used by the driver during the recording period.
(c) Steering Noise: A measure based on the frequency and magnitude of steering input during the measurement interval.
(d) Yaw Noise: A measure based on the frequency and magnitude of fluctuations in yaw angle of the vehicle during the recording period.

General Findings

We have found that the experimental perturbation is somewhat sensitive to changes in vehicle speed, and to the nature of the steering input which is being provided by the driver at the moment of perturbation onset.

Nevertheless, the task has demonstrated quite clearly the expected differences between highly skilled racing and rally drivers, less skilled club drivers, and ordinary non-competition drivers.
Work to date has shown the importance of non-visual information in meeting the task requirements. There is little impairment of the performance of either highly skilled or normally skilled drivers when vision is occluded for a period of one second at the time the perturbation is introduced.

On the other hand, degradation of non-visual inertial and angular acceleration cues, results in deterioration of performance in both groups, whether or not visual information is available. It is important to note, however, that in order to produce clear-cut effects, the interference with non-visual input must be substantial.

METHOD

Subjects
The subjects in the study of the effects of alcohol on performance were eighteen male members of the administrative staff or graduate schools of the University of New South Wales, aged 21–45 years. All subjects had held driving licences for at least two years and were accustomed to alcohol. Current weekly consumption of alcohol ranged from 20–580 grams, but most of the subjects would ordinarily be classified as light drinkers.

Alcohol Administration
Three BACs, 0; 0.03% (30 mg/100ml); and 0.06% (60 mg/100ml), were chosen for study on the following grounds:
(a) High BACs are known to impair virtually any performance, and the lower limits of impairment are of greater interest;
(b) The limited run-off area available at Warwick Farm would have made the use of high BACs somewhat hazardous;
(c) A BAC of 0.06% is between the legal limits for driving in Victoria (0.05%) and the remaining Australian states (0.08%), and has been shown to impair performance on conventional driving tests.

The BACs were achieved by administration of mixes of vodka and lemonade found appropriate by prior testing. Before each scheduled run the subject was required to drink the contents of three small glasses containing lemonade or vodka and lemonade. The subject rinsed his mouth with vodka between each glass, and held his nose whilst drinking, a procedure designed to limit the available cues to the alcohol concentration in the drinks.

After 30 minutes BAC checking by Breathalyser was commenced. Evidence was required that the BAC was peaking at a value within ± 0.005 per cent of the required value before a run was undertaken.

Detailed Procedure
At the commencement of each run the programming and recording systems were armed and the driver was instructed to accelerate, select second gear and reach and maintain 50 km/h. The driver was assisted in maintaining the required speed of the vehicle by an instrument which prominently displayed the RPM of the engine. The experimenters were able to determine whether the vehicle was within the limits of 47–53 km/h by observing a set of speed signal lights mounted externally on the car.

If the vehicle's speed was within the specified limits, an experimenter located near the entrance to the corner actuated the radio control unit to trigger the perturbation if it had been programmed for that run.

On all trials the radio control unit was triggered at the moment the car passed a marker, but the onset of the perturbation was randomly delayed by a timer within the limits of 5–20 metres of car travel. The spray operated for four seconds.
Each subject made eight runs at each BAC, four with perturbation and four without perturbation. No more than two sets of BAC runs per subject were scheduled on any one day. Most drivers completed all three BAC runs in two days of testing carried out within 3–10 days. BAC orders were balanced across subjects and runs within BAC sets were randomised.

Prior to the first set of experimental runs subjects were instructed in the techniques required to cope with the driving task. Each subject was allowed up to eight practice runs to become familiar with the vehicle and the handling perturbation. Four subjects who could not complete two consecutive perturbation runs without spinning were excluded from the experiment. A BAC run was completed in 15–20 minutes.

RESULTS

Figure 1 shows the mean steering reaction time on perturbation trials at each of the three BACs. The reaction times are virtually identical across the three conditions. Figures 2, 3 and 4 show mean perturbation trial performance levels on the remaining measures at each of the BACs.

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B.A.C.

Figure 1.  *Steering Reaction Time*

Figure 2.  *Yaw Noise*
In each case the units are arbitrary, but the baseline represents ideal performance. For example the minimum yaw 'noise' with which the driving task can be completed is represented by approximately 17 units on the scale.

On all three measures there is a small but statistically significant trend towards increasing scores (i.e. poorer performance) with increasing BAC.

Interpretation of the results requires reference to our earlier studies of the handling/stability factor in driving performance. It is possible to specify a number of distinct requirements for adequate performance on our car handling task.

Firstly, the driver must immediately sense the changes in non-visual input that indicates tail breakaway, and must rapidly apply opposite lock steering correction. There is every reason to believe that the initial steering correction required to control rear-end breakaway, and/or
incipient oversteer, is a highly probable, well-prepared or 'natural' response to the appropriate inertial and angular acceleration cues. Most drivers without previous experience of loss of control situations readily learn to react rapidly with opposite lock steering input. Furthermore, as we have seen, steering reaction time varies little across driver groups, and is not easily prolonged by interference with sensory cues.

Secondly, in order to perform adequately, the driver must match the degree of initial steering correction with the degree of rear-end breakaway. Appropriate grading of initial steering correction requires some experience with the particular vehicle, but again most drivers learn what is required quite rapidly.

If a driver is to reach a high level of performance in car handling, he must meet a third requirement: he must learn to anticipate the response of the vehicle to his corrective steering input, and begin to take off lock before the car becomes unbalanced in the opposite direction. The ability to make a smooth transition from opposite lock control to normal control is not readily acquired. Poor performance may result in the car fish-tailing violently. In extreme cases the driver may make a series of corrections, each of which is out of phase with the behaviour of the car.

Finally, a high level of performance requires the driver to maintain appropriate throttle openings throughout the corrective manoeuvre.

The most inappropriate use of the throttle in our task is to lift the foot off the accelerator when the initial breakaway is felt. Such an action practically ensures a spin. In order to bring the car under control, the driver must maintain or increase the throttle opening. In the limited time available, a few of our subjects could not learn to keep the required throttle openings, and had to be removed from the experiment.

It is quite clear from our data that alcohol effects occur mainly in the later and more difficult stages of the car handling task. In the two alcohol conditions we studied, the subjects' initial steering reactions were as rapid and appropriate as they were when they drove without consuming alcohol. It was the subjects' ability to cope with the additional and more difficult task requirements that was affected by the alcohol we gave them.

There seems little reason to doubt that much larger doses of alcohol affect all aspects of performance in car handling tasks. It seems likely, however, that the differential effects we observed in the case of relatively low BACs, have their counterparts in road driving.

REFERENCES