THE RELATIONSHIP BETWEEN DRIVERS' BLOOD ALCOHOL CONCENTRATION (BAC) AND ACTUAL DRIVING PERFORMANCE DURING HIGH SPEED TRAVEL.

JAN WILLEM LOUWERENS1, A.B.M. GLOERICH, dUVRIES, G., BROOKHUIS, K.A., O'HANLON, J.F.

1: Dept. of Clinical Psychiatry, State University Hospital of Groningen, the Netherlands. At the time of this study all authors were attached to the Traffic Research Centre, State University of Groningen, Haren, the Netherlands.

INTRODUCTION

The disabling influence of alcohol-use on daily life functions has always been as notorious as its allure. Yet much research-effort has been spent in this field since Goldberg (1) demonstrated scientifically such detrimental effects with his experimental psychological test-battery in 1943. Only few authors could reproduce the dose-dependent relationship that he found, while others couldn't find dose dependency or even any relationship at all.

Epidemiological research gave lead to the alcohol-legislation that has been introduced by many governments. Borkenstein (2) was the first to demonstrate a relation between blood-alcohol-concentration (BAC) and accident-risk in the famous Grand-Rapids study. These results were confirmed by many authors since (3).

O'Hanlon (4) developed a method to measure objectively the influence of conditional changes on aspects of real driving performance. The method has proven to be very sensitive for the effects of prescription drugs. This work was done and continuous still as a part of the research effort of the Traffic Research Center of the State University in Groningen (the Netherlands) on participation in traffic as a behavioural phenomenon. The aim of this study was to establish a dose-effect relationship between BAC and objectively measurable aspects of real driving performance. Such relation can also serve as calibration of the method and gives an indication of implications of the effects registered after drug-use.

METHOD AND MATERIAL

In this study we compared the effect of 4 dosages of alcohol on driving performance with the subjects' sober performance in a partially blind design.

Subjects. 12 female and 12 male volunteers were invited after random selection to participate in the study. They varied in age...
from 22 to 45 years and all had held a drivers' licence for at least 3 years and were used to drive at least 5,000 kms/yr, but not professionally. Furthermore "moderate" drinkers were selected who were used to drink more than 4 standard glasses a week and less than 4 glasses a day of alcohol-containing drinks.

Test method. The test consisted of a ride in a specially instrumentated car over 25 kms of a secondary road, which takes almost 20 minutes. In our country it is legally forbidden to drive at any place under the influence of more than 0.5 mg/ml (promil) of alcohol in the blood. Yet we were allowed to do this study in cooperation with the State-police, who, for this purpose, closed the road for all other traffic.

During the test rides the subjects were accompanied by two experimentists, one only guarding the safety and controlling redundant clutch and breaks, the other, sitting on the back-seat, controlling the registration equipment. The subjects' task was to drive with a constant speed of 90 km/hr with a constant lateral position between the right lane boundaries. The objective variables were the amount of weaving (SD lat. pos.) and the speed variability.

Testcar. All data were collected by means of a normal stationcar that was equipped with an electro-optical device that registers the position of the interrupted midline of the road with regard to the car. A doppler radar was attached under the rear bumper of the car and monitored speed. Lateral position- and speed data were sampled every second and stored on floppy disk by an onboard computer, that also served for editing and analysis of the data. Lateral position (weaving) and speed registrations were computed to their Standard Deviations, our main dependent variables.

Bloodalcohol levels were monitored by breath-analyses before and after tests. Bloodsamples were collected immediately after the tests and twice detected by means of the NAD-NADH method (5).

Design. The 4 alcohol treatments were administered in an alternating order on 2 different days, spaced 1 week apart to 6 subjects at a time in a party-like atmosphere. In this period the subjects did not use any drugs, they didn't eat after 5 hours before testing and arrived all sober at our experimental pub, where they got a meal of soup and sandwiches. The alcoholic drink was prepared in advance in individual bottles and consisted of 1 part vodka to 3 parts of orange juice. Different alcohol levels were achieved by administration of 0.5, 1.0, 1.5 and 2.0 grs of alcohol per kg.
The subjects were left in doubt on the concentration of alcohol in the different bottles. Baseline-performance measures were collected on separate days in open tests because of practical constraints, but could be compared with baseline performance in other studies. After every test the subject and the driving instructor assessed the performance on a linear scale.

RESULTS

Mean BAC's were 0, 0.24 (SD 0.08), 0.60 (SD 0.11), 0.85 (SD 0.15) and 1.22 (SD 0.18) mg/ml (promil). Mean concentrations were higher in women than in men. There was no relevant pre- and posttest difference in BAC, as measured by breath-analysis.

The behavioural data were analysed by curvefitting through group mean data and individual results as well. The curve of the exponential function $SD_{lp}=16.74e^{0.29BAC}$ fits the mean data pairs of SD lateral position and BAC very well ($r = 0.99; n = 24$) (Fig. 1). This function was correlated significantly with 17 of the curves, that were fitted through individual datapairs. A significant difference between baseline- and alcoholperformance was found from 0.6 mg/ml and on. Women turned out to be more sensitive for behavioural effects of the same BAC than men ($p < 0.03$), (Fig. 2).

![Fig. 1. Mean SD lateral position (+SE) as a function of BAC (+SE).](image1.png)

![Fig. 2. Mean SD lateral position (+SE) as a function of BAC (+SE) for men and women separately.](image2.png)
Speedcontrol was not significantly effected by alcohologestion.

The subjects assessment of their own driving performance corre-
related poorly with both SD lat. pos. and BAC (resp. \( r = -0.28 \) and \( r = -0.37 \)). The instructor's judgements were higher correlated (resp. \( r = -0.56 \) and \( r = -0.71 \)). But the instructor was aware to some extend of the administered doses.

DISCUSSION AND CONCLUSIONS

This method is sensitive for the impairing influence of alcoholuse on driving performance and shows a clear dose-dependency. Women were more sensitive in this respect than men, what could be related to a weaker development of tolerance, though this is not clearly supported by our data. Several authors (e.g. 1 (1943)) described judgement-impairment after alcohol-­ ingestion. This impairment as well as the loss of control (SD lat. pos.) found in this study parallels results in studies on the effects of prescription drugs with the same method (6). This emphasises the necessity to approach regular drug-use in traffic as stern as drunken driving.

REFERENCES

2. Borkenstein RF, Crouther RF, Schumate RP, Ziel WB, Zielman R (1964): The role of the drinking driver in traffic accidents. Dept. of Police Administration, Indiana University, Bloomington, Indiana.
3. Simpson HM, Warren RA (1981): Alcohol, other drugs and dri-
4. O'Hanlon JF (1984): Driving performance under the influence of

This study was supported by grants of the Dutch Alcohol Fund (S.A.F.) and the Dutch Ministry of Health Care. Next to these authorities we are grateful to the State Police, the County dept. of Public Works and dr. D.R.A. Uges (Univ. State Hosp. Groningen), whose collaboration with the project team made such exceptional project feasible.