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THE INFLUENCE OF DRUGS ON DRIVING ABILITY

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The current research concerning drug effects on driving ability is reminiscent of that in the mid-1950s on the relation between alcohol and driving. At that time epidemiological research on the subject was inadequate; and while the quality of the experimental laboratory research was better, it was insufficient.

Thus the extent of the dangers associated with driving under the influence of alcohol required clarification, which was provided by epidemiological studies conducted primarily in the 1960s, such as those by Haddon, Vamosi and Borkenstein. Besides determining the probabilities of accident involvement as a function of blood-alcohol (BAC), these studies determined characteristics of accident-involved drinking drivers and of the times of such accidents. Further advances in experimental research have defined more clearly the nature of the behavioural impairments produced by alcohol which lead to accident involvement.

Our current knowledge regarding drugs and driving is regretfully limited. In particular, epidemiological research in this area is incomplete. To return to the alcohol example, there is nothing comparable to the Borkenstein study which produced estimates of accident probability as a function of blood levels and which illuminated the role of such co-variates as age, driving experience, drinking experience, sex and other social factors. These results were the product of relatively complete sampling of all accident-involved drivers in the study timespan, with determination of their BAC and a comparison with the BAC of an adequate control group of drivers passing the accident scene at similar times. This task was rendered feasible by the cooperation of drivers requested to give breath samples.

Attempts to perform similar studies on drugs and driving have been hindered severely by difficulty in getting cooperation from accident-involved drivers and controls in supplying body fluid specimens, and by the technical difficulty and expense involved in performing scientifically accurate quantitative blood-drug analyses. Perhaps these difficulties account for the rather large variability in reported presence of drugs in accident-involved drivers or in drivers arrested for impaired driving.

Given the problems associated with performing such large-scale studies as those of Borkenstein, more information at this time might be obtained from epidemiological investigations of smaller scope. An example is the study of diazepam levels in injured accident-involved drivers in Oslo, Norway, by Hafner et al. It might be simpler to perform epidemiological studies in industrial situations where skills similar to those required in driving are frequently involved. Clearly, at this time, few broad generalizations can reliably be derived from the existing epidemiological literature.

Our current knowledge of the effects of drugs on driving ability rests primarily on experimental laboratory or simulator studies. These studies have the usual advantages of experiments with administration of known levels of drugs and the ability to follow behavioural changes as a function of drug levels, either as administered or as found in blood and urine. The prime difficulty with the studies has been the frequent use of behaviours as response variables which have unknown or questionable relevance to driving.

Among variables often seen in the studies are digit symbol substitution, simple reaction time, visual acuity, flicker fusion, nystagmus, accommodation, visual field, oculomotor balance and mood or subjective effects. These variables are of value in a complete behavioural definition of the effects of the drugs. However, they are not variables that recent research literature suggests are of importance in man-machine interactions. The literature concerning human factors engineering and skills performance research is in agreement with findings on accident causation from on-site driving and flying accident investigation teams. This literature has identified the key behavioural factors in accident causation as primarily perceptual and decision-making errors (both in the general areas of information processing) with motor control as a third factor. Simple sensory factors, such as visual acuity or simple reaction time, fail to show significant correlations with accident causation.

Findings in examining the effects of drugs on non-relevant variables are likely to lead to incorrect conclusions suggesting a lack of effects of the drugs on driving abilities, because simple behavioural functions are often more resistant to drug effects than the complex behavioural processes involved in perception, information processing and decision-making. Behavioural variables which human factors research suggests as germane include attention, vigilance, division of attention, information load capacity, rate of information processing, tracking ability and risk taking.

Unfortunately, there are few studies examining drug effects on the latter group of variables. Only alcohol and marihuana appear to have been examined adequately with reference to relevant behaviours, but generally only during peak time of drug action. Examination of the literature on a wide range of psychoactive drugs reveals sparse and incomplete study of relevant behaviours. Reviews conducted under the Organisation for Economic Cooperation and Development (OECD), and reviews sponsored by the National Institute of Drug Abuse and the National Highway Traffic Safety Administration in the United States, agree that alcohol and marihuana significantly impair a wide range of driving-related behaviours. Sparse but relevant evidence on similar impairment appears to exist for some barbiturates and tranquilizers. Evidence on other drug categories involves sampling such a small number of behaviours with so few drug samples that conclusions appear premature.

It should be noted that even within a given category of drugs such as minor tranquilizers, major differences exist in the extent and duration of skills impairment. Since many drugs have socially useful functions, it appears important to examine each drug individually rather than to determine the effects on driving on the basis of a drug's membership of a particular category.

The extent of drug impairment found in our survey is sufficient to suggest the need for systematic examination of the entire range of psychotropic drugs with relevant behavioural measures. Skills impairment represents not only a public health menace in driving but also a hazard in other man-machine interactions as in industry, recreation and even our modern home environments.

A comprehensive programme of experimental studies on drugs and driving should elucidate certain factors, as follows:

1. Studies should include a range of drug doses in order to adequately sample the range of usual dose levels.

2. Acute dosage studies should be followed by chronic dosage studies. Many psychoactive drugs have active metabolites that accumulate to large levels over periods of weeks. Moreover, this approach permits analysis of the role of tolerance, an important factor in psychoactive drugs. For example, in examining methadone, no impairment was found after six months of use.

3. Even for a single acute dose, it is important to test repetitively over an extended period of time to ensure that the duration of drug action is known. Thus, with marihuana, behavioural impairment is found for 4-6 hours after a single treatment, despite disappearance of the subject's "high" and return of pulse levels to normal within an hour.

4. Only a small portion of the studies have examined drug interaction with alcohol. Since alcohol serves in most societies as a universal solvent, it is important to determine combined alcohol-drug effects. Moreover, taking alcohol by itself as a variable serves to establish the sensitivity of the dependent behavioural variables.

What conclusions can be drawn from the above regarding future research and concrete action on drugs and driving? Although the knowledge to be acquired from epidemiological studies is extremely important, an assessment of the problems observed in this area, coupled with the difficulties in obtaining adequate representation of the large and growing number of psychoactive drugs, are such as to suggest that knowledge regarding the possible dangers of the drugs must come primarily from experimental studies. Many of the drugs have been placed on the market after government approval based on compliance with safety standards that has not included adequate behavioural testing. For future drugs and those currently on the market, governmental regulations should require evidence of safe use by individuals required to interact with machinery in an increasingly complex world, which would be obtained by testing with relevant sensitive behavioural measures. Examination of the difficulties involved in measures against the drinking-driver suggests that a programme of prevention and control of drug abuse would be the first and probably the most likely effective step in curtailing drug impairment of driving.

The National Institute of Drug Abuse and Department of Transportation in the United States have initiated a programme to examine drugs for possible impairment of driving. Eight drugs are being studied at four dose levels, each over a 24-hour period after a single acute dose. The drugs are diazepam, chlordiazepoxide, flurazepam, secobarbital, methaqualone, codeine, diphenhydramine and marihuana. Behaviours examined include visual search, signal detection, tracking, dual task performance under divided attention and information processing. Pharmacokinetic data based on repetitive examination of blood, urine and saliva specimens permit correlation with changes in behavioural impairment over tiem.

The following is a representative figure from the diazepam study, showing impairment relative to placebo treatment for tracking error under division of attention, given average dosages of 2.5, 5 and 10 mg of the drug.

A concurrent study is examining the degree of impairment for each drug in relation to each behavioural variable with performance in a complex driving simulator, to establish task validity. An examination has been made of several of these drugs in interaction with alcohol, exhibiting increased driving-related impairment. Such information will provide the basis for drug control and other programmes against the dangers involved in driving under the effects of impairing drugs.

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ANNEX I

Mean tracking error score in the divided-attention task for 24 hours after drug treatment:

Percentage change from placebo and diazepam