Research Issues 20
DRUG USERS AND DRIVING BEHAVIORS

National Institute on Drug Abuse

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DRUG USERS AND DRIVING BEHAVIORS

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Contents

Foreword

The issues of psychosocial drug use and abuse have generated many volumes analyzing the "problem" and suggesting "solutions." Research has been conducted in many disciplines and from many different points of view. The need to bring together and make accessible the results of these research investigations is becoming increasingly important. The Research Issues Series is intended to aid investigators by collecting, summarizing, and disseminating this large and disparate body of literature. The focus of this series is on critical problems in the field. The topic of each volume is chosen because it represents a challenging issue of current interest to the research community. As additional issues are identified, relevant research will be published as part of the series.

Many of the volumes in the series are reference summaries of major empirical research and theoretical studies of the last fifteen years. These summaries are compiled to provide the reader with the purpose, methodology, findings, and conclusions of the studies in given topic areas. Other volumes are original resource handbooks designed to assist drug researchers. These resource works vary considerably in their topics and contents, but each addresses virtually unexplored areas which have received little attention from the research world.

The Research Issues Series is a group project of staff members of the National Institute on Drug Abuse, Division of Research, Psychosocial Branch. Selection of articles for inclusion in this volume was greatly aided by the suggestions of a peer review group, researchers themselves, each of whom reviewed a topic of particular interest. It is my pleasure to acknowledge their contribution to the project.

Dan J. Lettieri, Ph.D.
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Preface

A major factor in the American public's concern over unconventional drug use is its effect on traffic safety. This volume contains summaries of the latest experimental and epidemiological research on the interactions between drugs and driving behaviors. The experimental studies, which make up most of this volume, deal with the effects of drugs on cognition, coordination, reaction time, and other psychomotor functions, all of which are related to driving performance. The experiments at times use driving simulators and, sometimes, real driving situations; the epidemiological studies primarily deal with investigations of drug-involved auto accidents.

The studies are listed alphabetically immediately following the preface. Within the volume they are organized into three sections, and are arranged alphabetically by author within each section. A supplementary bibliography of additional readings and a set of indexes are included at the end of the summaries.

An extensive and comprehensive literature search was carried out to identify materials for inclusion in this volume. Major clearinghouses, data bases, library collections, and special bibliographies were searched. The editors also corresponded with professional organizations, institutions, and research specialists in searching for relevant materials. Current issues of newsletters and journals were scanned throughout the project. The list of bibliographic sources searched includes:

Addiction Research Foundation, Bibliographies
Dissertation Abstracts
Index Medicus
Psychological Abstracts
Public Affairs Information Service
SPEED: The Current Index to Drug Abuse Literature
National Clearinghouse for Drug Abuse Information
Transportation Research Information Service

The criteria for selection of documents were drawn up by a consultant group of researchers working with the contractor and representatives of the National Institute on Drug Abuse. For inclusion, a study had to meet the following general criteria:

- Empirical research studies with findings pertinent to the particular topic, or major theoretical approaches to the study of that topic.
- Published between January 1960 and December 1976, preferably in the professional literature, with the exception of certain older "classics" which merited inclusion, and unpublished dissertations.
- English language, with a focus on American drug issues.

After a first review of citations and annotations to weed out obviously irrelevant materials, the body of collected literature was subjected to two reviews: one to ensure that materials met the selection criteria, and a second, accomplished by Dr. Robert Sterling-Smith, to ensure that studies representative of the universe were included. Each completed abstract was subsequently reviewed to ensure that it reflected accurately and faithfully the contents of the study.

The talents and contributions of many individuals made this volume possible.

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Weil, Andrew T.; Zinberg, Norman E.; and Nelsen, Judith M. Clinical and psychological effects of marihuana in man. Science, 162:1234-1242, December 13, 1968. 156

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Burns, Marcelline, and Sharma, Satanand. Marihuana effects on driving: Performance and personality. In: Proceedings of the 19th Conference of the American Association for Automotive Medicine, San Diego, California, Nov. 20-22, 1975. Lake Bluff, Ill.: the Association, 1975. pp. 274-284.

PURPOSE

The most direct means of assessing the impact of any substance of abuse on traffic safety is an examination of epidemiological data. A number of laboratory studies on the effects of both alcohol and marihuana on the individual's ability to process information have been performed; data from these experiments were reviewed in terms of their implications for driving.

SUMMARY

Moskowitz, Sharma, and Schapero (1972) measured dark adaptation, visual acuity, binocular fusion and vergence, and found no impairment on these measures by either alcohol or marihuana except for a slight loss of ocular motor control. Similarly, Moskowitz and DePry (1968) with alcohol, and Moskowitz and McGlothlin (1974) with marihuana, found no evidence of auditory sensory processes being impaired, and concluded that the locus of the drug effect was probably in central processes. They also found that alcohol impaired performance only under the demands for division of attention, while marihuana impaired performance of both concentrated and divided attention in a dose-related manner. Similar findings have been reported for concentrated and divided attention in the visual modality (Moskowitz and Sharma, 1974; Moskowitz, Sharma, and McGlothlin, 1972). The data from these studies strongly suggest that both substances impair central processes, but that the modes of action differ.

Psychological refractory period (PRP) has been widely used as an experimental paradigm. It involves presenting two stimuli to the subject in close succession with each requiring a response, usually a key press. A delay of the second reaction time reflects an increase in central processing time. Using the PRP technique, Moskowitz and Burns (1971) found that 0.69 g alcohol/kg body weight slows information processing. Moskowitz, Shea, and Burns (1974) also found a slowed reaction time to the second stimulus in a PRP experiment with marihuana treatments of 100 and 200 mg THC/kg body weight. However, the reaction time was increased more than could be accounted for by PRP theory, and it was concluded that there were treatment effects unrelated to the refractory phenomenon. Again, the data indicate that alcohol and marihuana both act to impair central processing of information, and that the actions of the two substances differ.

Sharma and Moskowitz (1973) investigated both alcohol and marihuana effects on vigilance by means of a task requiring sustained attention to a light display during a one-hour session. Alcohol did not impair performance, but for marihuana there was a performance decline over the entire session. Moskowitz and Murray (1975) examined changes induced by alcohol and marihuana on the rate of information processing in regard to visual backward masking (for which the subject is required to recall stimulus letters). Alcohol doses of .414 and .828 g/kg both slowed the processing rate, while marihuana had essentially no effect.

Further evidence of the differences in effect of these two substances is provided by memory studies. Carpenter and Ross (1965) and Ryback et al. (1970) demonstrated alcohol impairment of short-term memory (STM). Miller and Dolan (1974) concluded that alcohol exaggerates the confusion that occurs when a subject tries to sustain a memory trace and also handle new input. Abel (1971) postulated that the most likely reason STM is adversely affected by marihuana is that subjects cannot concentrate. Dittrich et al. (1973) supports Abel's findings. These investigators cite an increase in temporal disintegration during marihuana intoxication, a characteristic reported by Melges et al. (1970) and Tinklenberg et al. (1970) and attributed to memory lapses. Tinklenberg et al. (1972) examined a time-production task, showing that an alcohol dose of 0.7 ml/kg had no effect on this task, while marihuana at 0.35 mg/kg THC accelerated the subject's internal clock (e.g., he would feel that 120 seconds had elapsed when only 105 had elapsed). The preceding comparisons of data have made it clear that there are performance deficits associated with marihuana intoxication, but--unlike with alcohol--it is not clear that they stem from a slowing of central processes. Abel (1971) cited an inability to concentrate; Melges et al. (1970) and Tinklenberg et al. (1972) postulated memory lapses and the focusing of

attention on internal events; Sharma (1973) reports data from two experiments supporting the hypothesis of temporary lapses of attention. Subjective reports of marihuana intoxication often note the disruption of ideas and thought processes (Melges et al., 1970; Allentuck and Bowman, 1941). Sharma (1973) also examined the nature of subjects' failures to respond to events in the environment. After a 200 mg THC/kg dose there was a 95% increase in failures to detect a target, and these errors were not attributed to attention to other stimuli in the external environment. These experiments are further evidence for the hypothesis that marihuana induces a shift of attention away from external events and heightened responsiveness to internal events.

Some personality data also relevant to the issue of traffic safety includes the Minnesota Multiphasic Personality Inventory (MMPI) which assesses mental and emotional stability. Alcohol abusers and alcoholics typically score high on scales which reflect deviance, depression, and anxiety. Addict populations in general are likely to show signs of paranoia and schizoid or schizophrenic tendencies, as well as pathological anxiety.

CONCLUSIONS

Impairment by marihuana presents considerable risk in driving, but the action of the drug--as demonstrated in laboratory studies--differs from the action of alcohol. The nature of accidents related to use of these substances can be expected to differ as a function of the specific underlying deficits in information processing. Driving skills are likely to be impaired by either substance. On the basis of available data, there is no reason to believe that marihuana use will create a greater traffic hazard than alcohol use.

Frankenhaeuser, Marianne. Drug effects on emotions: Relevance to driving accidents. In: Israelstam, S., and Lambert, S., eds. Alcohol, Drugs, and Traffic Safety. Proceedings of the Sixth International Conference on Alcohol, Drugs, and Traffic Safety. Toronto, September 8-13, 1974. Toronto, Canada: Addiction Research Foundation of Ontario, 1975. pp. 259-270.

PURPOSE

From the point of view of experimental psychology, traffic safety may be regarded as a problem involving the adjustment of the driver to his environment. Drugs may either counteract or facilitate the driver's ability to adjust to the demands posed by the environment. A review of the literature was undertaken to determine how driving behavior is affected by low and high arousal levels induced by (1) different aspects of the driver's environment, (2) alcohol and other drugs, and (3) drug-environment interactions. Particular attention was paid to the emotional aspects of behavior, and to the interplay between emotional, motivational, and cognitive factors. The investigation was restricted to the behavior of normal, healthy persons under the acute influence of low-to-moderate single doses of alcohol and some centrally-acting drugs.

SUMMARY

There is general agreement between arousal theorists in postulating an invert-U relationship between mental efficiency and arousal level. At low arousal levels, the organism tends to be inattentive and easily distracted, and poor performance is probably associated with a slowing down of cortical processes. At somewhat higher arousal levels, the organism's resources are mobilized, full attention is given to the task, and it performs to the best of its abilities. Still higher arousal levels are associated with excessive tension and intense emotion, a decline in performance reflecting impaired cortical control or impaired selectivity of responses. Safe driving requires medium arousal. Barry (1973) evaluated the relative danger involved in conditions of low and high arousal, noting that the majority of fatal car accidents with alcohol involvement were single-car accidents. Driving off the road or into an obstacle are the types of accident associated with low arousal, whereas excessive speeding, risky maneuvers, and loss of control are more likely to occur in high arousal states.

Centrally acting drugs, such as stimulants and depressants, are powerful determinants of arousal level, and drug effects may either enhance or reduce the effects of concomitant environmental influences. In experiments dealing with drug effects on risk-taking (Frankenhaeuser and Post, 1966), emphasis was placed on relations between actual and self-perceived reactions to the drugs. Measures of performance speed were obtained by a battery of sensorimotor and perceptual tests given to a group of students before and after intake of either 15 mg of dexamphetamine, 200 mg of pentobarbitone, or a placebo. In the placebo condition, both objective and subjective speed remained relatively constant. The two drugs, in accordance with predictions, affected both variables in opposite directions: after dexamphetamine, the subjects performed more quickly and felt quicker, while after pentobarbitone they were slower and tended to feel somewhat slower. Further, there was a general tendency towards overestimation, particularly of the low level of performance induced by the depressant. Since improvements were only slightly overestimated after dexamphetamine, these data do not support the commonly held view that stimulants give rise to an exaggerated belief in one's own ability. It is also important to note that stimulants and depressants influence time-estimation in opposite directions. Frankenhaeuser (1959) showed that when time estimates were plotted against physical time, the same time period regularly appeared longer after a stimulant (metamphetamine) than after a depressant (pentobarbitone). Within the same series of experiments, caffeine produced effects on time-estimation similar to amphetamines, while nitrous oxide produced effects similar to barbiturates.

As to the effects of alcohol, studies of nerve conduction, EEG, and mental performance all indicate a stimulant action of low doses and a depressant action of moderate and high doses. It is the combination of weakening restraints on behavior and impairment of sensorimotor functions and motor coordination that endangers driving. The method of magnitude estimation has been used to quantify subjective intoxication, and the mean blood-alcohol concentration in a group of subjects, plotted over time, and their self-estimates of intoxication at corresponding points in time after alcohol intake of .55 g/kg body weight were measured. The quality and intensity of

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the various components of the intoxication pattern were modified by the psychosocial setting in which drinking took place, as well as by motivational and cognitive characteristics of the individual. The problem of alcohol and aggression has been approached in laboratory studies by Buss (1961). The outcome of these experiments indicates that alcohol alone, in an emotionally neutral setting, does not influence the level of aggression. Berkowitz (1969) hypothesized that arousal interacts with aggressive cues in the environment to produce aggressive responses. This suggests that states of heightened arousal following intake of small doses of alcohol may increase the tendency of a person to react aggressively--e.g., to competitive elements in the driving situation. In another experiment (Frankenhaeuser et al., 1964), a placebo introduced as a depressant drug had more powerful depressant effects than did the actual drug given without suggestive instructions. These examples illustrate the point that effects of drugs on driving behavior are only partly determined by the pharmacological properties of the drug. The driver's cognitive appraisal of his own state and of the external situation will guide his choices and decisions. This view is consistent with the basic ideas in Schacter's (1966) cognitive theory of emotion. Equally important is the fact that fear and stress may, under some circumstances, counteract the depressant effects of alcohol. According to several reports, stressors such as pain, exertion, fatigue, and cold tend to enhance the ability of subjects under the influence of alcohol to regain control of themselves. Frankenhaueser (1964) showed support for the hypothesis that mild psychological stress counteracts the detrimental effects of a moderate dose of alcohol. Support for the view that compensatory effects are mediated by arousal reactions is provided also by the analysis of individual differences in sensitivity to alcohol, which suggest that highly anxious individuals tend to have a high alcohol tolerance as determined by behavioral effects (Wallgren and Barry, 1970).

CONCLUSIONS

It may be concluded that the reason for the intoxicated person tending to overestimate his own ability and choose the risky alternative is partly a cognitive one: he underestimates the impairments caused by alcohol. Pharmacological effects have to be considered in relation to the psychosocial environment as perceived by the individual. Personality factors and other constitutional characteristics interact with situational factors in determining the response. Thus, from the point of view of behavioral science, the outstanding characteristic of the problem of drugs, alcohol, emotion, and driving is its immense complexity.

Gordon, Norman B. Influence of narcotic drugs on highway safety. Accident Analysis and Prevention, 8(1):3-7, 1976.

PURPOSE

Relatively few studies exist which assess the functional capacity of persons who use narcotics. It is estimated that there are currently over 250,000 individuals using heroin and other narcotics in the United States; in addition, the number of individuals maintained on methadone is estimated to be about 100,000. Extrapolating from figures obtained in previous studies, it can be estimated that, including legitimate drug use by methadone patients, a minimum of about 80,000 addicts currently drive. Studies on the effects of narcotic drug use on human performance relevant to automobile driving were reviewed.

SUMMARY

General studies have included: Jaffe (1970) on the effects of narcotics from a pharmacological and medical point of view, Uhr and Miller (1962) on theoretical and methodological examples relevant to the evaluation of narcotic effects, Beecher (1959) on the subjective effects of single doses of narcotics, and Forkes (1972) on information relevant to the consideration of the impact of drugs including narcotics on driving skills.

Crancer and Quiring (1968), Finkle (1969), and Brownstein et al. (1968) presented data which showed that drug abusers have poorer driving records than the general population, and that the use of drugs makes the abuse of alcohol worse. On the other hand, Waller (1965) and Moser et al. (1970) found that drug users' accident rates do not exceed those of the general population. Babst et al. (1973) studied the driving records of a sample of 440 methadone patients from New York State, and found that when drivers' ages were taken into account, accident and conviction rates during both heroin addiction and methadone treatment periods did not differ from similar rates applicable to New York City drivers in general.

Blomberg and Preusser (1972) found that neither records nor driving offenses for 1,500 methadone patients and over 1,000 contrast individuals, who were drug-free, differed. The weight of evidence from these studies is that narcotics users do not present a driving risk. Blumberg and Preusser (1972) suggested that the heroin user, conscious of the fact that an arrest for a driving offense may lead to discovery of drug use and/or possession, compensates by using greater caution while driving.

There are practically no studies which have attempted to assess the functional capacity of narcotic addicts. Wikler (1965) found that the effects of single doses of narcotics elevate reaction time; and Beecher (1959) found that the user experiences "mental clouding." In any case, no studies have been found which attempt to evaluate narcotic effects on a dose-response basis. Frazer et al. (1963) administered heroin to addict patients who volunteered for study, and found that chronic administration led patients to show pronounced tendency to retreat from all forms of activity and social contacts, and concluded that, based on clinical observations and pursuit-rotor tests, the depressant effects on activity observed during chronic heroin administration were not due to debility or to psychomotor impairment, but rather suggested a reduced responsiveness of the patient to ambient stimuli.

Using the rotary-pursuit task (Uhr and Miller, 1962) with the first methadone patients studied (Gordon et al., 1967), comparisons with nondrug-using control subjects and the same patients over a period of time did not reveal performance effects that could be ascribed to the taking of methadone. Later studies (Gordon, 1970; Gordon and Appel, 1972) showed that reaction times of methadone patients were either equal to or superior to those of the various control groups in simple and complex reaction-time experiments. More recent studies have been done on vigilance, the capacity of individuals to sustain their attention to sequences of events (analogous to the task of maintaining attention while driving long stretches of monotonous roadway). In one set of experiments (Appel and Gordon, 1974), there was some evidence of a decrement in performance for employed methadone patients. This is being investigated further in a follow-up study, as

well as in a study in which a vigilance task is being used in conjunction with electroencephalographic recordings.

CONCLUSIONS

Based on the data obtained from driver records and laboratory studies, it is clear that the use of narcotics in and of itself does not present a hazard or exist as a significant factor in automobile driving.

Hurst, Paul M. Amphetamines and driving behavior. Accident Analysis and Prevention, 8:9-13. 1976.

PURPOSE

Currently, amphetamine and most of its relatives are placed on Schedule II of the 1968 Drug Control Act, a listing that includes the most abuse-prone substances for which legitimate medical purposes are recognized in the U.S. In order to determine the relationship between amphetamines and driving behavior, a review of the literature was undertaken.

SUMMARY

In relating any drug to driving behavior, the primary issue is whether the drug has an effect on accident hazard. To assess a drug's contribution to highway losses, the classical method has been to compare the prevalence of the drug in crashed drivers with its prevalence in the driver population at risk. With amphetamines, there is very little data; consequently, there has never been a representative drug screening in nonfatally crashed drivers. Without epidemiological data, the only thing to be done is to try to make some inferences based on laboratory studies.

The major acute effects of amphetamines in the normal clinical dose range is that they do not impair performance, but rather enhance it. The lone negative influence relating to driver behavior is the tendency for subjects to take greater risks (Hurst, 1962) or to overestimate their performances (Smith and Beecher, 1964; Hurst et al., 1967). Consideration must be given to whether or not the acute use of amphetamines adds to or detracts from the impairment due to alcohol. Newman and Newman (1956) found no consistent effects of prior medication on the blood alcohol concentrations at which failure occurred on tests of balance. Hughes and Forney (1964) also found no evidence that amphetamines either enhanced performance or antagonized the impairment produced by alcohol in a series of reading and arithmetical tasks. Brown et al. (1966) found that amphetamine had no effect on pursuit meter performance after alcohol. However, Kaplan et al. (1966) reported that amphetamine temporarily alleviated the impairment in reading and arithmetical performance produced by alcohol, and by itself had a significant positive effect. Bernstein et al. (1966) reported that amphetamine overcame the optokinetic nystagmus effect produced by alcohol. Finally, Wilson et al. (1966) found that amphetamine antagonized the decrement produced by alcohol in coding, mental addition, and trail-making. In summary, amphetamines mitigated alcohol impairment of some, but not all, of the functions tested.

CONCLUSIONS

To assess the role of a drug in traffic accidents without adequate epidemiological data requires conjecture. If the role of a drug in accidents is not known, what is known about the drug and what is known about accidents must be considered and combined.

Kielholz, P. Alcohol, drugs, and driving behaviour in Switzerland. In: Israelstam, S., and Lambert, S., eds. Alcohol, Drugs, and Traffic Safety. Proceedings of the Sixth International Conference on Alcohol, Drugs, and Traffic Safety. Toronto, September 8-13, 1974. Toronto, Canada: Addiction Research Foundation of Ontario, 1975. pp. 395-397.

PURPOSE

A review of studies conducted in Switzerland on the effect of alcohol and drugs on driving was undertaken.

SUMMARY

A survey of 14 hospitals located in seven different parts of Switzerland, undertaken by the Swiss Commission Against Alcoholism, indicated that 35.2% of a total of 1,030 hospitalized persons injured in traffic accidents were found to be under the influence of alcohol. Bicycle and motorcycle accident victims were more often under the influence of alcohol (43% and 44%, respectively) than were motorists (40%) and pedestrians and co-drivers (26%). Precise statistical evaluation concerning the frequency of driving under the effect of medication was not available. However, in a series of tests of 6,200 road accident victims carried out by Forney (1973), 4% were found to have centrally stimulating prescription drugs in their blood and urine. Overall, statistics clearly showed that alcohol was the most common intoxicant involved in road accidents (8 to 1 ratio).

As to the effect of drugs on driving, it was determined that psychotropics can impair driving capacity by: (1) having a direct influence on driving capacity through sleepiness, numbness, and neurological side effects; (2) altering the personality through acute or chronic intoxication, or through abstinence after states of drug dependence; and (3) intensifying the effects of alcohol. Psychotropic drugs, especially neuroleptics, antidepressants, and tranquilizers, ordinarily have an impairing effect on driving ability only in the beginning (the first 10 to 14 days), after which driving ability improves because of the adaptation of the user to the drug effects. The main danger of the psychotropic drugs is not their own effect but their intensifying effect on alcohol.

Kleinknecht, Ronald A., and Donaldson, David. A review of the effects of diazepam on cognitive and psychomotor performance. Journal of Nervous and Mental Disease, 161(6):399-414, 1975.

PURPOSE

Diazepam (Valium) has become an increasingly popular drug in the treatment of various physical and emotional disorders. There are several reasons for the popularity and wide appeal of the drug; it has been found effective in a wide array of medical and psychiatric disorders. Among these, its most prevalent use is as an antianxiety agent. Another reason for its wide appeal is its reported relative absence of adverse side effects. Compared with similar drugs, diazepam produces less drowsiness, and it has no overdose potential; tolerance, abuse, and abstinence syndromes are rare. Despite its wide use, only in the past 4 to 5 years have extensive controlled human performance studies been conducted in a systematic fashion. A review of the literature was undertaken in order to describe the findings concerning effects of diazepam on various psychological and psychomotor functions, to identify those areas in which more research is needed to clarify effects, and to discuss methodological problems that need to be dealt with before a clear and full picture of the range of the effects of diazepam on human performance can be known.

SUMMARY

Drug Effects on Test Performance

Two types of performance measures--simple reaction time and tapping speed--have assessed simple reflex-like reactions uncomplicated by decision-making or coordination involving large muscle movements. Simple reaction-time tests have assessed the speed of response to either an auditory or a visual stimulus. In both cases, it appears that diazepam has little or no effect. Tapping speed, assessed by the number of times a subject presses a hand counter during a given time unit, appears to be related to functions of reflexive speed. Diazepam again does not appear to affect tapping speed.

Critical flicker fusion threshold (CFF) is related to the excitability of the central nervous system (CNS), such that drugs which depress CNS function are associated with lowered thresholds, while stimulants raise the threshold. Several studies have assessed the effect of diazepam on CFF and all have found significant decrements in threshold. Haffner et al. (1973) administered 10 mg and 20 mg of diazepam orally and found significant depressions of CFF at 2 hr 20 min, and 5 hr following ingestion of the drug. Auditory flutter fusion threshold (AFF) was used by Healy et al. (1970) to assess recovery time from diazepam in dental clinic patients. It was found that as long as 2½ hours were required for some patients to return to their predrug AFF levels following a 0.2 mg/kg intravenous injection.

Regarding decision-making tests, Haffner et al. (1973) and Morland et al. (1974) used a sorting task in which subjects were required to place wooden tablets into holes on the basis of color. To add an element of stress, orders to sort were presented with increasing speed. No decrement was found after administration of 10 mg of the drug; there was a significant decrement after 20 mg, but this only occurred 1½ hours after administration and not at 4 hr and 10 min. On choice-reaction time, there has been some evidence of slower reactions after taking diazepam, and although not totally clear from the studies surveyed, there appears to be a dose-related trend emerging in the affecting of decision-making performance. Three studies using 10 mg found no effects, while two using 20 mg did show effects.

To determine the drug's effects on learning and memory, Clarke et al. (1970) used 0.24 mg/kg of intravenous diazepam, and asked subjects to read lists and later to recall and recognize the words they had read. Subjects showed significant impairment in both recall and recognition compared with a placebo control group. Unfortunately, conclusions concerning the effects of diazepam on learning and memory must remain speculative due to the small number of studies undertaken and the dissimilarity of tasks investigated so far.

The ability to sustain concentration or attention has been assessed by letter cancellation and digit symbol substitution. In five studies of letter cancellation, the number of cancellations attempted or completed was significantly reduced, whereas no significant decrement was found for errors. The digit symbol substitution test, taken from the Wechsler Adult Intelligence Scale, was presented in three of the reviewed studies; there was no clear effect of diazepam in the test, although an effect trend was noted.

Motor skill tasks and tracing have been used to test perceptual motor performance. Three types of tracing--maze tracing, mirror tracing, and dot tracing--have been assessed. Haffner et al. (1973) and Morland et al. (1974) used a mirror-tracing task. In the Haffner study, subjects receiving 10 mg took a significantly longer time to complete the test but were not different from control subjects in number of errors. Morland's subjects with the same dose also took longer to complete the tracing. Other tracing studies confirm these results. On motor skill tasks, three studies used auto driving simulators, and their results are conflicting. Linnoila and Hakkinen (1974) reported a decrement in driving ability, while Milner and Landauer (1973) and Dureman and Norrman (1975) found no decrement.

A frequently observed effect of diazepam is that the user tends to underestimate the passage of time. Perhaps related to the time-estimation deficit is a potentially more hazardous effect noted by several investigators: subjects taking diazepam are apparently unable to assess accurately their level of impairment, and therefore cannot compensate for induced performance deficits.

Regarding the combination of alcohol and diazepam, it appears that, for the most part, alcohol and diazepam taken together result in performance decrements greater than either drug taken alone; often an additive effect is seen, and occasionally a potentiative effect is reported.

Methodological Considerations

Several methodological variations need to be introduced into research designs in order that the multitudinous, complex, and interactive effects of diazepam can be more fully comprehended. Such variables as age, sex, personality, and population characteristics need to be controlled. For example, most drug experimenters seem to be at least superficially cognizant that sex is a potentially important subject variable, however few use it in the analyses of their data. Out of 17 perceptual-motor effects studies reviewed, 10 had no females, and in the remaining 7, the sample population was 79% male and 21% female. This disproportionate use of males to test drug effects is even more disconcerting in light of the fact that significant sex differences were found in response to diazepam in the one study that adequately analyzed its data (Jaattela et al., 1971).

In addition, although diazepam is typically given only to medical, psychiatric, or dental patients, 17 of 23 studies reviewed used young, "normal," healthy volunteer subjects, primarily male. Another factor which limits the extent of generality of the reviewed studies is the length of time the subject has been taking the drug. Using nonclinical populations, most researchers give subjects either a single dose or multiple doses over a short period of 2 to 3 days before testing for drug effects. They may not be comparable to clinic patients taking diazepam for several weeks. The long-term effect of diazepam on psychomotor and cognitive functions has not been evaluated in clinical patients. The only way to solve this problem is to extend the range of subjects to include clinic patients, and test them before taking diazepam, at periodic intervals while on the drug, and after termination.

Moskowitz, Herbert. Validity of driving simulator studies for predicting drug effects in real driving situations. In: Israelstam, S., and Lambert, S., eds. Alcohol, Drugs, and Traffic Safety. Proceedings of the Sixth International Conference on Alcohol, Drugs, and Traffic Safety. Toronto, September 8-13, 1974. Toronto, Canada: Addiction Research Foundation of Ontario, 1975. pp. 295-304.

PURPOSE

Investigators have used two alternate methods to investigate the influence of drugs and their impairment of skills related to driving. One is to use driving simulators, and the other is to use real cars in a closed driving course with curtailed traffic. Driving simulators have generally been chosen because: (1) an impoverished environment removes opportunities to study the effects of drugs upon perception; (2) the simulator is more capable of ensuring replication of exactly the same stimulus presentation to all subjects; and (3) instrumentation is easier for simulators than for cars. The survey described here examined the validity of driving simulator studies for predicting drug effects in real driving situations.

SUMMARY

A simulator must meet certain requirements in order for it to be an adequate research tool for the study of drug/driving interactions. Demands placed upon the subject must include behavioral elements which are required for driving and which have the potential to be affected by the drug under investigation. Also, it is necessary to analyze driving systematically in order to describe and enumerate all the major components of the driving task in their proper proportions. Finally, the performance of subjects in the simulator must be correlated with their performance in typical traffic situations on the road.

It appears impossible to build the ideal all-purpose research simulator. Not only is it impossible to specify all the features it should have; it is also technically impossible to create the features that are obviously necessary. Therefore, it can be concluded that all current simulators sample only a restricted range of the possible behavioral demands met on the road. This limits the conclusions to be drawn from the presence or absence of any drug/performance interaction found in a given simulator. Thus, when examining the reliability and validity of drug simulator studies, it is necessary first to understand the specific behavioral demands of the simulator used and, second, to compare drug/performance changes in the simulator with the nature of drug-involved accidents.

Only sparse visual elements are presented by many simulators used in drug research. For example, the study by Landauer et al. (1969) investigating alcohol and amitriptyline, and the study by Binder (1971) investigating marihuana and alcohol, required the subject to respond simultaneously to a subsidiary task while performing the primary pursuit-tracking task. In contrast, Buikhuisen and Jongman (1972) studied the effects of alcohol on performance in a simulator which required no measurable motor response. There is no existing simulator by which a subject can be tested under the influence of a drug accurately enough for it to be concluded that if there is no change in performance as compared to placebo condition, there will be no effect upon actual driving.

No simulator samples all stimulus inputs and demand characteristics of driving. A drug might be potentially detrimental to some behavioral mechanism not required in the simulator. On the positive side, since simulators do sample a restricted subset of behaviors, the potential drug effects on a behavioral subset in actual road conditions can be generalized to the extent that the subset can be specified. It should be noted that to speak of a subset of behaviors is not necessarily to refer to the specific response measures of a simulator; drug impairment of a behavioral mechanism such as vigilance could be reflected in performance decrements on many simulator measures--from frequency of steering wheel reversals to brake pressure. Moskowitz (1971) reported two studies on the effects of approximately 0.10% blood alcohol concentration (BAC) on performance in the UCLA film simulator. The subject's responses permit the derivation of 25 performance measures of car control and tracking. Only by specifying precisely what the simulator is testing --that is, what behaviors are required for performance in that particular simulator--can the validity of those simulator measures for driving performance on the road be investigated.

An alternate approach to these simulator and other laboratory studies is to utilize categories suggested by Stephens and Michaels (1963), who concluded that driving could be initially and broadly categorized into a compensatory tracking task, an environmental search and recognition task, and a joint time-sharing system for performing the two tasks. Using these categories, Moskowitz (1973) noted that most experimental studies either of compensatory tracking or of visual search and detection tasks, when undertaken in isolation, showed little impairment until beyond a BAC of 0.20%. However, both these task systems showed impairment when subjects were required to perform two or more tasks concurrently. The brain's capacity to handle two tasks simultaneously appears to be the most susceptible to impairment by alcohol. Investigators conducting simulator studies using alcohol have agreed that performance is impaired at low-to-moderate BAC's (Newman and Fletcher, 1940; Asknes, 1954; Loomis and West, 1958; and Von Wright and Mikkonen, 1970).

There is considerable agreement among simulator studies when the emphasis of the analysis is upon the psychological function affected by the drug, rather than upon the response variable in which the particular psychological function is exhibited. Thus, to examine the issue of the validity or relevance of the results in the simulator, one must first isolate the behavioral functions that are being affected by the drugs. One criterion for validation of the simulator would be data describing the nature of the accidents of persons under the influence of drugs. In a study of 10 accidents involving the presence of alcohol (Clayton, 1972), 6 were ascribed to either misperception or failure to look, 2 to excessive speed, and 2 to decision errors. In the simulator studies noted here, when subjects were unable to maintain performance on both tracking and visual search and recognition tasks, it was the visual task which suffered the larger performance decrement, agreeing with this study of on-site accident causation. While there is little validating data from either on-site accident studies or experimental field studies, what data there is conforms to conclusions regarding the nature of alcohol impairment drawn from studies done in simulators.

After alcohol, the most examined drug in simulators is probably marihuana. Three simulators have been used to examine visual detection and recognition, while two others have been used to examine risk-taking. There is considerable agreement or reliability in regard to the effects of marihuana: the studies of Crancer et al. (1969), Moskowitz et al. (1973), and Rafaelsen et al. (1973) examined attention or perceptual functioning, and found impairment by marihuana. The Moskowitz and Rafaelsen studies also examined tracking and car control performance, and found no impairment. Studies by Dott (1972) and Ellingstad et al. (1973) examined risk-taking performance, and found no impairment. Again it should be noted that the agreement is in respect to behavioral functions involved in the drug effect, not a general agreement across simulators. There is no means by which the validity of the results can be assessed, since there has been no reported analysis of the types of accidents associated with marihuana use. While other drugs have been examined in conjunction with driving simulators, there appears to be insufficient data to permit determination of simulator reliability, much less validity.

CONCLUSIONS

In general, in regard to the behavioral aspects being examined via the use of specific simulators, the results appear reliable for these functions across simulators. The validation process for simulator studies of drugs can only refer to the specific behavioral aspects under study; this requires analysis of the nature of driving accidents under that drug in comparison with the behaviors revealed by the simulators. These conclusions suggest that simulators are of value in the study of drug/driving interactions. However, such studies require an understanding of the character of the behavioral demands of the specific simulator under examination, and of how these behavioral demands are reflected in actual driving situations.

Sharma, Satanand. Barbiturates and driving. Accident Analysis and Prevention, 8:27-31, 1976.

PURPOSE

Barbiturates are among the most widely used mood-modifying drugs. Survey findings have shown that 4.4% of the population between 18 and 74 years use barbiturates, and that about 12% of high school students and 17% to 19% of college students use barbiturates. A review was made of the relationship between barbiturate use and traffic accidents as assessed by epidemiological studies, and of the effects of barbiturates on driving-related skills as assessed by laboratory experiments.

SUMMARY

Smart et al. (1969) concluded from their observations that fewer traffic accidents were indicated in barbiturate users, although the sample size was small. A California Highway Patrol study (1967) estimated that 9% of 772 victims of single-vehicle crashes showed the presence of barbiturates or tranquilizers; Turk et al. (1974) found 2.5% of single-car crash operators having a positive incidence of barbiturates. Briglia (1966) estimated a 9.3% incidence of barbiturates in multiple-car crashes. Other studies showed variance in estimates of barbiturate involvement in traffic accidents to lesser degrees.

Motor control, perception, and information processing play substantial roles in driving. Dickins et al. (1965) report that barbiturate use degrades motor control. Simple reaction time also shows deterioration under barbiturates (Goodnow et al., 1951; Goldstein et al., 1960). Tasks requiring visual-motor coordination performance have shown impairment under barbiturates (Dickins et al., 1965), and barbiturates have affected arithmetic computation (Goldstein et al., 1960). Oculomotor functions have been shown to be affected by barbiturates (Bergman et al., 1952; Westheimer and Rashbass, 1961; Rashbass, 1959).

Vehicle-handling tests have indicated that men increased their failures in gap estimations under sodium amytal, and women decreased their distances from the curb in the parking test, but increased their success in gap-estimation (Betts et al., 1972). Simulated driving skills have also shown impairment under barbiturates (Loomis and West, 1957).

There is evidence that the combined use of alcohol and barbiturates produces a greater hazard for driving than the single use of either drug. A survey of traffic accidents (Turk et al., 1974) found 3% of pedestrian fatalities and 2.5% of operators involved in fatal single-auto crashes had both alcohol and barbiturate involvement. The consensus is that the effects of alcohol are enhanced by barbiturates (Joyce et al., 1959; Smith, 1966).

CONCLUSIONS

Clearly, barbiturates degrade skills which are components of driving: reaction times increase and performance of a variety of skilled tasks are impaired, indicating that driving may be severely impaired under barbiturates. The epidemiological evidence is unclear in implicating barbiturates in traffic accidents due to methodological problems. However, the increased deterioration in driving skills under barbiturates, alcohol, or a combination of the two, indicates that driving should be avoided under their influence.

Smart, Reginald G. "The Problems of Drugs and Driving: An Overview of Current Research and Future Needs." Addiction Research Foundation, Substudy No. 685. Toronto, Canada: the Foundation, 1975. 20 pp.

PURPOSE

The effect of drugs on driving as a serious research area has a short history; only a small amount of information has been developed which would foster a radical change in the way drugs and driving are handled as social problems. Some general issues pertinent to the subject in general and to the specific areas of risk identification, behavioral measurement of impairment, legal and practical constraints, drug measurement in the body, and countermeasure development were examined.

SUMMARY

Risk Identification

Drug use often precedes driving, but it is difficult to determine the extent of it from the available literature. Milner (1969) showed that 57% of men and 35% of women on psychoactives ran the risk of drinking and driving while on psychoactives (7.1% of the total population). There are also indications that about half of the licensed cannabis users drive after smoking, but the numbers of positives in nonaccident drivers is unknown. Studies made on the rate of positive drug samples among both fatal and nonfatal drivers and victims (Nichols, 1971; Smart, 1974) indicate a close connection between the presence of both alcohol and drugs and impaired and accident drivers; they also suggest that some of the behavioral impairment assumed to be from alcohol may well be contributed by other drugs.

Most drug accident studies have screened for barbiturates and some tranquilizers, but not for the stimulants, antidepressants, or cannabinoids, partly because the tests for these substances are more difficult and less sensitive. There is no large, dependable study which has examined fatal accident drivers or victims for evidence of hallucinogenic use. Another difficult area concerns actual impairment and accident responsibility. Some people may be better drivers with than without their drugs, especially if they are prescribed. Demers and Heninger (1971) found little impairment among manic depressive patients when speed was not an important element in performance. Only one study has been made of accident rates among psychoactive drug users (Smart et al., 1969), involving a small total sample and even smaller subcategories of similar drug users. Smart (1974) indicated that cannabis users have nearly as many accidents under cannabis as under alcohol. Unfortunately, multidrug use is the norm.

Behavioral Measurement of Impairment

Many of the major psychoactive and hallucinogenic drugs have been tested for their effects on cognitive and psychomotor skills. In general, the results of research indicate that most tranquilizers, cannabinoids, antidepressants, barbiturates, and hypnotics can impair psychomotor skills involved in driving. The impairments seem greatest where alcohol is also involved and where the tasks are long or boring. There are considerable difficulties in deciding what laboratory or simulator methods are most appropriate for assessing driving risks. A larger problem is that it is not known for certain what skills are needed to produce "safe" driving or how to simulate it. Edwards et al. (1969) found almost no correspondence between simulator behavior and actual driving; however, Crancer (1968) found that simulator driving was related to accident records, with good performers having fewer accidents.

An improvement in experimental design would be to enlarge the subject pool for drug-driving studies. The tendency in most studies (e.g. Klonoff, 1974) is to use male college students or professional drivers (Linnoila and Hakkinen, 1974) or army personnel (e.g. Rafaelsen et al., 1973). Although tolerance is known to greatly affect drug impairment, most drugs and driving studies with psychoactives are done with persons receiving the drug for the first time with no opportunity to develop tolerance. Finally, very few studies have examined the "hangover" effects of drugs such as hypnotics. Walters and Lader (1971) examined the effects of nitrazepam and amylobarbitone on psychomotor and cognitive tasks after 12 hours and found considerable impairment.

Drug Measurement Methods

Currently, a vast number of techniques of analysis are undergoing study, e.g., spectrophotometric methods, gas chromatography, immumoassay methods and the like. The research problem is how to relate the presence of a drug in an accident driver or victim to his impairment. There are drugs, probably important in traffic accidents, for which there are no reliable tests (cannabis, delta-9-THC, LSD, and maltrexone). Although methods have been attempted with cannabis, none are sufficiently well developed to have practical utility (WHO, 1974).

Legal and Practical Constraints

Some of the most obvious research problems are: (1) laws frequently have not attempted a sophisticated definition of "drug," and challenges to these laws are possible; (2) there is difficulty in proving "under the influence" of a drug; (3) many drug tests require blood or urine or both, and laws compelling the surrendering of either for self-incrimination would have strong civil rights opposition; and (4) research on behavioral impairment is not sufficiently well developed to ensure that driving impairment is related to all drugs and all drug users. Also, researchers rarely have the privilege of protecting their data from subpoena, unless these privileges are specifically granted.

Countermeasures Development

Most countermeasures against driving while on drugs that do not involve legal constraint or increased enforcement would involve educational or persuasive techniques. Many of these will be school-based and established chiefly for young people. Milner (1969, 1972) has suggested that physicians give warnings about driving after drug use, not prescribe drugs for patients who are likely to drink and drive or to be accident risks, prescribe drugs only for patients with a low impairment potential, and prescribe shorter courses of therapy for some drugs. A larger question concerns the need for so much psychoactive medication; perhaps society is overmedicated. Fejer and Smart (1974) found that among users of tranquilizers, 26% had good or excellent health. The drugs and driving problem might be ameliorated by a reduction in drug prescribing, and limiting psychoactives to those who require them.

CONCLUSIONS

The major research needs are for some restriction of research to the major psychoactive and hallucinogenic drugs; more studies of the level of drugs in various nonaccident populations and among accident-involved pedestrians and passengers; more studies of the proportions of fatal and nonfatal accident drivers with opiates, antidepressants, amphetamines and cannabinoids in their system; some study of how accident responsibility relates to drug levels in drivers; more studies of behavioral impairment from drugs involving older subjects, females, patients, and less experienced drivers; the development of methods of detecting cannabis and LSD in body fluids; some experimentation with efforts to have physicians prescribe fewer psychoactive drugs or give warnings about driving after drug use; and studies of why people appear to need so many psychoactive drugs and what can be done to decrease their needs.

Weiss, Bernard, and Laties, Victor G. Enhancement of human performance by caffeine and the amphetamines. Pharmacological Reviews, 14:1-36, 1962.

PURPOSE

Although many drugs have been used in attempts to enhance performance, only caffeine and the amphetamines have been studied extensively enough to permit a fairly thorough evaluation of their effects. A review of the literature was undertaken to elicit information on the effects of these drugs on human performance. Summarized here are their effects on motor coordination and control (specifically reaction time, steadiness, and coordination), and judgment.

SUMMARY

Motor Coordination and Control

The studies included here were brought together because they involved tasks which called for relatively fine motor adjustments rather than gross muscular effort and endurance. Unfortunately, much of the evidence presented is variable and contradictory, and few consistencies emerge. This situation is partly attributable to the neglect in many experiments of the crucial role played by slight variations in method, and by the fact that the interaction of performance parameters and dose level is rarely assessed. Without this information, conclusions must be regarded as provisional.

The effects of caffeine on reaction time are in dispute. Cheney (1935, 1936) found that discriminative reaction time to a series of lights reduced by 4% after ingestion of coffee (1 cup) and 8% after ingestion of caffeine (180 mg two hours before the test). Horst and Jenkins (1935) reported a decrease in simple reaction time after ingestion of 3 or 4 mg of caffeine/kg, as did Gilliland and Nelson (1939). In contrast, lengthened reaction time after caffeine was reported by Hollingworth (1912), Schilling (1921), and Hawk (1929). The most thorough of the studies was done by Hollingworth, who found a dose-related effect on reaction time: smaller amounts of alkaloidal caffeine (60 to 240 mg) produced longer reaction times than did placebo.

Caffeine appears to have little effect on the increase in reaction time produced by certain doses of alcohol. Carpenter (1959) administered alcohol in doses of 0, 0.4, and 0.8 ml/kg to nine subjects. Capsules containing placebo, 1.47 mg caffeine/kg, or 2.94 mg caffeine/kg were ingested at the beginning of a 15-minute drinking period. Reaction time tests began 30 minutes after ingestion of capsules, and continued at 10-minute intervals until 80 minutes after ingestion. Alcohol increased reaction time in proportion to dose level. Caffeine had no overall effect on reaction time. The data also suggested that caffeine lowered reaction time at the higher doses of alcohol when a high-intensity visual stimulus was used.

The effects of amphetamines are somewhat more consistent. Several studies using nonfatigued subjects indicated a decrease in reaction time after ingestion of d-amphetamine. The effect was also seen in fatigued subjects (Kornetsky et al., 1959; Seashore and Ivy, 1953; Tyler, 1947).

In steadiness tests, caffeine seems to impair the ability to maintain one's arm in one position without tremor, while amphetamines seem to improve such ability slightly. Hollingworth (1912), for example, who required his subjects to hold a metal stylus in a hole without touching the sides, observed a pronounced unsteadiness that reached its peak about 3 to 4 hours after the administration of 360 mg of caffeine. Seashore and Ivy (1953) found a significant improvement in arm-hand tremor and sway using 10 mg of amphetamine or 5 mg of methamphetamine.

The data available on coordination indicate that amphetamines can improve this kind of performance, with positive results more likely to appear when the task is complex rather than simple. For example, in a simple finger-tapping test, Adler et al. (1950) produced no significant change in tapping rate with amphetamine, d-amphetamine, or methamphetamine. However, in a more complex task called tracking (subjects follow a moving target or compensate for movement of a target), Eysenck et al. (1957) found that 10 mg of d-amphetamine produced a considerable increase in time-on-target score relative to placebo. Using a simulated automobile device, Graf (1950) gave his

subjects a series of tests every two hours, starting at 6 p.m. and continuing until noon of the following day. Drug preparations (6 mg of methamphetamine or 200 mg of caffeine) were administered at 1 a.m. A maximal effect was indicated 3 hours after administration, with methamphetamine producing a greater and more prolonged effect than caffeine. There are also reports in the literature of attempts with amphetamine or caffeine to combat the motor deterioration produced by sufficiently high doses of alcohol. Rutenfranz and Jansen (1959) studied the effects of ethyl alcohol in doses of 0.5 g/kg and 1 g/kg in two subjects working on a task which simulated automobile driving. The performance decrement produced by the lower dose of alcohol was only partly counteracted by 200 mg of caffeine, but completely counteracted by 9 mg of methamphetamine.

Judgment

Judgment is defined as the appropriateness of behavior to the environment. There has been little research on the subject in relation to drug effects, and existing research deals with amphetamines only. Most studies do not report any decrement in judgment after administration of amphetamines. For example, Winfield (n.d.), in his study of RAF bomber crews on combat missions, reported that no evidence of recklessness or lack of judgment was apparent after 10 or 15 mg of amphetamine. Hauty and Payne (1957) found that the ability of a subject to predict his future performance on the Air Force SAM Pursuit Confusion Task was not affected by 5 mg of d-amphetamine. Some studies do indicate a mild time-distortion effect, however. Dews and Morse (1958), for example, required subjects to space successive key-presses a certain minimum length of time apart in order to win money. The subjects tended to press slightly earlier when they worked 30 minutes after an oral dose of 5 mg of d-amphetamine.

CONCLUSIONS

The foregoing evidence indicates that a wide range of behavior can be enhanced by caffeine and the amphetamines. Moreover, the superiority of the amphetamines over caffeine is unquestionable. Two questions are implicit in these conclusions: (1) How do these drugs enhance performance; can they actually produce superior performance or do they merely restore performance degraded by fatigue, boredom, and so on? (2) What is the "cost" of obtaining this enhancement; is it great enough to prohibit the practical use of these agents, particularly the amphetamines? Further study is needed to answer these questions.

Zylman, Richard. Mass arrests for impaired driving may not prevent traffic deaths. In: Israelstam, S., and Lambert, S., eds. Alcohol, Drugs, and Traffic Safety. Proceedings of the Sixth International Conference on Alcohol, Drugs, and Traffic Safety. Toronto, September 8-13, 1974. Toronto, Canada: Addiction Research Foundation, of Ontario, 1975. pp. 225-237.

PURPOSE

Every nation continues to be plagued by people who abuse alcohol and then drive. In spite of costly and increasingly sophisticated countermeasure programs, and in spite of massive numbers of arrests for alcohol-related offenses, impaired or intoxicated driving is reported as a factor in almost half of all traffic deaths in the United States. A review of the literature on the subject is presented here in an attempt to determine why mass arrests for impaired driving are not preventing traffic deaths.

SUMMARY

One reason for the difficulty in measuring progress in the prevention of alcohol-related traffic deaths is that the problem has been poorly defined. Statements to the effect that alcohol is involved in 50% of all traffic deaths are usually based on incomplete and biased data (Zylman, 1974), and refer in part to accidents involving blood alcohol concentration (BAC) levels which have been shown by epidemiological study not to have a causal relationship to crash involvement (Zylman, 1972). It is widely believed that fatal crashes are part of a continuum that includes minor collisions. This belief is expressed in the widespread use of the curve from the Grand Rapids Study (1974), which indicated that the probability of causing a collision at 60 mg/100 ml BAC is twice what it would be if one had not been drinking; at 80 mg/100 ml, four times as great; at 100 mg/100 ml, six or seven times as great; and at 150 mg/ml, or more, 25 times as great. The probability curve is based on collisions in general. Actually, in fatal crashes, about 44% of all drivers killed have a BAC of 100 mg/100 ml or more (Brenner and Selzer, 1969). For this and other reasons, fatal crashes should be considered as being quite different from collisions in general and probably require different countermeasures.

It has become popular to blame fatal crashes on "problem drinkers." This is true if the term is expanded to include all those whose excessive drinking results in auto crashes; however, it is usually used in reference to alcoholics. It is easy enough to cite a number of studies showing that alcoholics as a group are involved in more collisions than nonalcoholics, and are arrested more often for driving while intoxicated (DWI) and for other related offenses. However, not all alcoholics drive, and not all the alcoholics who do drive do so while drunk. Not all alcoholics are dangerous, and not all alcoholics have long records of collision involvement and police contacts. Filkins et al. (1970) studied 1,247 hospitalized alcoholics known to be drivers, and found that 86% had not been involved in more than one collision in the six-year study period; 83% had neither a DWI charge nor more than one driving conviction in that period. Selzer et al. (1963) studied 50 alcoholics and found that the majority had not been involved in more than two collisions in their lifetimes. Recalculation of data presented by Schmidt and Smart (1959) reveals that among 98 alcoholics known to be drivers, there were only 79 reported collisions over a 12-year period, an average of less than one collision every 12 years for each alcoholic. Regardless of which study is considered, it is clear that the majority of alcoholic drivers are not involved in serious crashes.

It is popular to point to youth as comprising a large portion of all drinking drivers in fatal crashes, but this appraisal should be used with caution. It has been found repeatedly that the drinking and driving habits and crash involvement of young drivers 20-24 years old are very different from those who are even younger (Pelz and Schuman, 1973; Pelz et al., 1975; Zylman, 1973). Pelz et al. (1975) made it clear that it is not alcohol per se that leads to crashes, but rather alcohol in combination with other characteristics. It is becoming increasingly evident that not all drivers arrested for DWI are "killer drunks." Also, those who are arrested after being involved in collisions are generally involved in only minor collisions resulting from miscalculation, e.g., low speed rear-end collisions, sideswipes, and clipping parked cars. In contrast, those involved in fatal crashes have frequently been driving at high speed, and retrospective studies indicate that many of them have endured traumatic or extraordinary emotional experiences prior to the crash, or that they displayed symptoms of mental aberration (Brown et al., 1961; Selzer et al., 1968). This is only one reason to suspect that the "wrong drunks" are being arrested;

another is that so few of them act like "killer drunks." They apparently do not become involved in serious crashes. Filkins et al. (1970) and Perrine et al. (1971) found substantial similarities between drivers who were killed with high BAC's and those who were arrested for DWI; however, there are also important differences: fatality drivers were generally younger, of higher socioeconomic status, less likely to have prior arrest records, and had fewer prior collisions. Thomas and Chang (1970) compared the records of drivers who died after crashes, and found, even between these presumably similar groups, highly significant differences.

In the United States, 29 areas were selected for concentrated, community-centered, federally funded Alcohol Safety Action Programs (ASAP's) to combat drinking to excess before driving. In general, these projects involved special training for police, prosecutors, judges, and community leaders, as well as widespread public education programs. Zador (1974) evaluated the effectiveness of these programs on the basis of comparable areas used as controls, and refutes even minimal claims for success. Although it has traditionally been believed that massive numbers of arrests will lead to fewer alcohol-related fatal crashes, this belief is not substantiated by data from the ASAP sites. The opposite of traditional expectation actually occurred: the best reduction in nighttime fatal crashes was recorded in communities where enforcement was increased the least and, conversely, there was an increase in the number of such crashes where the number of alcohol-related arrests had increased the most (from 370% to more than 3000%). The authors of the official evaluation report (U.S. Dept. of Transportation, 1974) were correct: there was no evidence of a positive relationship between alcohol-related arrest activity and a decrease in nighttime fatal crashes.

CONCLUSIONS

Under the circumstances described, the logic for placing "the highest priority on increasing the arrest rate" must be questioned; there is no evidence that such increased arrests will prevent traffic deaths. The evidence suggests that more emphasis should be placed on the dissimilarities between drivers convicted of DWI and those who are killed with high BAC's rather than on the similarities. Continued emphasis on the similarities between those groups will only serve to encourage the continuation of present policies. Emphasis on dissimilarities may provide clues to why the present system is not working. This new perspective on the fatal crash problem should aid in the identification not only of high-risk drinking drivers, but also of high-risk non-drinking drivers. Real progress can be expected to occur only after the problem is more clearly defined and countermeasures specifically applied.

Epidemiological Studies

Babst, Dean V.; Inciardi, J.I.; Raeder, P.K., Jr.; and Negri, D.B. Driving records of heroin addicts. In: National Academy of Sciences. Committee on Problems of Drug Dependence, 1970. Report of the Thirty-Second Meeting, February 16, 17, 18, Washington, D.C. Washington, D.C.: the Academy, 1970. pp. 6514-6522.

DRUG	Opiates
SAMPLE SIZE	1,245
SAMPLE TYPE	Heroin Addicts
AGE	Adults
SEX	1,226 Male; 19 Female
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	New York
METHODOLOGY	Statistical Survey
DATA COLLECTION INSTRUMENT	Driver Records
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	6

PURPOSE

Despite the growing need for information on drug abuse and highway safety, almost none exists. Because of this vacuum of information, New York's Governor Rockefeller issued a Special Traffic Safety Message, which directed that a study be done on the problem of drivers under the influence of drugs. The study, conducted by the Department of Motor Vehicles and the Narcotic Addiction Control Commission, addressed two major areas of concern: (1) the effectiveness of current laws governing the arrest and prosecution of persons whose driving ability is impaired by the use of drugs; and (2) the size of the problem, and whether there is evidence that drug impairment is a factor in highway safety.

METHODOLOGY

In order to analyze the accident and violation record of known heroin addicts, 6,076 certified admissions to the Narcotic Addiction Control Commission (NACC) from April 1, 1967, to March 31, 1969, were matched against the 11 million records in the Department of Motor Vehicle's license file. This match produced a list of 1,226 men and 19 women with driver records. For each match, an abstract of driving record was produced including the name, birth date, most recent address, and sex of the operator, as well as a record of each accident or conviction for a violation. Also recorded was the type of license held by the driver, if any, and the date of the accident or violation.

RESULTS

Of the 1,245 heroin addicts with a driver's license or a driving record, 77% had one or more accidents or convictions for violations. In contrast, about 20% of the drivers in New York State

had accidents or convictions on their record. The 1,226 males had nearly 4,500 accidents and convictions, an average of nearly four per addict. Nearly 2,000 of the accidents and convictions were committed by 154 of the addicts who had a record of nine or more.

On an overall basis, it was found that the 1,226 males were responsible for at least 608 separate accidents. Of these accidents, two-thirds involved injury or death. One of the most striking findings was that none of the convictions was for driving while using drugs, and very few addicts were convicted of driving while intoxicated. The largest single violation on the records of heroin addicts was "failure to answer summons," followed by judgmental violations (failure to stop, yield, or obey traffic devices, etc.), and speeding.

Failure to answer summons was the violation group must closely related to age. The younger the addicts, the higher the percentage who failed to answer a summons. The percentage involved in accidents resulting in injury or death was about the same for all age groups.

Regarding the female addicts, 14 of the 19 women had been involved in an accident or convicted of a violation. The women's driving record was not as serious as the men's; they had a total of 27 accidents and convictions, or less than two per woman. Of the total accidents, only 4 involved injury or death.

CONCLUSIONS

The data indicate that heroin addicts have manifested poor driving records; yet at the same time, none of these have been convicted of driving while under the influence of drugs. This finding would suggest that the tendency towards poor driving may not be a result of the physical effects of drugs but rather a symptom of other problems. Similarly, the above observation suggests that the presence of drugs is difficult to detect in a driver; hence, a mode of detecting drug use needs to be developed for the use of enforcement officers.

Babst, Dean V.; Newman, Sandra; Gordon, Norman; and Warner, Alan. Driving records of methadone maintenance patients in New York State. Journal of Drug Issues, 3(4):285-292, Fall 1973.

DRUG	Methadone
SAMPLE SIZE	630
SAMPLE TYPE	General Population; Treatment (inpatient)
AGE	Adults
SEX	Both Sexes
ETHNICITY	White; Other
GEOGRAPHICAL AREA	New York, New York
METHODOLOGY	Statistical Survey
DATA COLLECTION INSTRUMENT	Driving Records
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	10

PURPOSE

Methadone maintenance is growing in use as a treatment modality for heroin addicts, and acceptance of such patients into the mainstream of life is partially dependent upon the public's awareness of their ability to function normally and safely while medicated. Furthermore, a key factor in employability--and, thus, continuing rehabilitative improvement--for many such patients lies in obtaining a driver's license and automobile insurance. The driving records of former heroin addicts who had been admitted to methadone maintenance treatment programs were examined.

METHODOLOGY

A list of patients was obtained from a New York Methadone Maintenance Treatment Program. All patients in this program were volunteers, and generally met the following criteria: (1) were 21 years of age or older; (2) had been primarily addicted to heroin or an opiate drug without continuous patterns of mixed drug abuse; (3) had used heroin for at least four years or more; (4) had unsuccessfully attempted alternative means of treatment; and (5) were free of clinically evident symptoms of mental illness or other serious diseases. In selecting patients for study, all new admissions from the onset of the program in 1965 were taken. No patient admitted after September 15, 1969, was included; this was to insure that all persons had spent at least 6 months in the program at the time of data collection (allowing for the six-week detoxification period and some time afterwards for adjusting to the program). The admissions used for the driving record search were very similar to all admissions in terms of sex, ethnicity, and age composition.

The 1,576 cases in the study group were matched against the 11 million driving records in the New York State Department of Motor Vehicles files, this match producing driving records for 448

(28%) of the patients under study. The cases for whom driving records were found were different from the regular admissions to the methadone maintenance program. Those with records were 95% male (vs. 84% of the total study group), 66% white (vs. 42%), and tended to be younger. To assess more accurately the driving records of the patients, their records were compared with a sample of 182 New York City male drivers drawn from the New York State Department of Motor Vehicles 1966-1970 applicants' file.

RESULTS

Accident and Conviction Rate

In order to make meaningful comparisons, an accident and conviction rate was computed for each driver (a rate of .33 would indicate the equivalent of 1 accident or conviction every 3 years). All rates were based on the five-year period from January 1965 through December 1969. It was found that accident and conviction rates within each age group were fairly similar both "before" and "during" treatment. In the six comparisons with New York City drivers, only the rate difference for 25- to 29-year-olds between the methadone-treated and the New York samples was statistically significant at the .05 level, with methadone patients having a .48 rate and New York drivers having a .23 rate. Although there were not enough females to allow testing for significance, rates of arrest and conviction were slightly lower for females while on methadone (25 years or older, .08; 24 years or younger, .25) than before admission to the program (.12 and .44, respectively).

Most Serious Accidents or Convictions

For most serious accidents or convictions, the methadone maintenance patients' accident and conviction records were no more serious than those for the sample of New York City drivers. The percentage in each accident and conviction category considered was about the same for both groups. Patient records compared to sample records showed, respectively: accident (injury or death), 44.3% and 47.8%; accident (others), 10.7% and 10%; speeding, 10.3% and 12.2%; unlicensed operator, 9.6% and 3.3%; judgmental violations, 7.7% and 6.7%; and all others, 17.4% and 20%. Seriousness of record before and during treatment was similar.

Other Studies

A study using a random sample of methadone maintenance patients drawn from the present study group (Gordon, 1973) suggested that these patients, like anyone else, may have worse driving records than those of people with fewer problems. In a California study (Waller, 1965), a finding somewhat similar to that for New York State was obtained. Another major study of the driving records of methadone maintenance patients in New York State (Blomberg and Preusser, 1972) showed that patients, while in the program, were not involved in any more accidents of any type than the comparison group, and the rate compared favorably with that for all New York drivers of similar age and sex.

CONCLUSIONS

As an epidemiological study, based on official records, this study has many limitations. Since it is not a laboratory experiment, there is no direct test of driving ability under drug influence and, therefore, no control for many factors. Waller (1971) expressed the need for both laboratory and epidemiological studies on the relation between drugs and highway safety, and, as such, this epidemiological study adds to this limited but growing body of knowledge.

Blomberg, Richard D., and Preusser, David F. Narcotic use and driving behavior. Accident Analysis and Prevention, 6:23-32, 1974.

DRUG	Opiates; Methadone
SAMPLE SIZE	1,562 Experimentals; 1,059 Controls
SAMPLE TYPE	Treatment (outpatient); Peers
AGE	Adults (mean 27.1)
SEX	89% Male; 11% Female
ETHNICITY	61% White
GEOGRAPHICAL AREA	New York
METHODOLOGY	Exploratory/Survey
DATA COLLECTION INSTRUMENT	Interviews; Questionnaire; Official Records
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	5

PURPOSE

Methadone maintenance is becoming an increasingly widespread treatment method for individuals addicted to narcotic drugs. An essential part of the rehabilitative process is finding productive employment for methadone patients. Since these individuals are not generally skilled, jobs involving driving represent a major potential source of employment. However, the relationship between the use of illegal narcotics (e.g., heroin) or therapeutic narcotics (e.g., methadone) and driving performance has been unclear. In light of this scarcity of information, a study was undertaken to: (1) determine the incidence of driving while under the influence of narcotic drugs as well as methadone; (2) determine the incidence of narcotic drug abuse in highway crashes and traffic violations; and (3) obtain insights into the effects of nonnarcotic drugs on driving.

METHODOLOGY

Data on 1,562 methadone maintenance patients in New York were obtained through face-to-face interviews. Interview questions dealt with the dates and degree of drug use, and driving habits. A control group of 1,059 people was constructed by asking the experimentals to volunteer the names of nonaddicted friends. State driving records for 718 experimentals and 579 controls were obtained and analyzed.

RESULTS

Of the 1,562 subjects interviewed, all had previously been addicted to an opiate drug. The typical subject was young (mean age 27.1), white (61%), and male (89%). Subjects were divided into four groups: predrug period, nonheroin drug period, heroin period, and methadone period. The heroin period began, on the average, at the age of 18.4. The average subject used heroin for

7 years before entering methadone maintenance. Subjects had been in the methadone program for an average of 1 year by the time of the interview.

Ninety-six percent of the subjects reported driving a motor vehicle at least once during the heroin period, and 94% reported driving at least once during the methadone period, even though only 74% and 66%, respectively, reported being licensed. Most of the driving, in terms of miles driven per year, was during the heroin period (18,300 miles for licensed drivers, 9,200 miles for unlicensed drivers). Of the subjects who drove, 69% reported doing so several times a day during the heroin period, compared to 55% and 56% who did so during nonheroin and methadone periods, respectively. Asked what the primary purpose of their driving was, subjects reported that it was "personal" or "work-related" during the predrug, nonheroin and methadone periods; in the heroin period, the most frequently cited purpose was "to get drugs." Subjects did much of their driving in close proximity to the time of their drug use. For the nonheroin drug period, 92% of those who drove at all reported driving at least once immediately after drug use. Sixty-four percent of the 385 subjects reporting the use of hallucinogens used these drugs at least once immediately before driving. Driving after heroin use was even more prevalent: of those who drove, 95% reported doing so at least once within 1 hour of heroin use; 65% reported driving within 1 hour of heroin use as a daily occurrence during this period.

Driving records obtained for 718 experimentals and 579 controls covered a five-year period. For the typical experimental subject, these years included the last half of the heroin period and all of the methadone period. Data were analyzed separately for each year individually, for the five-year composite, for the heroin period only, and for the methadone period only. Regardless of how the data were analyzed, there were no significant differences between the experimentals and controls in terms of auto accidents. The accident rate of methadone patients per million miles driven did not differ greatly from statewide accident rates. Regarding convictions for motor vehicle violations, experimental subjects had significantly more convictions for improper equipment and documentation than the control subjects. However, no difference appeared with respect to convictions for speeding, reckless driving, disobeying traffic signals, or any other violation type.

CONCLUSIONS

The data paint a clear picture of the methadone patient and heroin addict as a driver. He spends a relatively large amount of time on the road, and amasses average yearly mileage in excess of the general population, particularly while using heroin. The absence of a driver's license does not prevent him from driving a significant amount. Nevertheless, he is not overrepresented in either the accident or the serious moving-violation populations. It might be concluded from this evidence that the driving ability of these individuals is not impaired. However, another hypothesis is that addicts, while using heroin, are successfully compensating for their impairment. Those subjects who admitted driving within one hour of heroin use were asked to relate the "main thing on their mind" while doing this driving. Fully 50% gave responses related to concern about being noticed or apprehended. The severe penalties for drug-related offenses were obviously causing the addict to worry about contact with the authorities. It therefore seems apparent that the existing legal and social framework in which heroin addiction is occurring is providing a strong deterrent to unsafe driving behavior among addicts.

California. Department of the Highway Patrol. A Report on Alcohol, Drugs and Organic Factors in Fatal Single Vehicle Traffic Accidents. Final Report. Sacramento: the Department, 1967. 120 pp

DRUG	Multi-Drug
SAMPLE SIZE	772
SAMPLE TYPE	Driving Fatalities
AGE	Cross-Age
SEX	662 Male; 110 Female
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	California
METHODOLOGY	Exploratory/Survey
DATA COLLECTION INSTRUMENT	Laboratory/Examination
DATE(S) CONDUCTED	November 1963 - October 1965
NO. OF REFERENCES	24

PURPOSE

A two-year study of fatal car accidents was performed in California in order to estimate the contribution of the problems of alcohol, drugs, and organic factors in causing such accidents.

METHODOLOGY

California single-car accidents in which the driver died within 15 minutes were selected. A total of 1,474 cases were submitted for analysis during the two-year period from November 1963 through October 1965.

Since the presence of drugs is determined only from blood samples, the study was limited to 662 males and 110 females for whom valid blood samples were taken. All were California residents. Blood samples were checked for acid, neutral, and basic drugs. To insure accuracy, the drugs were screened by Kozelka-Hine spectrophotometer and gas chromatography.

RESULTS

Among the drivers, 102 (13%) were under the influence of drugs. Women used drugs more frequently than men, although the difference was not great. Of the 662 males, 12.7% showed a positive drug reaction; in comparison, 16.4% of the 110 females showed such reaction. The sexes differed in terms of the kind of drug used. Male use included: barbiturates, 45%; stimulants, 26%; tranquilizers, 6%; antidiabetics, 1%; and unidentified drugs, 22%. Female use included: barbiturates, 55%; stimulants, 17%; tranquilizers, 6%; and unidentified drugs, 22%. It was not known whether or not these drugs were prescribed. Of the 102 cases, 82.4% were male.

Barbiturates occurred most frequently in drug-involved accidents (48 times), followed by stimulants (25 times), and drugs not identified (22 times). The percentage of drivers having a positive drug reaction rose from 6.8% for the 15-19 year age group to 33.3% for the 70-79 year age group.

Of the 102 drivers with drugs in their systems, 31.4% had a blood alcohol level of zero, but 38% were excessively impaired. In 62 (60.8%) of the cases, the blood alcohol level was .10 or greater. Of the drivers with positive drug reaction, 199 were sober, 57 were social drinkers, 236 were drunk, and 280 were excessively impaired.

No great difference was indicated between drug reaction or alcohol factor cases. The effect of mixing alcohol and drugs was unknown. Drivers with physical problems did not differ from other traffic fatalities on sex, but were somewhat older, had less of an alcohol problem, and used drugs more often.

CONCLUSIONS

This study points out the extreme extent of the alcohol problem and the need for detailed research on the drug problem.

Crancer, Alfred, Jr., and Quiring, Dennis L. "Driving Records of Persons Arrested for Illegal Drug Use." State of Washington, Department of Motor Vehicles, Report No. 011, May 1968. 11 pp.

DRUG	Multi-Drug
SAMPLE SIZE	302
SAMPLE TYPE	Drug Offense Arrestees
AGE	Adults (mean 28.5)
SEX	260 Male; 42 Female
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	King County, Washington
METHODOLOGY	Exploratory/Survey
DATA COLLECTION INSTRUMENT	Driving Records
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	4

PURPOSE

A study of King County, Washington, drivers was undertaken to determine whether the driving records of persons arrested for illegal drug use were significantly different from those of comparable drivers in the same general driving environment. Drug users ranged from convicted narcotic addicts to those who only had a single arrest for possessing marihuana.

METHODOLOGY

The sample consisted of 302 licensed drivers who had been on the files of the Seattle Police Department since 1963 and were considered to be users of marihuana, dangerous drugs or narcotics, and/or had been classified by the U.S. Bureau of Narcotics as active narcotic addicts in King County as of March 31, 1967. All had been arrested at least once and charged with a drug offense. The population contained 100 narcotic users, 123 dangerous drug users, and 79 marihuana users; there were 260 males and 42 females; and their median age was 28.5 years. These persons were compared to the 687,228 currently licensed King County drivers of the same age and sex distribution. The comparison was made for number of accidents, number of violations, and type of violations accumulated in the period January 1, 1961, to October 1, 1967.

RESULTS

All groups of illegal drug users had higher accident and violation rates than the control population. The accident rate for narcotic users was 29% higher; for dangerous drug users, 57% higher; and for marihuana users, 39% higher. The accident rate for dangerous drug users and the combination of all groups was found to be statistically higher than that for the control group. With respect to violation rates, each illegal drug group was statistically higher than comparable

groups in King County of the same age and sex distribution. Since the majority of the marihuana and dangerous drug users were first arrested in 1964, a comparison was made of violation rates before and after that period. For dangerous drug users, the violation rate for the period January 1, 1961, to June 30, 1964, was 1.64 per driver, and increased to 3.12 per driver during the period July 1, 1964, to October 1, 1967. For marihuana users, the figures were 1.78 and 3.44 for the corresponding periods. This compares to 0.44 and 0.53 for King County drivers during the same period. The distinguishing feature of the figures is the low frequency of illegal drug users with driving records clear of both violations and accidents. Only 10.8% of all male drug users had clear records compared to 42.1% of male King County drivers.

Four types of violations on the records of each group of illegal drug users were found in a higher proportion than on the records of all King County drivers. They were: (1) reckless driving; (2) failure to stop; and (3) failure to yield. Regarding accidents, the narcotics group had a slightly higher percentage of injury accidents, while the dangerous drug and marihuana groups had a slightly lower percentage. No fatal accidents were reported for any of the drug user groups. Altogether, the marihuana group had the lowest percentage of both drunken driving violations and injury accidents; in fact, this group was the only illegal drug group to have a percentage of drunken driving lower than the King County population.

CONCLUSIONS

Knowledge of arrests for illegal drug use would be valuable in predicting driving performance. With regard to the problem driver, such knowledge might be an indication for license restriction or suspension, considering the increased violation rates subsequent to first arrest. Further, more detailed inquiry into the relationship between illegal drug use and driving performance is warranted. Such studies should attempt to determine the reason for the observed deviation in driving performance.

Finkle, Bryan S. Drugs in drinking drivers: A study of 2,500 cases. Journal of Safety Research, 1(4):179-183, 1969.

DRUG	Multi-Drug
SAMPLE SIZE	2,500
SAMPLE TYPE	Drug-intoxicated Drivers
AGE	Adolescents; Adults; Aged
SEX	75% Male; 25% Female
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Santa Clara County, California
METHODOLOGY	Exploratory/Survey
DATA COLLECTION INSTRUMENT	Laboratory/Examination; Police Records
DATE(S) CONDUCTED	1965 - 1968
NO. OF REFERENCES	11

PURPOSE

The fact that drugs, used with or without alcohol, are potentially a major factor in traffic safety has been recognized by forensic scientists and medicolegal experts for at least 15 years. However, little systematic scientific work has been undertaken to investigate the significance of drug use by drivers. An attempt was made to determine the extent of drug involvement in drinking driver investigations during the period 1965-1968 in Santa Clara County, California.

METHODOLOGY

During the three-year study period, the County Laboratory of Criminalistics determined the incidence of drug-involvement by conducting chemical testing of blood and urine samples from arrestees in 10,436 routine drinking driver investigations. Determination of drug involvement was also obtained through arresting officer questioning of the offending driver.

RESULTS

Almost 25% (2,559) of the cases had a drug involvement as determined by arresting officer questioning or chemical analysis. A total of 273 different drugs were encountered on 2,688 occasions. A little over half of the drug-involved cases (1,406) involved problem drugs--"dangerous drugs"--defined in California as drugs unfit for self-medication and requiring a physician's prescription. More than one-third of the 273 different drugs were problem drugs: ataractic and ataxic agents (19%), sedatives and hypnotics (7%), stimulants and anorectics (9%), and analgesic narcotics (4%).

As to the characteristics of the drug-involved drivers, most were also drinking drivers. Only 6% of those cases in which a clearly significant amount of drugs was detected were negative for alcohol. Approximately three-quarters of those involved with drugs were males, principally in the twenties and forties age brackets. The remaining quarter were female, mainly in the forty-to-fifty age group. In 1968, there was a sharp increase in the incidence of drug-involved males 15-20 years old, and most were using barbiturates.

The District Attorney issued complaints in 77% of the cases in which drugs were detected by analysis; more than 90% of these resulted in conviction, and most defendants pleaded guilty.

Finkle, Bryan S.; Biasotti, Alfred A.; and Bradford, Lowell W. The occurrence of some drugs and toxic agents encountered in drinking driver investigations. Journal of Forensic Sciences, 13(2):236-245, April 1968.

DRUG	Alcohol; Multi-Drug
SAMPLE SIZE	3,409
SAMPLE TYPE	Drinking Driver Cases
AGE	Not Specified
SEX	Not Specified
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Santa Clara County, California
METHODOLOGY	Exploratory/Survey
DATA COLLECTION INSTRUMENT	Police Records
DATE(S) CONDUCTED	1967
NO. OF REFERENCES	2

PURPOSE

There has been very little systematic work exploring the frequency with which drugs are involved in drinking driver cases. In Santa Clara County, California, routine drinking driver cases in 1966 were studied to determine the incidence of drugs in the cases.

METHODOLOGY

Analytical data on 3,409 drinking driver arrests were obtained as a result of requests by police for alcohol and/or drug analyses.

RESULTS

Twenty-one percent (705) of the cases indicated some kind of concurrent drug use upon routine questioning of the driver by the arresting officer. A total of 107 different drugs and numerous other unspecified and miscellaneous drug compounds were named by arrestees. Some of the drugs were relatively nontoxic, while others were obvious potential hazards to safe driving. The most frequently occurring drugs were Librium (28 occurrences), aspirin (32), codeine (21), and phenobarbital (19). The most frequently occurring drug group was the tranquilizer group, representing 19.3% of the total, followed by analgesics and antipyretics (15.7%), stimulants and anorectic agents (9.2%), sedatives and hypnotics (7.5%), and analgesic narcotics (3.8%).

The only cases screened for drugs by chemical analyses of blood or urine samples were those in which the subjects exhibited overt signs of intoxication but had blood alcohol concentrations of less than 0.15% w/v. There were a total of 180 such cases, and drugs were demonstrated in specimens from 21% of this group. The most frequently occurring drugs were phenobarbital (6), secobarbital (7), amobarbital (7), meprobamate (6), and pentobarbital (5).

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Garriott, J.C., and Latman, N. Drug detection in cases of "driving under the influence." Journal of Forensic Sciences, 21:398-415, 1976.

DRUG	Alcohol; Multi-Drug
SAMPLE SIZE	135
SAMPLE TYPE	Arrested Drivers
AGE	Adults (17-79)
SEX	Both Sexes
ETHNICITY	Black; White
GEOGRAPHICAL AREA	Dallas, Texas
METHODOLOGY	Exploratory/Survey
DATA COLLECTION INSTRUMENT	Laboratory/Examination
DATE(S) CONDUCTED	1973 - 1974
NO. OF REFERENCES	13

PURPOSE

The role of ethyl alcohol as a significant factor in traffic arrests has been established through numerous studies, while that of other drugs and their incidence in the driving population is less clear. In an attempt to determine the extent of driving under the influence of drugs, blood samples of drivers arrested in Dallas County, Texas, were analyzed.

METHODOLOGY

In Dallas County, Texas, individuals arrested for driving under the influence of alcohol are tested for alcohol intoxication by breath analysis. When results of the test are lower than would be expected from the apparent degree of intoxication, or when evidence of drug use is apparent from questioning or from drug samples found in the individual's possession, the subject is asked to submit a blood sample and is charged with driving under the influence of drugs (DUID). All cases submitted for analysis from July 1, 1973, through 1974 were included in the study. Two screening procedures--gas chromatography and ultraviolet spectrophotometry--were used to detect drugs in the blood samples. Altogether, blood samples for 135 cases were analyzed.

RESULTS

The five most frequently detected drugs in each year were ethanol, methaqualone, diazepam, the barbiturate mixture amobarbital and secobarbital, and one of the individual barbiturates, secobarbital or pentobarbital. In 1974, diazepam replaced methaqualone as the most frequently encountered drug other than ethanol, appearing in 22.5% of all cases; methaqualone appeared in 17% of the cases. Methaqualone had appeared in 28.2% and diazepam in only 6.2% of all cases in 1973. Barbiturates were found in 42.2% of all cases in 1973 and in 39.4% of all cases in 1974.

A large number of individuals were intoxicated with more than one drug, and most of them had also ingested alcoholic beverages. A total of 12 subjects in each year had more than one drug substance besides ethanol detected by the screening procedures.

The age range of arrestees for DUID was 17 to 56 years and the average age was 26.6, whereas the average age of those arrested for DWI (driving while intoxicated--alcohol) was 37 years. This suggests that there is a greater incidence of drug use other than alcohol among younger age groups. The ratio of females to males in the DUID group was more than twice as high as the same ratio for the DWI group (women made up 15% of those arrested for DUID and only 7% of those arrested for DWI).

CONCLUSIONS

It is apparent from the data that sedative-hypnotics account for almost all of the drugs detected in each year. The exceptions were one instance each of amphetamine, methamphetamine, and phenmetrazine. It was not possible to determine what percentage of the cases represented drug usage from illicit preparations, but it was clear from the blood concentrations obtained in most cases that the drugs were being taken in doses greater than therapeutic ones and, if obtained by legitimate prescription, were not taken as prescribed. There is no clear evidence as to why there was a shift in the incidence of diazepam and methaqualone between the two years. In view of the relatively high incidence of positive toxicologic findings in this study, it is suggested that drugs may play a larger role in the intoxicated driver population than previously recognized. Although the number of drivers arrested on this charge is low compared to those arrested for DWI (71 vs. 6,047 in 1974), the incidence of drug use among drivers is believed to be actually higher, with the infrequent detection being due to difficulties in implementing and enforcing a DUID program.

Jamison, Kay, and McGlothlin, William H. Drug usage, personality, attitudinal, and behavioral correlates of driving behavior. Journal of Psychology, 83:123-130, 1973.

DRUG	Multi-Drug
SAMPLE SIZE	164
SAMPLE TYPE	LSD-treated
AGE	Adults (mean 40)
SEX	67% Male; 33% Female
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	California
METHODOLOGY	Exploratory/Survey
DATA COLLECTION INSTRUMENT	Interviews; Psychological Tests; Questionnaire
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	21

PURPOSE

Driving behavior has been studied for many years by investigators using varying methods of approach. In this study, drug usage, personality, attitudinal, and biographical correlates of driving behavior were investigated in an attempt to replicate and expand on the findings of earlier work.

METHODOLOGY

Data were obtained from a sample of subjects who had been given LSD as part of psychotherapy or under experimental conditions between 1955 and 1961. The sample consisted of 164 persons for whom driving records could be obtained from the California Department of Motor Vehicles for the three years prior to the study. Sixty-seven percent were male; their mean age was 40; 52% had a B.A. or higher degree; 80% had been involved in psychotherapy at some time. Biographical and drug information was acquired by a personal interview; attitudinal and personality data were obtained via a questionnaire. Other inventories used included an aphorism scale, the Myers-Briggs Type Indicator, the Marlowe-Crowne Social Desirability Scale, and other personality tests. Subjects were divided into four groups on the basis of their driving records: Group I, no accidents or moving violations, N=52; Group II, two or more moving violations, N=61; Group III, one or more accidents, N=43; and Group IV, no accidents, N=121. Groups were not mutually exclusive.

RESULTS

There were no differences between the groups on the basis of age, educational level, history of broken families, or judged happiness of parents' marriage. Rates of socioeconomic status, involvement in psychotherapy, and marital stability of Group I were lower than those of Group II

The opposite was true for Group IV vs. Group III. However, none of these differences was statistically significant. The percentage of first or only children was higher in both Groups II and III (50.8% and 58.1%, respectively) than in their respective comparison groups (Group I, 46.2%; Group IV, 49.6%). The two biographical variables showing a significant difference ($p<.01$) between Group I and Group II were being male (50% vs. 78.7%), and owning a residence (82.7% vs. 57.4%).

Group II had a higher percentage of experimentation or usage in every drug category except for sedatives than did Group I. The differences approached significance for amphetamines, opium, morphine, cocaine, the strong hallucinogens, and for self-initiated vs. therapist-initiated LSD use. Differences were highly significant for marihuana and hashish (Chi-square = 9.0 and 8.4, respectively). The pattern was somewhat similar, although with fewer differences for the Group III versus Group IV comparison.

Group I scored significantly higher on the aphorism scale ($p<.05$) and significantly lower on relativity of sanity ($p<.001$), sensation-seeking ($p<.01$), and LSD cultism scales ($p<.001$), than did Group II. Group I also had a significantly higher rate of attendance at religious services ($p<.01$). Differences approached significance on the two Myers-Briggs Type Indicator subscales for Groups I and II. Group I subjects had less belief in paranormal phenomena, were less hypnotically suggestible, less liberal on social and economic issues and matters of individual freedom, and more willing to delay rewards in order to obtain later gratification. This group also showed more involvement in political activities and organizations of different sorts, but less involvement in such activities as meditation, yoga, or Zen. The only significant difference between Groups III and IV was on the sensation-seeking scale ($p<.01$).

CONCLUSIONS

It is easier to differentiate "safe" drivers (i.e., those with no moving violations or accidents) from those with two or more violations on the basis of drug, personality, attitudinal, and biographical measures than it is to differentiate those with accidents from those without. A definite syndrome of personality and behavioral characteristics emerges when describing the person likely to have had several moving violations, and at least limited predictive value was obtained by use of five variables (sex, marihuana and hashish experience, ownership of residence, religious attendance) to predict a "safe" driver.

Klein, Arnold W.; Davis, Joseph H.; and Blackbourne, Brian D. Marihuana and automobile crashes. Journal of Drug Issues, 1(1):18-26, 1971.

DRUG	Marihuana; Multi-Drug
SAMPLE SIZE	571
SAMPLE TYPE	College Students
AGE	Adults
SEX	Not Specified
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Florida
METHODOLOGY	Exploratory/Survey
DATA COLLECTION INSTRUMENT	Interviews; Questionnaire
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	5

PURPOSE

Will marihuana legalization, which would be tantamount to commercialization, lead to problems similar to those of alcohol abuse--now rated the fourth major health problem of the United States? The outstanding problem with alcohol and driving lies in the antisocial abusive misuse of alcohol; is it possible that marihuana could also become a major threat to traffic safety? In order to determine the effects of marihuana on driving, a survey of college students was undertaken.

METHODOLOGY

Sample populations of a liberal junior college, a liberal undergraduate university, a moderately conservative medical school, and a highly conservative law school were chosen with modes of distribution varying in the given institution. Approximately 2,000 survey forms were distributed and 571 replies collected, of which 225 indicated the present or past use of marihuana. The subjects were divided into five main groups: (1) nonusers, (2) previous users, (3) those who use less than four times per month, (4) those who use four to eight times per month, and (5) those who use more than eight times per month. Under each grouping, the responses were separated into variable categories concerned with use of tobacco, alcohol, and other drugs; subjective evaluation of self and others in ability to judge speed, time, distance, and reaction time; traffic violations and license revocations; and opinions as to the permissive attitudes of driving under marihuana influence in regard to airplane pilots, taxicab drivers, and drivers of private automobiles. Further data were obtained by observation and tape recordings of interviews with marihuana-intoxicated drivers.

RESULTS

The abstainer from marihuana was much less prone to the use of tobacco, alcohol and hard drugs. Regarding alcohol, 22% of the nonusers, compared to 50% of the weekly users, reported that they drank; none of the nonusers and 41% of the weekly users reported using LSD; none of the nonusers and 11% of the weekly users reported having used heroin.

More than any other effect, respondents consistently downgraded their ability to judge time. Of the former users or infrequent users, 78% consistently downgraded time. Within the chronic use group, only 54% did so. With self-evaluation of reaction time, 66% of the former users or infrequent users downgraded their performance, compared to only 36% of the chronic users. With speed estimation, 75% of former users downgraded ability to judge, compared to 45% of the chronic users. The driver frequently felt himself to be traveling at a faster rate than indicated; however, bursts of speed were observed in the recordings of actual driving experiences. Ability to keep the vehicle under control was downgraded by 76% of former users and only 18% of chronic users. Distance perception was downgraded by 76% of former or infrequent users, and 36% of chronic users. Observational data indicated that the drivers stopped too far from the stoplight, without being aware of the distortion. Under emergency situations, 75% of former users felt impaired in ability to respond, and 48% of chronic users so admitted. The differences in opinions in the chronic versus combined infrequent and former groups were significant ($p<.01$).

Drivers who had been stopped by police while under the influence of marihuana included 18% of the infrequent users and 53% of the chronic users. In addition, 8% of the chronic users had suffered a revocation of their driver's license compared to 4% of the weekly users, 5% of the infrequent users, and less than 1% of the nonusers.

Regarding opinions as to who should not be allowed to drive under the influence of marihuana, both users and nonusers felt that aircraft pilots should not so indulge. In regard to taxicabs and private automobiles, however, the chronic users were less willing than former users or nonusers to censure driving while under the influence of marihuana.

CONCLUSIONS

There is little doubt that marihuana is analogous to alcohol in its potential for detrimental effects upon driving. However, exact comparisons of psychological and physiological effects are difficult, as the two drugs probably alter the nervous system in different ways. In either case, the end result can be fatal. The lack of analytical methods for discovering marihuana in tissue, urine, or blood prevents the determination of its causation in traffic crashes. Unless adequate research is extended in this direction, marihuana-related traffic crashes or abnormal behavior shall remain unreported. Furthermore, any changes in the law regarding marihuana must take into consideration its potential role in traffic accidents.

Maddux, J.F.; Williamson, T.R.; and Ziegler, J.A. Driving records before and during methadone maintenance. In: National Academy of Sciences. Problems of Drug Dependence, 1975. Proceedings of the 37th Annual Scientific Meeting, Committee on Problems of Drug Dependence. Washington, D.C.: the Academy, 1975. pp. 275-288.

DRUG	Methadone; Heroin
SAMPLE SIZE	174
SAMPLE TYPE	Treatment (outpatient)
AGE	Adults
SEX	87% Male; 13% Female
ETHNICITY	95% Mexican-American; 3% White; 2% Black
GEOGRAPHICAL AREA	San Antonio, Texas
METHODOLOGY	Exploratory/Survey
DATA COLLECTION INSTRUMENT	Interviews; Program/Clinic Statistics; Driving Records
DATE(S) CONDUCTED	1972
NO. OF REFERENCES	9

PURPOSE

The driving records of former heroin users maintained on methadone in a San Antonio program were studied in order to identify and describe any changes in the records during three periods: before heroin use, during heroin use, and during methadone maintenance.

METHODOLOGY

Subjects consisted of all patients at the Drug Dependence Program of the Bexar County Mental Health Retardation Center who on September 30, 1972, had been continuously maintained on methadone for one year. This group contained 234 patients; however, only 174 subjects were available for interview, and this latter group became the study population. Eighty-seven percent of the subjects were male; 95% were Mexican-American, 3% were white, and 2% were black.

Data were collected from clinical records, a driving history interview with subjects, and official records. Driving records were obtained for 104 of the subjects. For data analysis, driving violation convictions and accidents were coded into five categories: (1) speeding; (2) negligent collision; (3) other moving violations (running through stop device, improper turn, driving on wrong side, driving on sidewalk, driving while intoxicated); (4) driving without a license; and (5) accidents. From this information, and from the self-reported driving data, the annual rates per 100 subjects were computed for each category of convictions and accidents during each of the three periods (before heroin use, during heroin use, and during methadone maintenance.)

RESULTS

In all five categories of self-reported convictions and accidents for each of the three periods studied, the rates decreased from the period before heroin use to the period during heroin use, but increased from the period of heroin use to the period of methadone maintenance. For example: for speeding, there were 18 violations per 100 drivers before heroin use, 11 per 100 during heroin use, and 20 per 100 during methadone use. For the self-reported conviction and accident rates per 100,000 miles of driving, again the rates decreased from the period before heroin use, but increased during methadone maintenance. Official driver records confirmed this pattern.

A correlation was found between the heroin and methadone periods: having a conviction for speeding while using heroin predicted having one while being maintained on methadone ($p<.05$), and having a conviction or accident in any category while using heroin predicted having one in some category while being maintained on methadone ($p<.01$).

In comparing the accident rates of the subjects with those of all Texas drivers in 1972, it was found that the annual accident rates of the subjects--11 per 100 while on heroin and 15 per 100 while on methadone--exceeded the rate of Texas drivers (6 per 100).

CONCLUSIONS

Although the subjects may not have recalled their preheroin driving experience with great precision, the decrease in convictions and accidents from the preheroin period--when most subjects were teenagers--to the later heroin period conforms to the expectation that teenagers become better drivers as they grow older. Both the self-reported data and the driver record data showed an increase in conviction and accident rates from the heroin period to the methadone period. This was only statistically significant for speeding; however, the moderate increase in most other categories gains importance because two previous studies in New York of driving records of methadone patients showed a small increase in accidents or in convictions and accidents from the period on heroin to the period on methadone.

Considered collectively, the findings of this study and the New York studies suggest a small but distinct deterioration in the driving records of heroin users from the period on heroin to the period on methadone. This is an odd finding, since methadone maintenance programs report increased employment and decreased evidence of antisocial behavior when heroin users are maintained on methadone. Blomberg and Preusser (1972) found that one-third of their subjects stated that, when driving after using heroin, the main thing on their mind was driving well enough to avoid being stopped by the police. Patients maintained on methadone presumably do not violate the drug laws daily, and perhaps they become more careless in their driving than they were while using heroin. Perhaps some deterioration of driving skill results from a sedative effect of methadone. In any case, the differences between the driving records are so slight that it is not recommended that the driving privilege of methadone users be restricted.

Mäki, M., and Linnoila, M. Characteristics of driving in relation to the drug and alcohol use of Finnish outpatients. In: Mattila, M.J. Alcohol, Drugs, and Driving. Modern Problems of Pharmacopsychiatry. Vol. 11. Basel: S. Karger, 1976. pp. 11-21.

DRUG	Alcohol; Unspecified Drugs
SAMPLE SIZE	3,117
SAMPLE TYPE	Treatment (outpatient)
AGE	Adults; Aged (18-70)
SEX	Both Sexes
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Finland
METHODOLOGY	Exploratory/Survey
DATA COLLECTION INSTRUMENT	Questionnaire
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	5

PURPOSE

Early questionnaire studies have demonstrated a moderate increase in the road traffic accident rate among drug users (Nichols, 1971); however, no particular emphasis was placed on specific drugs or specific groups of patients. The study presented here, conducted among three specific patient groups generally receiving drugs for prolonged periods of time, attempted to explore: (1) the driving habits of chronically ill outpatients; (2) the use of drugs and alcohol among outpatients; and (3) the relation between alcohol and drug use, and driving.

METHODOLOGY

The subjects were 765 rheumatoid arthritic, 715 tubercular, and 1,050 psychiatric outpatients treated by special society-supported outpatient clinics throughout Finland. The age of these subjects ranged between 18 and 70 years. A control group of 587 persons was matched with the patient groups for age range and district of residence. Ages of the subjects were within the legal age range for possessing a driving license in Finland.

RESULTS

Within all groups, the majority were men, aged 30 to 49 years. Males represented 70% of drivers in the control group, 89% of drivers in the tubercular group, and approximately 80% in both the psychiatric and rheumatoid arthritic groups. Social status of the drivers was similar in patient and control groups, except that 33% of the drivers in the psychiatric group were of the lowest social class, whereas the corresponding figure in the reference group was 13% ($p<.01$).

There was a relatively small number of driving license holders among rheumatoid (37%) and psychiatric patients (29%), whereas the tubercular group (59%) had as many licensed drivers as the control group (58%). Also, the annual driving experience of the rheumatoid arthritic and psychiatric patients was low. The main reason for driving was recreation, and the driving mainly took place on highways. Excluding the psychiatric patients, the patient groups had been involved less often in traffic accidents than the controls in the two years preceding the study.

The use of prescribed drugs was high in all patient groups (90% among rheumatoid arthritic and psychiatric patients, and 82% for the tubercular group). All these figures were significantly higher than the control group figure (41%). The patient groups generally did not differ from the control group in their choice of alcohol, but the rheumatoid arthritic subjects and the tubercular group used alcohol less often and also drank less alcohol per drinking session than the controls. The psychiatric subjects drank as much and as often as the controls.

In all patients, the use of drugs was in inverse proportion to the number of kilometers driven annually. This tendency was clearest in the rheumatoid arthritis and psychiatric groups. In the psychiatric group, 16% of heavy drug users drove 20,000 km or more per year, and in the tubercular group 41% did so. Increased drug use and driving to work correlated inversely with each other among tubercular and psychiatric patients. Drug use and accident involvement had no correlation in any group; however, subjects most often involved in accidents used one or two drugs.

In all patient groups, heavy alcohol intake during one drinking session seemed to correlate with driving experience: as the alcohol intake per drinking session increased, the number of kilometers driven annually increased. As a rule, drinking had no great effect on recreational driving.

Driving to work and the amounts of alcohol drunk during one drinking session were in direct proportion to each other. The increase in alcohol consumption per drinking session relating to an increased tendency to drive to work was strongest in the tubercular group. Nondrinkers were usually less frequently involved in traffic accidents, and the frequency of accident involvement increased in direct proportion to the amount of alcohol consumed per session. However, in the psychiatric group, accident involvement statistics were high in both drinkers and nondrinkers.

CONCLUSIONS

It is important to remember that a heavy medication generally reflected a severe disease, and the role of the illness itself in impairing driving skills remains somewhat obscure. The reliability of the present results is believed to be high, due to the high percentage of the subjects who returned the questionnaire (70%) and the strict confidentiality of the data. With respect to the combined use of drugs and alcohol, about half of the heavy drinkers--both control subjects and psychiatric outpatients using one or two drugs--had been involved in accidents during the two years previous to the study. Although heavy drinking was correlated with greater exposure to traffic in the present data, in combination with drugs there was an extra accident risk factor.

Smart, Reginald G. Marihuana and driving risk among college students. Journal of Safety Research, 6(4):155-158, 1974.

DRUG	Marihuana; Alcohol
SAMPLE SIZE	296
SAMPLE TYPE	College Students
AGE	Adults (18-23)
SEX	Both Sexes
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Toronto, Canada
METHODOLOGY	Exploratory/Survey
DATA COLLECTION INSTRUMENT	Questionnaire
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	10

PURPOSE

Studies of the accident involvement of cannabis users have yielded somewhat contradictory results and, as yet, the frequency of accidents and driving offenses after intake of marihuana is still not known. Drug users are typically alcohol users as well, and it is often difficult to assign their accident experience to the effects of a particular drug. Further, there is no indication of how many accidents or violations occur per unit of exposure (number of intoxicated occasions). A survey of college students was undertaken to determine how often students drive after marihuana use, how often they drive after using both alcohol and marihuana, the frequency of driving charges and accidents after alcohol use, and the relative risk potential of marihuana and alcohol in relation to driving.

METHODOLOGY

Subjects consisted of 296 male and female college students, aged 18 to 23 years. They were asked to answer a questionnaire about marihuana and driving. Data on driving experience (length of licensure, miles driven in past year, total miles driven), frequency of marihuana use in the past year and during the person's life, and marihuana and alcohol use related to driving and to accidents and violations were obtained. Drugs were considered to be related to a driving accident if it occurred within one hour of the subject's smoking marihuana or having at least two drinks.

RESULTS

Of the 296 respondents, 246 had held a license during the previous year. The majority (174) estimated their total miles driven to be less than 30,000. Of the 246 drivers, 105 (42%) reported some marihuana use. For most, the number of marihuana-using occasions was less than 20. Only

65 (62%) of the driver-users reported ever driving after marihuana use. Of these, however, 24 drove 10 or more times shortly after using marihuana. For 44 of the 65 driver-users, alcohol was involved in at least some of the marihuana-driving occasions.

Accidents and driving charges were reported to be rare under the influence of marihuana. Only three persons reported any driving charge under the influence, while 34 of the total sample reported such offenses under all circumstances in the previous year. Only 4 persons reported having accidents while under the influence of the drug, while 41 of the total sample reported accidents in the previous year.

The majority (74%) of the licensed drivers reported driving at least once within an hour of having at least two drinks. Of the 246 drivers, only 11 (5%) reported ever having had an accident while under the effects of alcohol. In absolute terms, alcohol use was associated with nearly three times as many accidents as was marihuana use. However, the frequency of marihuana-driving occasions in the previous year was about 35% of the frequency of alcohol-driving occasions (467 vs. 1,356).

CONCLUSIONS

The results suggest that for this population, marihuana use contributes to very few accidents and driving charges--only about one-third as many as does alcohol. On the other hand, driving occasions after marihuana use were much less numerous than after alcohol use. There is a need to study the infrequency of marihuana-related accidents in relation to the low level of actual exposure.

Smart, Reginald G., and Fejer, Dianne. Drug use and driving risk among high school students. Accident Analysis and Prevention, 8:33-38, 1976.

DRUG	Multi-Drug
SAMPLE SIZE	710
SAMPLE TYPE	High School Students
AGE	Adolescents
SEX	67% Male; 33% Female
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Toronto, Canada
METHODOLOGY	Exploratory/Survey
DATA COLLECTION INSTRUMENT	Questionnaire
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	13

PURPOSE

Several studies have been made of accident and offense rates among users of heroin and cannabis, all with rather inconsistent results. Apparently, no epidemiological study has been made to determine the frequency of accidents occurring under the effects of various drugs, focusing on high school students. The present study uses high school students, one of the heaviest drug using groups. The general aim was to determine the frequency of accidents for users and nonusers, and the frequency of drug-related accidents. A further goal was to make some comparison of driving exposure while under various drug effects.

METHODOLOGY

This investigation was part of a larger questionnaire survey of drug use among Toronto high school students which has been conducted every 2 years since 1968 (Smart and Fejer, 1974). The original sample involved 1,538 Grade 11 and 13 students chosen at random by a method established in previous surveys in 1968. As part of the survey, they were requested to complete a section of the questionnaire on driving and drug use. In all, 710 students held driving licenses and their responses provide the basic data for this study.

RESULTS

About 67% of the 710 were male, and most were 18 years of age or older. Eighty-four percent had held a license for two years or less, and 7.5% for three years or more. Driving exposure in terms of miles was low, and only 15% reported one or more car accidents in the previous year; 20.2% reported a driving offense.

Users of all drugs more often reported accidents than did nonusers. The differences were statistically significant ($p<.001$) for tobacco, marihuana, opiates, speed, LSD, and other hallucinogens. The largest differences were for users of opiates, speed, LSD, and other hallucinogens where the rate was three to four times as high for users as nonusers. For driving offenses, all types of users had higher rates than nonusers, but the results were statistically significant ($p<.001$) only for tobacco, marihuana, stimulants, and other hallucinogens. The largest differences were for stimulants and other hallucinogens. Only 2.7% of all drivers had an accident under the influence of alcohol, exceeding the total for all other drugs combined (2%). However, when those with accidents were expressed as a proportion of users, alcohol was one of the less dangerous drugs. Users of drugs such as LSD, tranquilizers, and stimulants more often reported accidents under their influence than did drinkers of alcohol. Exposure to drinking accidents was greater (56% of all drivers drank and drove) than exposure to drug accidents (only 1.3% to 6.1% of drivers drove after drug use). Drinking and driving was 9-60 times as common as any type of drug use and driving; taking this rate of exposure into account, reported accidents under all drugs were more common than those under alcohol.

CONCLUSIONS

Unfortunately, few relevant studies have been made with which to compare the present findings. Until further data are available, it seems possible to conclude that most drug use is rarely a driving risk for whole populations, but a much larger risk given the small number of drug and driving occasions.

Smart, Reginald G.; Schmidt, Wolfgang; and Bateman, Karen. Psychoactive drugs and traffic accidents. Journal of Safety Research, 1(2):67-73, June 1969.

DRUG	Multi-Drug
SAMPLE SIZE	30
SAMPLE TYPE	Treatment
AGE	Not Specified
SEX	Both Sexes
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Toronto, Canada
METHODOLOGY	Exploratory/Survey
DATA COLLECTION INSTRUMENT	Interviews; Official Records
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	24

PURPOSE

Research on drugs and driving has focused on ethyl alcohol as the most commonly used chemical which causes impairment. The accident rates of persons addicted to, or dependent on, one or more of the psychoactive drugs were examined.

METHODOLOGY

The 30 persons studied were all psychoactive drug users who had been licensed drivers for some time during 1961-1966. They were patients at psychiatric treatment services in Toronto, Canada, chiefly the Addiction Research Foundation, Toronto Western Hospital, and Lakeshore Psychiatric Hospital. All patients had been diagnosed as "addicted to or dependent upon" some psychoactive drug prior to their being included in the study, and all used psychoactive drugs in an uncontrolled, addictive manner in that they supplemented therapeutic doses with illegal supplies and evidenced signs of physical or psychological dependence on them. The drug users were interviewed as to their driving experiences, both after alcohol and drug ingestion and while sober, between 1961 and 1966. In order to obtain estimates of exposure, questions were asked about the number of miles each had driven per year, and an independent check on accidents was obtained from the Department of Transportation records.

RESULTS

There were a total of 20 accidents involving 13 of the 30 drug abusers. A Kolmogorov-Smirnov Sample Test used to compare the observed number of drivers involved in accidents (N=20) with the expected rates (N=10.93) showed statistically significant results ($p<.01$), indicating that substantially more drug abusers were involved in accidents than was expected. The group (N=17)

which used alcohol and barbiturates, barbiturates only, barbiturates and tranquilizers, or tranquilizers only had only 4 observed drivers involved in accidents, compared to an expectancy of 6.328. The group of drivers who abused alcohol and tranquilizers, with or without barbiturates (N=5), had 3 times as many drivers involved in accidents as was expected (observed=5, expected=1.610). Drivers who only used tranquilizers showed more than 4 times as many accidents as expected (observed=9, expected=1.76). Drug users who used amphetamines with or without alcohol, tranquilizers, or barbiturates (N=8) also showed a surplus of observed over expected accidents. The 11 amphetamine users involved in accidents were 3.7 times as high as the expected value of 2.991. Two of the four drug abusers who used alcohol with or without tranquilizers had taken the drugs before their accident, and two had not done so. None of those in the alcohol and barbiturates, alcohol only, or tranquilizers only groups, had used drugs within 12 hours before their accident. The heaviest drug use prior to accidents occurred in the amphetamine group, 6 of whose drivers had taken amphetamines shortly beforehand. Only 2 out of 20 accidents were of the single-vehicle type.

CONCLUSIONS

Results indicate that drug abusers of the type studied have far more accidents than expected for their age, sex, and exposure in terms of miles driven. However, the number of noncollision accidents was smaller than expected and much smaller than that found among alcoholics involved in accidents. The results point to the need for further research on drug use in relation to driving. Since at least some of the drug-impaired drivers involved in accidents are addicted to or dependent on these drugs, rather than being mere prescription users, drug-related accidents may eventually be shown to be a problem substantially created by drug abusers rather than normal users.

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Sterling-Smith, Robert S. Alcohol, marihuana and other drug patterns among operators involved in fatal motor vehicle accidents. In: Israelstam, S., and Lambert, S., eds. Alcohol, Drugs, and Traffic Safety. Proceedings of the Sixth International Conference on Alcohol, Drugs, and Traffic Safety. Toronto, September 8-13, 1974. Toronto, Canada: Addiction Research Foundation of Ontario, 1975. pp. 93-105.

DRUG	Multi-Drug
SAMPLE SIZE	267
SAMPLE TYPE	Drivers in Fatal Car Accidents
AGE	Adults (mean 32)
SEX	236 Male; 31 Female
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Boston, Massachusetts
METHODOLOGY	Longitudinal
DATA COLLECTION INSTRUMENT	Interviews; Official Records
DATE(S) CONDUCTED	January 1973 - February 1975
NO. OF REFERENCES	22

PURPOSE

For 30 months (January 1973 - February 1975), the National Highway Traffic Safety Administration contracted the Boston University Traffic Accident Research Team to conduct an extended psychosocial investigation into the historical and focal variables associated with the operators of motor vehicles judged to have been "most responsible" for a vehicular accident resulting in a personal fatality in the greater Boston area. The initial purpose of the research described here was to evaluate the extent and degree of alcohol involvement, as well as the relationship between alcohol and other drugs, as they correlated with highway fatalities.

METHODOLOGY

Three major types of accident-involved drivers were identified early in the research, and were classified as follows: TYPE I operator--killed in the focal collision; TYPE II operator--survived the crash but was "most responsible" for the death of another vehicular occupant; and TYPE III operator--struck and killed a pedestrian. The research design for the collection of the data called for initial notification of a fatal vehicular accident through the Massachusetts Registry of Motor Vehicles. Data were also gathered from a variety of sources, including: police records; medical, social, and legal records as well as reports from the Chief Toxicologist of the Commonwealth; and probation and arrest histories from the Registry. Personal interviews were arranged with survivors, peers, professional counterparts, and surviving drivers. The assembled data were scored in a Human Factors Index devised by the Boston team. Relevant variables chosen from nearly 300 collected for each "most responsible" driver were analyzed. Altogether, 267 cases were examined.

RESULTS

The 267 cases under consideration represented: 103 (38%) TYPE I operators, 63 (24%) TYPE II operators, and 101 (38%) TYPE III operators. The sex distribution for the entire sample was 236 (88%) males and 31 (12%) females, and did not differ significantly between the three separate operator groups. The mean age for all operators was 32 years; there was a significant difference in mean ages among the groups: TYPE I and TYPE II operators were in the same basic age categories, and TYPE III operators were significantly younger ($p<.01$). The three groups did not differ significantly in their historical patterns of alcohol use when classified on a 6-point scale ranging from abstainers to alcohol abusers. They did not differ significantly when the three groups were evaluated for normal patterns of pharmaceutical and street drug use, but did differ in patterns of marihuana use, with TYPE II operators showing considerably more frequent smoking patterns ($p<.05$).

Of the total sample, 122 (46%) of the "most responsible" operators were influenced by alcohol at the time of their fatal accident (Group A), and 145 (54%) were not influenced by a commercial alcoholic beverage at the time of the focal crash (Group B). Included in these two groups were 59 (22%) operators influenced by another drug (marihuana, a street drug, or a pharmaceutical), with and without the appending influence of ethyl alcohol. The alcohol-influenced operator was identifiable from his nondrinking counterpart; in particular, the alcohol-influenced driver exhibited a significantly greater number of risky behaviors as assessed by variables associated with antisocial behaviors and problems correlated with previous social errors resulting from alcohol use ($p<.01$). He was also more likely to have been a user of other intoxicants, namely marihuana and street drugs.

Regarding the historical patterns and focal accident use of marihuana, 146 (55%) of the total sample of "most responsible" operators either had never smoked marihuana or had only smoked it once or twice during the year prior to the accident; 121 (45%) smoked with some frequency. Analysis of age showed that younger operators were far more likely to be heavier smokers of marihuana ($p<.01$). The total age range of the marihuana smokers in the study was 16 to 53 years. Of the operators in Group A (focal alcohol involvement), 56 (46%) were either abstainers or experimenters with marihuana, and 66 (54%) were somewhat regular users. The proportion of users and nonusers was significantly different when compared with the operators in Group B (no focal alcohol involvement) where 90 (62%) of these subjects were either abstainers or experimenters, and 55 (38%) were somewhat regular users of the drug ($p<.01$). There was also a significant difference between the two groups of operators as to the relative frequency of use ($p<.01$); the operators in Group A were not only more likely to have been smokers, but were also likely to have been more regular smokers than the operators in Group B. From the total sample, 43 (16%) were known to have been involved in the focal accident after they had been smoking marihuana. Marihuana use was suspected for another 18 (7%). Within the group of the 43 operators, 25 (58%) admitted that they had been drinking, smoking, and under the influence of some street drug when they experienced the crash; a total of 30 (70%) of the 43 operators were under the influence of alcohol and marihuana. The mean age of the marihuana-involved "most responsible" operators was 22 years. Nineteen (44%) of the marihuana-influenced "most responsible" operators were killed themselves (TYPE I accidents); 18 (42%) survived the accident which resulted in fatal injuries to another vehicular occupant (TYPE II accident); and 6 (14%) were the "most responsible" operators in an accident involving a pedestrian death (TYPE III accident).

The use of street or pharmaceutical drugs on the part of a "most responsible" operator prior to the focal crash was not as dominant as the use of alcohol or marihuana. This subsample included 22 (8%) "most responsible" operators, many of whom were also influenced by alcohol or marihuana. Eight (36%) were barbiturate users: two operators were influenced by barbiturates alone, four were under the influence of alcohol, and two others had been smoking and drinking as well as using this drug. Two (9%) had been using hallucinogens, both in combination with alcohol and marihuana. A total of 4 (18%) had mainlined heroin, with 2 of these operators also having consumed an alcoholic beverage. One additional operator was taking methadone and alcohol. Other drug use in this sample included amphetamines, methaqualone, and antihistamines, all in combination with alcohol and/or marihuana. Of the total sample, some variety of drug involvement was evidenced for 139 (52%) of the "most responsible" operators: alcohol only, 79 (57%); marihuana only, 13 (9%); street/pharmaceutical drugs only, 4 (3%); alcohol and marihuana, 25 (18%); alcohol and street/pharmaceutical drugs, 13 (9%); and alcohol, marihuana, and street/pharmaceutical drugs 5 (4%).

During the time span of the research, fatal motor vehicle accidents represented from 37% to 60% of the monthly case intake for the research team. There was a nonsignificant drop in alcohol-

related fatalities between January and August of 1973 in the team's area of responsibility, but there was a steady increase in the number of alcohol-related fatal accidents from September 1973 until the close of the field investigation in February 1974. The fatal accidents with known marihuana use on the part of the "most responsible" operator increased throughout the 30 months.

CONCLUSIONS

The findings show that the drinking operator likely to become involved in a fatal crash as the "most responsible" operator can be identified in advance. It is suggested that this task should not be delegated to law enforcement officials but rather to psychosocial professionals whose skills have prepared them for such an effort. Apprehension and prosecution after the fact do not appear to be the means of controlling traffic fatalities. Instead, the potentially risky driver should be sought out, reeducated, and, if necessary, rehabilitated as quickly as he can be identified.

Sterling-Smith, Robert S., and Graham, David D. "Marihuana and Driver Behaviors: Historic and Social Observations Among Fatal Accident Operators and a Control Sample." Final Report to the National Highway Traffic Safety Administration, Department of Transportation, Washington, D.C., under Contract DOT HS-310-3-595, May 1976. 180 pp.

DRUG	Marihuana; Alcohol
SAMPLE SIZE	1,068
SAMPLE TYPE	Drivers in fatal accidents; General population
AGE	Adolescents; Adults (16-78)
SEX	941 Male; 127 Female
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Boston, Massachusetts
METHODOLOGY	Exploratory/Survey
DATA COLLECTION INSTRUMENT	Interviews; Police Records; Psychological Tests
DATE(S) CONDUCTED	January - May 1975
NO. OF REFERENCES	33

PURPOSE

A study reporting marihuana intoxication as an actual contributing factor to highway accidents was done in 1975 by the Boston University Traffic Accident Research Special Study Team. During the months following the investigation, this group was contracted by the National Highway Traffic Safety Administration to collect a closely regulated control sample from the Boston metropolitan area to determine whether marihuana smokers were overrepresented in the fatal sample collected earlier.

METHODOLOGY

The 1,068 drivers of motor vehicles who contributed the data for this analysis came from two studies: the first 267 (25%) drivers, comprising the experimental sample, were selected in complete sequential order as they became "most responsible" for a motor vehicle accident in the greater Boston area which resulted in fatal injuries to themselves, another vehicular occupant, or a pedestrian. These drivers were investigated between September 1971 and February 1974. The second group, comprising 801 (75%) operators collected randomly in the greater Boston area, was controlled to the experimental sample for sex, age by decade, and township of residence. This group was collected during the first 5 months of 1975. None of the control operators was to have been involved in a fatal vehicular accident. Demographic, psychosocial, alcohol, marihuana, and other drug information was collected on each of the operators. A number of data points referring to marihuana use patterns and driving attitudes were scored and computerized on the control marihuana smokers. A marihuana smoker was defined as a driver who admitted to smoking marihuana on 3 or more occasions during the previous year. Included in the experimental sample were 121 (45%) marihuana smokers and 146 (55%) nonsmokers. The control sample included 272 (34%) marihuana smokers and 529 (66%) nonsmokers.

RESULTS

The experimental nonsmokers (ENS) and the control nonsmokers (CNS) were more alike and differed from the smoking groups in that they were more frequently older, married, nonstudents, employed in good occupations, had poor health, were heavy cigarette smokers, used less alcohol, and abstained from street or entertainment drugs. The differences between the control marihuana smokers (CS) and the experimental smokers (ES) were pronounced: the control smokers were over-achievers, the experimental smokers underachievers. The average control smoker was slightly younger (mean age 23.1, $p<.01$), better educated (167 had attended some college or institution, $p<.01$), more likely to be a student (133 were active students, $p<.01$), much better employed, in better health (264 reported good-to-excellent health), smoked fewer cigarettes (129 did not smoke), more likely to have a history of psychological treatment (CNS and CS comparisons at $<.05$), had heavier general drinking patterns but was drunk less frequently, and was less likely to be a problem drinker (significant differences between CNS and CS at $<.01$). The control smokers were heavier users of marihuana, with a greater proportion smoking several times a week or more (147, or 54%), and fewer were exposed to street or entertainment drugs (53%).

The information supplied by 242 (89%) of the 272 control marihuana smokers resulted in three patterns of use; users conforming to the three different patterns were compared to observe any differences in response. The sample included 11 (4%) light marihuana smokers (less than monthly), 84 (35%) moderate marihuana smokers (between monthly and weekly), and 147 (61%) heavy smokers (several times a week, daily, or more than once a day). Overall, the smokers reported that when under the influence of cannabis it was easier for them to think creatively (70%; a significant difference at $<.01$ for heavy smokers), be distracted from a task or project (65%), hear (54%), and make foolish or impulsive decisions (76%). On the other hand, it was more difficult to: remember things (73%), concentrate (60%, with heavy smokers finding least interference in concentration), become angry (79%), make sudden decisions (71%), and make sudden physical movements (74%). They reported no subjective change in their vision when intoxicated by marihuana. Drivers were presented with a variety of driving situations, and asked to hypothesize how risky each situation would be if they were sober and if they were marihuana-intoxicated. In general, respondents felt that marihuana intoxication was riskier in each situation than was being sober. The situations most affected in the opinion of the drivers, in terms of percentage of subjects who felt the tasks would be riskier in a condition of intoxication, were: driving on an unfamiliar road (50%), driving in heavy traffic (49%), and driving an unfamiliar vehicle (43%).

Forty-three (16%) of the experimental drivers were evaluated to have been marihuana-influenced at the time of the focal accident. The full battery of statistical comparisons was executed using the group of 43 drivers as a base for comparison to evaluate the differences and similarities between this subsample and the others. Generally there were fewer differences between the experimental drivers involved in marihuana-related fatal accidents than expected. The identification of the high-risk marihuana smoker who was involved in a fatal vehicular accident while under the influence of marihuana was not necessarily found in demographic or perfunctory psychosocial variables. There was a lighter trend in the smoking patterns of the high-risk marihuana smoker, and he used the same amount of street/entertainment drugs. The salient variable was that he was more likely to have been a problem drinker of alcohol before his focal accident.

CONCLUSIONS

A hypothesis that marihuana smokers were overrepresented in the previous experimental sample was proved true. An evaluation overview of the control smokers' attitudes toward marihuana smoking and driving would seem to indicate that most of these individuals approached the matter of driving an automobile with unusual caution after they had been smoking. Finally, there are distinguishable differences between experimental drivers who smoked marihuana and the control drivers who smoked marihuana which indicate that these two groups of smokers came from dissimilar segments of the greater Boston population.

Woodhouse, E.J. The prevalence of drugs in fatally injured drivers. In: Israelstam, S., and Lambert, S., eds. Alcohol, Drugs, and Traffic Safety. Proceedings of the Sixth International Conference on Alcohol, Drugs, and Traffic Safety. Toronto, September 8-13, 1974. Toronto, Canada: Addiction Research Foundation of Ontario, 1975. pp. 147-158

DRUG	Multi-Drug
SAMPLE SIZE	710
SAMPLE TYPE	Driver Fatalities
AGE	Adults
SEX	Both Sexes
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Cross-sectional
METHODOLOGY	Exploratory/Survey
DATA COLLECTION INSTRUMENT	Laboratory/Examination
DATE(S) CONDUCTED	June 1971 - September 1973
NO. OF REFERENCES	0

PURPOSE

The National Highway Traffic Safety Administration of the United States Department of Transportation is sponsoring programs to determine the occurrence of drugs in both fatally injured drivers and drivers on the road. In this initial study, the frequency with which various drugs are found in fatally injured drivers was examined.

METHODOLOGY

Between June 1971 and September 1973 specimens of blood, urine, and bile, and alcohol swabs from the fingers and oronasal area, were collected from 710 fatally injured drivers throughout the U.S. The blood was analyzed for drugs including alcohol, the urine and bile for drugs excluding alcohol, and the alcohol swabs for traces of marihuana. Also obtained were data on the date, time, and location of the crash, the time of death, the time the specimens were taken, the type of accident, single or multiple vehicle, type of collision, road and light conditions, whether or not the driver was at fault, and the sex and age of the victim. Only 699 specimen sets were usable; of these, 97% contained alcohol swabs, 74% contained urine, blood, and bile. The specimens were analyzed by thin-layer chromatography and gas chromatography. Drugs in urine and bile were assigned as being positive only if a level of 1 mcg/ml or greater was found; drugs, including alcohol, in blood were assigned as positive at any level. Quantification was conducted on all drugs except nicotine, aspirin, salicylic acid, and the cannabinoids.

RESULTS

Blood alcohol concentrations were found in 684 blood samples collected. Almost 3 of 5 (58%) drivers had been drinking, and nearly half (47%) were "drunk" (BAC 0.10%). Three swab tests

to detect presence of marihuana were available for 323 drivers. The right-hand/left-hand/mouth results were homogeneous and detected 28%-34% marihuana usage. Forty-nine percent of the drivers showed a positive on at least one swab. The percentage of three positive marihuana results was only 15%. The 50 positive sedative results were examined in an attempt to differentiate between alcohol presence in sedative and nonsedative users; there was no difference--the sedative user was neither more nor less likely to use alcohol than the nonsedative user.

Regarding quantitative analysis, it was apparent that a given drug was much more detectable in one test than another. Approximately one in 11 urine or bile tests was positive, whereas about one of 20 blood tests was positive. This may have been due to the fact that urine and bile are drug concentration centers, whereas blood is not. A positive response to one or more of the quantitated drugs, excluding alcohol, was found in 91 of 695 drivers (13%). This figure would have been somewhat higher, presumably, if all samples had been subjected to all three tests (there were fewer bile and urine tests than blood tests).

Overall, alcohol was the only drug overinvolved in at-fault crashes and in single-vehicle crashes. Sex was a factor with respect to alcohol and nicotine use; in both cases, males were overinvolved. Lastly, alcohol was the only drug upon which time of day was a significant influence (with increasing usage as time increased). The drug groups tranquilizers, antihistamines, and stimulants did not furnish a large enough sample to be stratified meaningfully. The data suggest, however, that males were overrepresented among users of tranquilizers and antihistamines, and that young people were overrepresented among those who used stimulants.

CONCLUSIONS

The data indicate that alcohol was by far the most dangerous drug examined in the study and was used by many more people than any other drug (except nicotine).

Experimental Studies

Adams, Anthony J.; Brown, Brian; Flom, Merton C.; Jones, Reese T.; and Jampolsky, Arthur. Alcohol and marihuana effects on static visual acuity. American Journal of Optometry and Physiological Optics, 52:729-735, November 1975.

DRUG	Marihuana; Alcohol
SAMPLE SIZE	10
SAMPLE TYPE	Volunteer
AGE	Adults (18-28)
SEX	Not Specified
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Not Specified
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Laboratory/Examination; Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	13

PURPOSE

Despite the importance of vision in driving, and the well-documented effects of alcohol on accident rate, a careful assessment of static visual acuity in alcohol-intoxicated subjects has not been made. In view of this, and the lack of adequate controls in previous experiments, the effects of alcohol and marihuana on both high- and low-contrast visual acuity were reexamined.

METHODOLOGY

Ten subjects (paid volunteers aged 18-28) were used. All were "social drinkers," had previously smoked marihuana at least five times, and were currently smoking two to five marihuana cigarettes per week. All had 20/20 vision. The double-blind experiment used a replicated balanced 5X5 Latin square design. There were five experimental conditions: 0.5 and 1 ml/kg body weight of 95% ethanol, 8 and 15 mg delta-9 tetrahydrocannabinol (THC), and a placebo. The subjects were required both to drink and to smoke, but were given only one experimental drug at each session. Blood alcohol levels were monitored and pulse rates measured. During the experiment, subjects were asked to rate how "high" they felt on a 0-100 scale where 0 was normal and 100 was as high as they had ever been on alcohol or marihuana.

Landolt rings (ranging in size from 1 to 11.6 minutes of arc corresponding to Snellen letters of sizes 20/20 to 20/232) were projected at two contrast levels (49% and 12%). Randomly oriented targets were presented to the subject for 500 milliseconds at random times after a warning tone. Threshold was determined using the method of limits, and calculated as the mean of one descending and one ascending determination. The subject responded by pressing buttons corresponding to the four gap positions used. Two successive correct or incorrect responses (for ascending and descending procedures, respectively) were the criteria used for ending a run.

RESULTS

There were no consistent changes from predrug baseline in high- or low-contrast visual acuity for either drug at any time interval. Further, when compared to the acuity changes with the placebo, the acuity changes after drug intoxication were not statistically significant. There were no consistent trends in the number of individuals showing an acuity change. Standard deviations were generally higher for the low-contrast measures than for the high-contrast measures, and there was also a tendency for the 1 ml/kg alcohol condition to show greater variance than the placebo. There was no consistent trend for any individual across drug treatments, doses, time intervals, or contrast levels.

In spite of the lack of evidence that static visual acuity was altered, there was no question about the effectiveness of the drugs. The group blood-alcohol levels peaked 45-60 minutes after the end of the drinking period, and were 0.24 g% and 0.077 g% for the 0.5 and 1 ml/kg body weight of 95% ethanol, respectively. The pulse rates after marihuana were increased by a mean of 31.7% and 45.6% for the 8 mg and 15 mg THC doses, respectively. The peak increase in pulse rate occurred close to the end of the smoking period, and after two hours was back to predrug levels.

CONCLUSIONS

No significant change in high- or low-contrast visual acuity was shown with socially relevant doses of either marihuana or alcohol; larger, less relevant doses were not studied. The relative insensitivity of static visual acuity to alcohol and marihuana is in sharp contrast to the decrements in acuity that have been shown to occur when the acuity targets are in motion and require coordinated eye movement behavior for their resolution (Brown et al., 1975).

Adams, Anthony J.; Brown, Brian; Haegerstrom-Portnoy, Gunilla; Flom, Merton C.; and Jones, Reese T. Evidence for acute effects of alcohol and marijuana on color discrimination. Perception and Psychophysics, 20(2):119-124, 1976.

DRUG	Marihuana; Alcohol
SAMPLE SIZE	9
SAMPLE TYPE	Volunteer
AGE	Adults (19-28)
SEX	Not Specified
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	San Francisco Bay Area, California
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Laboratory/Examination
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	13

PURPOSE

The increasingly common use of such "recreational" drugs as alcohol and marihuana has resulted in a heightened interest in the acute effects of these drugs on sensory functions, particularly vision. In view of the nature of previous studies of the acute effects of alcohol on color vision, the lack of studies of effects of marihuana on color vision, and the widespread use of both drugs for recreational purposes, a double-blind color discrimination experiment was conducted using a placebo and two doses of each drug.

METHODOLOGY

The subjects were nine paid volunteers (aged 19 to 28) all of whom were social drinkers, had previously smoked marihuana at least five times, and were currently smoking 2-5 marihuana cigaeettes per week. All were screened for normal color vision, and the Farnsworth-Munsell 100-hue test (FM 100) was administered three times before any drug treatments to reduce practice effects. The FM 100 test consists of 85 colored chips selected from the Munsell color circle (Farnsworth, 1943). The subjects were tested for five days. Two doses of alcohol and two doses of marihuana as well as a double placebo were given to each subject, using a balanced Latin square design. In addition to drinking, the subjects smoked a marihuana cigarette each test day. If the subject received an active dose of marihuana, he drank an alcohol placebo; if he was given alcohol, he was given a marihuana placebo. The doses of alcohol were 0.5 and 1 ml/kg body weight; marihuana, 8 and 15 mg of THC. The subjects were tested prior to the drug treatment to establish a baseline for all recorded values including blood alcohol level, pulse rate, and subjective "high" rating. Tests were performed 30 and 90 minutes after the end of the drug ingestion period.

RESULTS

The total number of errors 30 minutes after the treatment increased for all drug conditions and dose levels except placebo, when compared to pretreatment levels. The high doses of alcohol and marihuana produced 60% and 51% increases in error scores, respectively. Ninety minutes after treatment, the initial postdrug increase in errors was reduced slightly for the high alcohol condition. When the postdrug change in error score was compared to the relative increase in error score for each subject, the relative increase was not statistically significant.

Walsh tests for significance of changes performed for each color zone 30 minutes after treatment showed a statistically significant increase in error score in the blue zone ($p<.05$) for both alcohol (1 ml/kg) and marihuana (15 mg THC). At these same dose levels, and at the same time, the increased error scores for the yellow zone for alcohol and the red zone for marihuana were statistically significant ($p<.02$ and $p<.05$, respectively). For both the alcohol and marihuana conditions, the mean error score was markedly increased in the blue region of the color circle. A less marked loss of color discrimination showed in the yellow-green region for alcohol and in shades of red for marihuana. The low doses of alcohol and marihuana produced little or no increase in error scores, while high doses produced more than double the error score of the corresponding placebo treatment. The reduced blue discrimination for 1 mg/kg alcohol was still evident 90 minutes after drinking, whereas for 15 mg THC there was a return to presmoke levels.

CONCLUSIONS

The regions of reduced color discrimination (blue, yellow-green, and yellow-red) resemble those seen in acquired color vision defects associated with retinal disease, which leads to the speculation that the site of the drug effect may also be retinal. The transient impairment, which cannot be explained by a general drug-induced loss of test aptitude, may have practical implications in tasks where stable color perception is important.

Brown, Brian; Adams, Anthony J.; Haegerstrom-Portnoy, Gunilla; Jones, Reese T.; and Flom, Merton C. Effects of alcohol and marijuana on dynamic visual acuity: I. Threshold measurements. Perception and Psychophysics, 18(6):441-446, 1975.

DRUG	Alcohol; Marihuana
SAMPLE SIZE	10
SAMPLE TYPE	Volunteer
AGE	Adults (18-28)
SEX	Not Specified
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	California
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Laboratory/Examination; Observation
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	12

PURPOSE

Dynamic visual acuity (DVA), the resolution of detail in moving targets, is a complex task involving precise sensory and motor coordination. It is important in such practical situations as driving and flying. Substantial decrements of oculomotor tracking of sinusoidally moving targets have been shown in alcohol-intoxicated subjects. Smaller deficits in tracking have been seen in marihuana-intoxicated subjects. In this study, DVA measurements of 10 subjects were taken after administration of alcohol, marihuana, and placebo, in a double-blind fashion. Reductions in tracking performance were expected to produce decreased DVA in subjects under the influence of alcohol, and to a lesser extent in subjects under the influence of marihuana.

METHODOLOGY

The 10 subjects were paid volunteers aged 18 to 28 who had 20/20 vision. All were social drinkers who had previously smoked marihuana at least five times, and were currently smoking two to five marihuana cigarettes per week. Subjects were given two doses of alcohol, two doses of marihuana, and a placebo. Subjects were required both to drink and to smoke, but were given only one experimental drug at each session. Blood alcohol levels were monitored with an "intoxilizer," which determines the alcohol content of a breath sample using infrared spectroscopy. During the experiment, subjects were asked to rate how "high" they felt on a 0-100 scale on which 0 was normal and 100 was as high as they had ever been on alcohol or marihuana. Pulse rates were also measured. Landolt rings were projected at two contrast levels (49% and 12%) at velocities of 0, 5, 15, 25, and 40 deg/sec. The targets were brighter than the background. The subject tracked the moving targets, which were randomly presented after a warning tone, and responded by pressing buttons corresponding to the four gap positions used. Threshold was

determined using the method of limits, and was calculated by averaging one descending and one ascending determination. The criterion used for ending a threshold determination was two successive correct or incorrect responses (for ascending and descending procedures, respectively).

RESULTS

The relationship between DVA and target velocity was linear over the range of target velocities. Straight lines fitted to the data accounted for 97.3% and 98.6% of the variance for high- and low-contrast data, respectively. Threshold size increased by 40% for the high-contrast targets and by 25% for the low-contrast targets 30 minutes after ingestion of 1 mg/kg ethanol. DVA after alcohol at high- and low-contrast levels decreased substantially, and this persisted for four to five hours after drinking. Recovery to predrink DVA occurred within six hours after drinking. For the 0.5 ml/kg alcohol dose, significant decrement in DVA was shown for low-contrast targets. The marihuana data for high-contrast targets showed a clear and significant treatment effect for the 8 mg dose. The 15 mg THC dose produced a decrease in acuity with recovery by the end of the testing period. The improvement in acuity seen with the 8 mg THC dose failed to reach statistical significance. The marihuana dose produced peak high ratings at least 25% greater than the corresponding alcohol dose. The alcohol-induced decrements of DVA were generally greater than those produced by marihuana.

The 1 ml/kg dose of alcohol produced significant decrements in DVA for both high- and low-contrast targets ($p<.022$ and $p<.012$, respectively). The 15 mg THC dose also produced significant decrements for high- and low-contrast targets ($p<.004$ and $p<.051$, respectively). The alcohol-induced decrement (with respect to placebo) increased as a function of target angular velocity for high-and low-contrast targets 30 minutes after 1 ml/kg ethanol and 15 mg THC.

CONCLUSIONS

Alcohol and marihuana produced significant dose-related reductions in dynamic visual acuity. The reduction of DVA produced by alcohol was greater than for equivalent doses of marihuana, and it is suggested that this difference was produced by differential oculomotor effects of the two drugs. Since DVA correlates with accident record, reduction in DVA under alcohol may be an important contributing factor in alcohol-related traffic accidents.

Bye, C.; Munro-Faure, A.D.; Peck, A.W.; and Young, P.A. A comparison of the effects of 1-benzylpiperazine and dexamphetamine on human performance tests. European Journal of Clinical Pharmacology, 6:163-169, 1973.

DRUG	Stimulants
SAMPLE SIZE	24
SAMPLE TYPE	Volunteer
AGE	Adults (21-47)
SEX	16 Male; 8 Female
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	England
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Laboratory/Examination; Questionnaire; Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	16

PURPOSE

While the effects of amphetamine and related compounds on normal and fatigued human subjects are well known and have been reviewed, little information is available about the relative sensitivity of different measures used. A series of experiments was designed to compare the relative sensitivities of various tests used for the detection of amphetamine-like activity while investigating the pharmacodynamic activity of 1-benzylpiperazine in man.

METHODOLOGY

Twenty-four healthy volunteers were included in the study. Trial 1 was conducted with 9 men and 3 women aged 21 to 46 years, and Trial 2 with 7 men and 5 women aged 21 to 47. The test schedule lasted 2 hours and consisted of 105 minutes of tests followed by a 15-minute rest. This was repeated four times. The tests included: (1) a 15-minute period of addition of two-digit numbers, arranged in groups of five pairs; (2) a hand-steadiness test in which the subject held a metal stylus in a hole in a metal plate, with the arm supported only at the elbow; (3) a tapping test, which used a microswitch and the preferred hand (Trial 1= 1-minute period; Trial 2= a half-minute period); (4) an auditory vigilance test lasting 1 hour, in which subjects listen through headphones to a series of short tones 0.5 sec in duration occurring randomly through the hour, and respond by pressing buttons. The steadiness and tapping tests were then repeated. Subjective effects were assessed from a checklist consisting of 41 adjectives given at the beginning of the second and third rest periods. Heart rate and blood pressure were measured after a ten-minute rest before the beginning of each rest period. No tea, coffee, or cigarettes were allowed on the experimental day, and the subjects omitted breakfast. Subjects were fed during the second, third, and fourth rest periods.

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Individual drug treatments were administered orally under double-blind conditions during the first rest period. Subjects received each of six treatments at weekly intervals in a balanced design. In Trial 1, the treatments were dexamphetamine sulphate 2.5, 5.0, and 7.5 mg; 1-benzylpiperazine hydrochloride 50 and 100 mg; and a lactose placebo. In Trial 2, a lactose placebo was used on two occasions; the other four treatments included dexamphetamine sulphate 1 and 2.5 mg, and 1-benzylpiperzine hydrochloride 20 and 50 mg.

RESULTS

In Trial 1, there were no significant differences in the number of two-digit additions completed following different treatments. A significant increase was noted following both doses of 1-benzylpiperazine in Trial 2 after $4\frac{1}{2}$ hours (50 mg, $p<.01$; 20 mg, $p<.05$). No significant changes in hand steadiness occurred in either trial. A consistent, small dose-related increase in tapping rate followed administration of both drugs. The effects, however, were not statistically significant except at 2 hr 36 min and 4 hr 36 min after 1-benzylpiperazine 50 mg in Trial 2 ($p<.05$ and $p<.01$, respectively).

In both trials there was a decrement in auditory vigilance after taking the lactose placebo during each quarter of the one hour test, with the exception of hour 3 in Trial 1. The performance pattern following the placebo was similar in both trials. The performance decrement during each one-hour test was reduced by dexamphetamine, with significant improvement occurring at the end of hour 2 and the beginning of hour 3. Trial 2 confirmed the effect of dexamphetamine 2.5 mg at the beginning of hour 3; there was also a statistically significant improvement at this time for dexamphetamine 1 mg. 1-Benzylpiperazine 50 mg and 100 mg produced similar changes to dexamphetamine in Trial 1. Significant improvement occurred during the final quarter of hour 2 and the first three quarters of hour 3. Trial 2 confirmed the effects of the lower dose.

Regarding subjective effects, a significant increase in the proportion of subjects experiencing stimulant effects occurred only following the two highest doses of either drug, dexamphetamine 7.5 mg and 1-benzylpiperazine 100 mg, compared with the proportion occurring following lactose.

In Trial 1, heart rate was significantly increased by all doses of both drugs 1 hr 54 min, 3 hr 54 min, and 5 hr 54 min after administration. Systolic blood pressure was raised by all drug treatments except dexamphetamine 5 mg. No changes occurred in diastolic blood pressure. Trial 2 confirmed the increases in heart rate for dexamphetamine 2.5 mg and 1-benzylpiperazine 50 mg. No significant changes in systolic or diastolic blood pressure occurred in Trial 2.

CONCLUSIONS

The results show that the two drugs produce similar effects in man. Numerous studies have suggested that the prolonged and monotonous tests are more suitable for detection of amphetamine-like activity than tests of short duration, and this work confirms this. In marked contrast to the vigilance test, the short duration performance tests and subjective effects were less sensitive to drug effects. Consistent dose-related trends towards improvement occurred in hand steadiness, and tapping rate increased following both drugs but did not reach significance levels. A significant increase in the proportion of subjects experiencing stimulant effects only occurred after the highest doses of each drug, indicating that the auditory vigilance test is capable of detecting changes in performance produced by dosages of these compounds which fail to produce any subjective effects.

Caldwell, D.F.; Myers, S.A.; Domino, E.F.; and Merriam, P.E. Auditory and visual threshold effects of marihuana in man. Perceptual and Motor Skills, 29:755-759, 1969.

DRUG	Marihuana
SAMPLE SIZE	20
SAMPLE TYPE	College Students
AGE	Adults (mean 23.3)
SEX	Male
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Detroit, Michigan
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Perception Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	7

PURPOSE

Psychological and physiological changes following marihuana smoking in a neutral setting have previously been reported (Weil et al., 1968). The present investigation was an attempt to measure auditory and visual acuity in a group of experienced marihuana smokers using standardized psychophysical techniques (Guilford, 1954). To allow for a more natural set, subjects were fully informed of the substances they were about to receive, and were allowed to smoke until they experienced their own subjective "high".

METHODOLOGY

Subjects were 20 college students with a mean age of 23.3 years, and all were experienced users of marihuana. Each was assigned to either an experimental or a control group. Marihuana cigarettes contained 300 mg of crude marihuana (3.93 mg THC). Alfalfa cigarettes (300 mg) were used for the control substance. The following test battery took approximately one hour to administer: Visual Brightness Test (VBT); Auditory Threshold Test (ATT); Auditory Intensity Differential Threshold Test (AIDT); and Auditory Frequency Differential Threshold Test (AFDT). The tests took place before and after drug administration.

RESULTS

The mean amount of crude marihuana smoked to reach a subjective "high" was 483 mg. Analyses showed that groups met the criterion of random sampling for treatment assignment. Furthermore, practice effects were not a confounding variable. Only the measure for auditory intensity DL differed between control and marihuana groups ($p<.02$), with the marihuana group scoring higher than the control group (1.51 vs. 0.94) in the second test session. In the first test session,

the control group score was 1.46, and the experimental group score was 1.71. All group comparisons for point of subjective equality and constant error were statistically nonsignificant.

CONCLUSIONS

The results indicate that marihuana minimally affects those measures of sensory acuity tested in this study. Although a significantly lower intensity DL was recorded for control subjects when compared to the marihuana subjects for the second test session, the absence of a significant difference in performance between the first and second tests for marihuana subjects makes an interpretation of this finding difficult. Neither the position of this test in the battery nor its nature appears to account for this result. However, since the intensity DL decreased from first to second test session for the marihuana subjects, another interpretation would be that marihuana subjects failed to improve as much as control subjects. This view suggests the possibility of a specific task-related, dose-response phenomenon. Setting may affect subjective "high," and data obtained both under a neutral and "psychedelic" setting are needed to elucidate the marihuana experience.

Clark, Lincoln D., and Nakashima, Edwin N. Experimental studies of marihuana. American Journal of Psychiatry, 125(3):379-384, September 1968.

DRUG	Marihuana
SAMPLE SIZE	12
SAMPLE TYPE	Students; Medical Residents
AGE	Adults (21-40)
SEX	Male
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Salt Lake City, Utah
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Psychomotor and Perception Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	10

PURPOSE

The pilot studies reported here were designed to extend knowledge of the behavioral toxicity of marihuana, and illustrate some of the problems involved in measuring the effects of such a drug.

METHODOLOGY

Twelve subjects were run in one control and two or three subsequent drug sessions. These volunteers (21 to 40 years of age) were drawn from among psychiatric residents and graduate students from medicine, pharmacology, and psychology. None had had previous marihuana experience, and none had a history of psychiatric disorder. The range of doses used (0.0125, 0.02, and 0.03 gms/lb) corresponded by calculation and dose effect with lower "2-5 cc" doses used by earlier investigators.

A series of tests was given in random order from one and one-half to four hours after drug administration: (1) hand and foot reaction time to simple (single) and complex (choice) visual signals; (2) a digit code learning test; (3) depth perception; (4) visual flicker fusion; (5) auditory frequency discrimination; (6) duration of afterimage induced by Archimedes Spiral; (7) mirror pattern tracing; and (8) visual motor coordination measured by a pursuit-motor apparatus.

RESULTS

For mirror tracing, the control group and all drug subjects improved in speed and error reduction with successive trials. Practice effects complicated interpretation of the pursuit-rotor test,

and no consistent drug effects were observed. However, performance decrement did appear in some subjects at the highest dose level. Depth perception measurements were highly variable and showed no consistent trend. Accuracy of perception of auditory frequencies was unchanged at all dose levels. The duration of the Archimedes Spiral was very variable in control subjects, the end point being a highly subjective one. The most common drug effect was a shortening of the duration of the afterimage. Marihuana was found to have predictable effects upon reaction time, the magnitude of which was dose-related. Complex reaction time was more sensitive to marihuana than simple reaction time. Performance on the digit code learning test was unchanged in a few subjects, but most showed impairment; there was a greater frequency of impaired performance at higher dose levels. There was a decreased learning rate during the final block of trials for one subject, while another showed marked impairment during the initial block, but progressive improvement thereafter, reaching control levels by the fifth block of trials. One subject showed progressive deterioration of learning rate on the digit code test with increasing doses of marihuana. The marked difference between the effect of 0.025 and 0.030 gms/lb suggests that the dose effect relationship was not a straight line, but a positively accelerated function. This was supported by subjects' reports and observation of their general behavior.

CONCLUSIONS

A number of performance tests proved insensitive to marihuana in the doses used. Effects on complex reaction time and on digit code memory tasks were impaired, but there were marked individual differences. These results are not different than those often found in studies of drug effects on complex behaviors, which are obviously influenced by a variety of nonpharmacological variables.

Clayton, A.B.; Betts, T.A.; and Mackay, G.M. A study of the effects of certain tranquillizers and small amounts of alcohol on driving performance. European Journal of Toxicology, 5(4):254-256, 1972.

DRUG	Alcohol; Tranquilizers
SAMPLE SIZE	100
SAMPLE TYPE	Students
AGE	Adults (mean 21.8)
SEX	50 Male; 50 Female
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	United Kingdom
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Driving Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	5

PURPOSE

Much research has been undertaken in the attempt to determine the effects of psychotropic drugs upon driving, both in laboratory studies of skills and field research on accidents. In many cases, the experimental methods chosen have been those used in studies on alcohol, and thus the pharmacological differences between psychotropic drugs and alcohol, as well as the differences in the methods of administration of the two types of substance--alcohol is normally taken acutely and psychotropic drugs chronically--have been ignored. In this study, an attempt was made to isolate the effects of four drugs commonly prescribed in the United Kingdom, one from each of the four major groups of tranquilizers. The effect of alcohol on driving was also assessed.

METHODOLOGY

The subjects were 50 men and 50 women, mainly students (mean age 21.8 years) of varying driving experience. None of them normally took prescribed psychotropic medication. The drugs used were chlordiazepoxide 10 mg, amylobarbitone sodium 30 mg, trifluoperazine 2 mg, haloperidol 0.5 mg, and a placebo. During the 36 hours prior to testing, each drug was administered five times. Measurement of the effects of the drugs was achieved by use of the following three low-speed vehicle-handling tests: (1) weaving--the subjects were required to drive a vehicle around a series of posts 5.97 meters apart, situated in a straight line; (2) parking--subjects were required to park a vehicle between two boards 5.97 meters apart and as near the curb as possible; and (3) gap estimation--subjects were required to estimate the minimum gap between two posts necessary to drive the vehicle through without hitting either post, and then drive through the chosen gap.

After a practice session, the subjects were given the drugs in a double-blind fashion such that each drug group contained ten men and ten women. After drug administration, the subjects performed three runs on weaving, three runs on parking, and five runs on gap estimation. They were given a measured dose of alcohol (0.5 mg/kg body weight); after an hour their blood alcohol concentration was measured, and they repeated the test procedure. The entire testing procedure was repeated one week later.

RESULTS

Analysis of variance was used to analyze the data. The results were not consistent either between drug groups or between sexes. All the drugs produced at least one significant effect (significance levels at 5% or better). Trifluoperazine significantly affected weaving skills for men and women; while total time to complete the task decreased for men, it increased for women. Haloperidol did not significantly affect men on any task; for women, on the other hand, mean successful gap decreased on the gap estimation test. Chlordiazepoxide increased the total time taken to accomplish the weaving task for men, while for women, mean successful gap decreased. Mean unsuccessful gap increased for men while on amylobarbitone sodium; in contrast, for women, mean successful gap increased and distance from the curb decreased. Objective assessment of the subjects showed significant differences ($p<.05$) in terms of mood between the drug and placebo condition, but there was little interaction with alcohol.

CONCLUSIONS

It is apparent that these drugs (with the possible exception of haloperidol) affected the performance of the subjects on the vehicle-handling tests. The main effects were on speed, accuracy, and judgment. Although the direction of the change in performance was not necessarily consistent, any significant changes in performance must be regarded as potentially dangerous. Men and women were equally likely to be affected, though not necessarily in the same direction. Little evidence on drug-alcohol interaction was found, perhaps partly because of the comparatively low levels of alcohol used and the chronic administration of the drug.

Crancer, Alfred, Jr.; Dille, James M.; Delay, Jack C.; Wallace, Jean E.; and Haykin, Martin D. Comparison of the effects of marihuana and alcohol on simulated driving performance. Science, 164:851-854, 1969.

DRUG	Alcohol; Marihuana
SAMPLE SIZE	36
SAMPLE TYPE	Not Specified
AGE	Adults (mean 22.9)
SEX	29 Male; 7 Female
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Washington
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Laboratory/Examination; Simulated Driving Test
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	17

PURPOSE

The effects of marihuana, alcohol, and no treatment on simulated driving performance were determined for experienced marihuana smokers.

METHODOLOGY

Subjects were required to be: experienced marihuana smokers who had been smoking at least twice a month for the previous six months; licensed motor vehicle operators; engaged in a generally accepted educational or vocational pursuit; and familiar with the effects of alcohol. Seven of the subjects were female and 29 were male (mean age 22.9). A simulator test, presenting a programmed series of emergency situations that are impractical and dangerous in actual road tests, was chosen. The effects of marihuana intoxication, alcohol intoxication, and no treatment on three simulated driving performance tests over a four and one-half hour period were compared. Three treatments were given to each subject: treatment M, in which subjects smoked a total of 1.7 g marihuana; treatment A, in which subjects consumed two drinks containing equal amounts of 95% alcohol; and treatment C, in which subjects waited in the lounge with no treatment for the same period of time required for treatments M and A. Treatments M, A, and C were begun at zero hour and finished ½ hour later; one hour, 2½ hours, and 4 hours after treatment, the subjects were tested on the simulator.

Five test variables were monitored: speedometer, steering, brake, accelerator, and turn signals. Pulse or Breathalyzer readings, depending on the treatment, were taken immediately before each simulator test.

RESULTS

The simulated driving scores for subjects experiencing a normal social marihuana high (treatment M) and the same subjects under control conditions were not significantly different. However, there were significantly more errors ($p<.01$) for alcohol-intoxicated than for control subjects (difference of 15.4%), which was consistent with the mean error scores of the three treatments (control, 84.46 errors; marihuana, 84.49 errors; alcohol, 97.44 errors). The time response curves for marihuana and control treatments were comparable. In contrast, the curve for alcohol showed more total errors ($p<.01$), with the scores persisting across all three time periods.

A separate Latin-square analysis of variance completed for each test variable showed that comparing alcohol-intoxicated and control subjects, significant differences ($p<.05$) were found for accelerator errors in periods 1 and 2; for signal errors in periods 1, 2, and 3; for braking errors in periods 2 and 3; and for speedometer errors in period 1. In the comparison of marihuana smokers and controls, a significant difference ($p<.05$) was found for speedometer errors in period 1. In all of these cases, the number of errors for the drug treatments exceeded the errors for the control treatment.

A cursory investigation of dose response was made by retesting four subjects after they had smoked approximately three times the amount of marihuana used in the main experiment. None of the subjects showed a significant change in performance. Four additional subjects who had never smoked marihuana before were pretested to obtain control scores, then given marihuana to smoke until they were subjectively high. All subjects showed either no change or negligible improvement in their scores. A significant difference ($p<.01$) was found between pulse rates before and after marihuana treatment for both experienced and inexperienced marihuana subjects.

CONCLUSIONS

When subjects experienced a marihuana "high," they accumulated significantly more speedometer errors on the simulator than under control conditions, but there were no significant differences in accelerator, brake, signal, steering, and total errors. The same subjects intoxicated from alcohol accumulated significantly more accelerator, brake, signal, speedometer, and total errors than under control conditions, but there was no significant difference in steering errors. Impairment in simulated driving performance apparently is not a function of increased marihuana dosage or inexperience with the drug.

Dalton, William S.; Martz, Robert; Lemberger, Louis; Rodda, Bruce E.; and Forney, Robert B. Effects of marihuana combined with secobarbital. Clinical Pharmacology and Therapeutics, 18(3):295-304, 1975.

DRUG	Depressants; Marihuana
SAMPLE SIZE	12
SAMPLE TYPE	Volunteer
AGE	Adults (22-30)
SEX	Male
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Not Specified
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Psychological Tests; Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	15

PURPOSE

It has been reported that approximately 30% of regular marihuana users occasionally use barbiturates (Carlin and Post, 1971). The independent use of either of these drugs is known to cause psychomotor impairment. The present investigation was designed to study, under controlled conditions, the psychomotor performance and psychological responses of humans to whom secobarbital and marihuana were administered in combination.

METHODOLOGY

Twelve male volunteers between the ages of 22 and 30 were chosen. All subjects had had at least one previous experience with marihuana, but were not habitual drug users. Marihuana cigarettes were prepared for each subject, containing 0 or 25 mg/kg body weight THC. Sodium secobarbital (150 mg/70kg) and placebo were prepared in opaque capsules containing lactose filler. Drug or placebo medications were administered in a double-blind manner with all treatments assigned to each subject according to a randomized complete block design. The following subjective and objective tests were administered: Modified Cornell Medical Index (CMI); Pursuit Meter (PM); Wobble Board (WB); Delayed Auditory Feedback (DAF); and manual coordination tests, including the placing of colored pegs in a pegboard and a tapping test.

RESULTS

The effect of marihuana, secobarbital, and their combination on standing steadiness as measured by the Wobble Board indicated that marihuana significantly decreased stability in all four tests (eyes open, $p<.001$; eyes shut, $p<.001$; eyes open with vibrator on, $p<.05$; eyes closed with

vibrator on, $p<.01$). Secobarbital had no effect on WB scores with the exception of decrease in score with eyes open and vibrator off ($p<.05$).

In each of the PM tests, the combined administration of secobarbital with marihuana produced an increase in scores. Neither reaction time nor ability to respond to the appropriate light was altered by either drug or by a combination of the two drugs. In the DAF test, marihuana caused a significant decrement in performance for forward reading and reverse count ($p<.05$ and $p<.01$, respectively), whereas secobarbital decreased performance in the color chart test and reverse count ($p<.01$ and $p<.05$, respectively). A significant decrease in manual dexterity was apparent in subtests "any color" and "all white" when the subject was administered secobarbital during the peg board test ($p<.001$ and $p<.01$, respectively). Performance in the more complex test, "red, white, and blue," was significantly impaired by marihuana ($p<.01$). Secobarbital also significantly decreased the number of times a subject could tap a pencil-shaped stylus against a metal plate within a 10-second time period ($p<.01$); marihuana had no effect. For CMI scores, secobarbital produced a slight increase in subjective responses 40 minutes after drug administration. A significant increase in subjective effects, indicated by CMI scores immediately after the experimental session, was also produced by both marihuana and secobarbital ($p<.001$ and $p<.01$, respectively).

Although 10 of the 12 subjects were able to recognize a drug effect when administered secobarbital alone, only 3 were correct in their belief in what they had received. Nine of 12 subjects believed their driving would be impaired when they were administered the combination, as compared to 6 of 12 who believed it would be impaired if they were administered either marihuana or secobarbital alone.

CONCLUSIONS

Manno et al. (1971) reported that alcohol increased impairment in motor and mental performance caused by marihuana in an additive fashion. This study demonstrates that, at the doses administered, sodium secobarbital (also a central nervous system depressant) and marihuana exert additive effects on certain psychomotor tests and subjective responses.

Dott, A.B. Effect of Marihuana on Risk Acceptance in a Simulated Passing Task. Public-Health Service Report ICRL-RR 71-3, DHEW Publication No. HSM-72-10010, Washington, D.C. 1972. 19 pp.

DRUG	Marihuana
SAMPLE SIZE	12
SAMPLE TYPE	Volunteer
AGE	Adults (mean 22.9)
SEX	Male
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Providence, Rhode Island
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	24

PURPOSE

Classical behavioral studies of persons under the influence of marihuana reveal loss of recent memory, decreased attentiveness, changes in mood, alterations in the perception of time, and deterioration in the performance of complex functions (e.g., arithmetical tasks and digital letter coding problems) and complex motor skills such as tracking behavior. Although driving is the major cause of accidental injuries and deaths in America, only a few studies have evaluated the effect of marihuana on driving behavior. This study was designed to assess the capacity of experienced marihuana smokers to perceive and accurately judge risk in an automotive passing situation.

METHODOLOGY

The study was conducted at the Injury Control Research Laboratory of the U.S. Department of Health, Education, and Welfare in Providence, Rhode Island. Subjects included 12 male volunteers whose mean age was 22.9 years. Eight of the subjects had used marihuana or hashish several times a week, two used these drugs at least daily, and two used them once or twice a week. Eleven of the 12 subjects had more than 25,000 miles of driving experience; the members of the group had a total of 11 automobile accidents and 7 moving violations.

Three types of cigarettes were given to the subjects: placebo, a mixture of one-half placebo and one-half active (THC) leaf, and full-strength active leaf. The cigarettes were prepared and administered in a double-blind manner. Each subject smoked two of these cigarettes in three of the experimental sessions, thereby receiving either 0 mg, 11.25 mg, or 22.5 mg of THC. In one session, nothing was smoked. The experimental sessions were spaced a week apart, and subjects

were requested not to smoke marihuana 3 days before testing. Each subject received one practice session a week before testing began.

Subjects were placed in an optical driving simulator, a two-door sedan with an automatic transmission which is optically interfaced with five movable belts. These five belts simulate the two lanes of a rural road, the center line, and the two shoulders. Synchronous movement of the outer scenery, or roadside belts, and the center line is controlled by the accelerator and the brake of the simulator. The driver views the roadway on a rear projection screen located in front of the driver's windshield. An informational display system, the "Passing Aid System II: PAS-II," was used to provide situations structured for the observation of risktaking behavior. The system provides visual and auditory information that may be used in car passing situations where oncoming traffic is not completely visible to the passing driver. The system provides information concerning the period of time during which the oncoming lane will be free of traffic (the number of seconds remaining until the driver's car and the oncoming car reach the same position on the road). The information provided is coded by color and rate of flashing. One of the messages is an abort signal which notifies the subject of an emergency. The abort signal is initiated when the driver's automobile is approximately 40 feet behind the lead car. The distance is selected so that a quick decision to continue passing or pull back can be successful. Eighty percent of the trials were of a single-decision or nonabort variety; 20% involved two decisions: the initial decision to pass, and the decision to pull back or finish the pass (abort). Three variables were assessed: passes attempted, passes completed, and accidents. In this study, every attempt to pass the lead car was viewed as containing a relative degree of risk; a direct measure of the subject's willingness to accept risk was the total number of passes completed.

RESULTS

Significant differences ($p<.05$) as a function of the marihuana condition were found only in passes completed. The subjects under the influence of marihuana completed fewer passes than subjects not under the influence of marihuana. Separation of the data into abort and nonabort trials failed to show any significant differences except for completed passes under the nonabort condition: subjects under the influence of 22.5 mg marihuana completed fewer passes ($p<.05$).

Regarding decision/reaction time, subjects under the influence of marihuana had a statistically significant prolongation of the decision/reaction time during the nonabort condition ($p<.05$). Total reaction-time score for the placebo group was 4.67 sec, 6.36 sec for the 22.5 mg marihuana group, and 6.46 sec for the 11.25 mg marihuana group. Each time the subject completed a pass, he selected a path that allowed adequate clearance of the lead car before returning to his lane. The maximal outward point, the maximal inward point, and the total tracking range were scored for each attempted pass. Analysis of variance revealed no significance as a function of the drug effect.

CONCLUSIONS

The subject under the influence of marihuana appears to be more cautious or more passive when confronted with a potentially hazardous passing situation than is a normal subject. He appears to be able to judge risk as accurately as a normal individual, and consequently does not have more accidents. A comparable subject under the influence of alcohol does not judge risk as accurately, is more aggressive, and has more accidents. Marihuana does appear to reduce vigilance, but the person under its influence is able to compensate effectively in a high-stress situation.

Ellingstad, V.S.; McFarling, L.H.; and Struckman, D.L. Alcohol, Marijuana and Risk Taking. Virginia: NTIS, January 1974. 74 pp. (Pb-228 450/3)

DRUG	Cannabis; Depressants; Alcohol
SAMPLE SIZE	96
SAMPLE TYPE	College Students
AGE	Adults (20-28)
SEX	Male
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	South Dakota
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Psychological Tests; Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	16

PURPOSE

The investigation presented here represents a preliminary attempt to provide a comparative evaluation of the effects of marihuana and alcohol on the perceptual-judgment and decision-making components of automobile driving. Two laboratory analogs of driving, both representing aspects of car passing situations, were used in this evaluation.

METHODOLOGY

Subjects were 96 male students at the University of South Dakota. These subjects were evenly divided into six groups. Marihuana nonusers comprised one control group, and marihuana users made up the remaining five groups: one group of user controls, two alcohol, and two marihuana treatment groups. The selection process consisted of a general screening questionnaire, the Minnesota Multiphasic Personality Inventory (MMPI), a personal interview, and a physical examination administered by a licensed physician.

The first task was a film passing task in which the subject indicated his decision as to the last safe moment to pass by pressing a hand-held switch. Direction of the error was defined as either early or late. An early response indicated the subject had decided to pass at a point in time such that, had he actually initiated the pass, he would have been able to successfully complete it with time to spare. A late response indicated that the subject had responded in such a manner that he could not have successfully completed the pass, and his decision would have resulted in a possible collision. The magnitude of the error was presented in seconds early or late (+ or -). The second task was a passing decision task in which, once he had opted to pass, the subject could reverse his decision if in his judgment the pass could not be

successfully completed. An additional cost factor was built into the backout decision, in that once the subject decided to reverse his decision he would remain in the backout condition for a period of time equal to the time that had elapsed in the pass condition.

The determined dosage of 95% ethyl alcohol was equally divided into two drinks. The two desired Blood Alcohol Concentrations were .05 and .10 as measured by a breathalyzer. Dosages for marihuana were 11.25 mg THC and 22.5 mg THC for the moderate and high marihuana conditions, respectively. No attempt was made to adjust dosage to weight of the subject. Subjects in the moderate marihuana condition were given two prepared marihuana cigarettes--one contained the 11.25 mg dosage and the other a placebo; the high marihuana condition subjects were given two cigarettes both containing the 11.25 mg dosage.

In addition to the performance measures taken on the two tasks, all subjects completed a shortened version of the Nowlis Mood Scale immediately prior to, and immediately after, being tested on the tasks. Subjects were required to rate on a four-point scale how well each of 24 adjectives described their feelings at that point in time. These adjectives were descriptive of eight mood factors: aggression, anxiety, urgency, concentration, fatigue, social affection, sadness, and egoism. Upon completion of the posttask mood scale, subjects were asked to indicate the number of times they would actually have operated a motor vehicle under the effects of the treatment they had received.

RESULTS

Error score means on the film passing tasks showed the marihuana groups to be substantially divergent from the control and alcohol groups. Both marihuana groups showed lower judgment accuracy than the other four groups. To further document this, a series of special contrasts was conducted, each representing essentially a two-group multiple discriminant analysis. The first of these contrasts compared the performance of the two marihuana groups, combined, with that of the other four groups combined. This analysis yielded an F ratio of 2.932 on 11 and 176 degrees of freedom, and was statistically significant at $p<.001$. The contrast comparing the two alcohol groups with all other groups yielded an F of 1.016, and was not statistically significant. Similarly, a comparison of the two control groups with each other, ignoring the remaining four groups, failed to attain statistical significance, as did comparisons of the two alcohol groups and of the two marihuana groups with one another.

The second set of discriminant function weights obtained in the primary analysis emphasized two passing decision task measures. Safe backouts (SBO) and no responses (NR) showed loadings of -.713 and .592, respectively, on this dimension. All other loadings on the second root were unsubstantial. In contrast to the first root, this dimension appeared capable of discriminating the alcohol groups, and was apparently related to a performance continuum of riskiness/conservatism by virtue of the contribution of SBO and NR to this root. Further, the alcohol groups were seen to occupy the "riskiness" or "indecisiveness" end of the continuum relative to the control and marihuana groups.

The analyses conducted to assess the effects of the experimental treatments on subjective mood factors showed no statistically significant differences ($p<.10$) between treatment groups. Subsequent to their treatment condition, subjects were asked to indicate the extent to which they would be willing to operate a motor vehicle in their present condition. Responses were given in terms of the percentage of times they would drive after receiving a treatment similar to the one they had experienced, and were grouped into three categories: would not drive, would drive half of the time or less, and would drive more than half of the time. The result of this analysis was significant at the .001 level. Marihuana groups indicated very little willingness to operate an automobile, with more than half of these subjects reporting that they would not attempt to drive; on the other hand, 72% of the alcohol group subjects indicated they would drive more than half of the time after consuming the specified amount of alcohol.

CONCLUSIONS

On the dimension of "judgmental accuracy," the marihuana subjects tended to overestimate time required to complete passes, and showed considerable variability in their estimates. On the dimension of "riskiness/decisiveness," the alcohol group subjects exhibited patterns of psychomotor performance suggesting a tendency to make "snappy decisions," which were subsequently overridden. No dose-related responses were found for either alcohol or marihuana.

Goodnow, Robert E.; Beecher, Henry K.; Brazier, Mary A.B.; Mosteller, Frederick; and Tagiuri, Renato. Physiological performance following a hypnotic dose of a barbiturate. Journal of Pharmacology and Experimental Therapeutics, 102(1):55-61, 1951.

DRUG	Barbiturates
SAMPLE SIZE	30
SAMPLE TYPE	College Students
AGE	Adults (18-26)
SEX	Male
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Boston, Massachusetts
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Psychological Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	14

PURPOSE

An attempt was made to develop criteria for appraising the sedative agents, both narcotic and hypnotic. The primary goals were to evolve methods of study that would (1) permit accurate comparisons of therapeutic power from one agent to another and (2) allow measurable comparisons of toxic and other side effects, when doses of equal strength are administered.

METHODOLOGY

Thirty normal young men (college students between the ages of 18 and 26) were studied. The study period consisted of two sessions (two days each) spaced five days apart. In the first session, half of the subjects received an oral dose of 0.1 g pentobarbital sodium. The other half got a similar appearing lactose placebo. The drugs and placebos were always given as "unknowns." After five days, the subjects returned for a second session identical to the first, except that the subjects who had previously received the barbiturate were given the placebo and vice versa.

The following battery of tests was administered at 9:00 a.m., 1:00 p.m., 4:00 p.m., 7:00 p.m., and 10:00 p.m. on each of the four days and also at 6:00 a.m. on the second and fourth mornings: tapping speed; auditory reaction time; naming of opposites; and digit memory. The barbiturate or placebo was given at 1:45 a.m. on the first and third days, fifteen minutes before the subject went to bed.

RESULTS

The results for the thirty subjects were broken down into three groups of ten subjects each. All four psychological tests satisfactorily demonstrated a deterioration in performance at

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6:00 a.m., one hour after being awakened and four hours after medication. At 9:00 a.m., all four tests showed negative "t" values, the four together being highly significant. Again at 1:00 p.m., all four tests were negative, but not as radically. At 4:00 p.m., three of the four tests continued to show negative "t" values, one of them significant ($p<.05$). All of the tests, as well as body temperature, showed a marked diurnal trend on all four days.

At the end of the last test session, each subject was asked to guess whether he had received a sedative. Twenty of the subjects guessed correctly. Assuming an equal probability of the occurrence of right and wrong guesses, the differences between the expected and observed values produced a Chi-square value of 9.0 ($p<.01$). It is important to note that the whole range of functions spanned by these tests was significantly affected to some degree when the group of subjects was considered as a whole.

CONCLUSIONS

Although previous studies have been unable to demonstrate the effects of small doses upon test performance, the present findings were made possible by controlling many of the sources of variability, by means of the experimental design and analytic procedures.

Gordon, Norman B. Reaction-times of methadone-treated ex-heroin addicts. Psychopharmacologia, 16:337-344, 1970.

DRUG	Methadone
SAMPLE SIZE	95
SAMPLE TYPE	Treatment; Volunteer
AGE	Adults
SEX	77 Male; 18 Female
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	New York, New York
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Psychomotor Test; Urinalysis
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	13

PURPOSE

Because patients maintained on methadone return to community life and engage in a wide variety of activities, it was considered important to study certain aspects of their psychomotor functioning to determine whether the ingestion of the relatively high daily doses of methadone impaired their ability to function. In this study, it was decided to investigate reaction-time behavior both because it is an important component of psychomotor performance and because it has been shown to be a sensitive indicator of single-dose drug effects.

METHODOLOGY

Six groups of subjects, defined by drug status, were used in the experiment. Group 1 consisted of 18 males who were outpatients at the Beth Israel Medical Center in New York for at least one year, and who were receiving an average daily oral dose of 100 mg of methadone. Their average age was 32.5 years. Group 2 consisted of 20 nondrug-using males, mean age 25, drawn from the nonprofessional hospital staff. Group 3 consisted of 20 male detoxified heroin-dependent patients with an average age of 31.5 years, who were voluntarily hospitalized for heroin withdrawal and who had been detoxified for a minimum of 14 days. Group 4 consisted of 19 male patients with a mean age of 30 who had been detoxified for 4 days. Group 5 contained 9 female methadone outpatients with a mean age of 33.5 years who had been maintained on 100 mg of methadone for at least one year. Group 6 consisted of 9 female nondrug users with a mean age of 23 drawn from the nonprofessional hospital staff.

Each subject was seated at a tabletop console. Stimulus lights were approximately 10 degrees below the subject's approximate seated eye level. A row of six buttons was mounted on a panel parallel to, and just below, the display. The buttons required approximately 312 g of pressure

to activate the switches, and were spaced so as to evenly correspond with the positions of corresponding stimulus lights. Each subject was tested under three conditions: (1) a simple reaction time condition SRT, in which the single button was depressed in response to the single stimulus light; (2) a multiple-discrimination multiple-response reaction time condition MSMRT, which required a response, selected from one of six, to one of six stimuli; and (3) a multiple-discrimination single response condition MSSRT which required a single response to any one of six stimuli presented in random spatial and temporal order. Total time consumed by the testing session was about 45 minutes. Fifteen stimuli were presented in each test situation, with foreperiods randomly selected between 3 and 48 seconds in the first two test conditions. A urine sample was taken after testing to monitor unexpected drug use.

RESULTS

Overall differences in simple reaction time (SRT) for the male subjects were significant ($p<.01$). Male methadone patients achieved the shortest r.t.'s and male nondrug controls the longest r.t.'s. Tests of differences between ordered pairs of means of medians indicated that only the 4-day and 14-day detoxification groups did not differ significantly. Women methadone patients had significantly shorter r.t.'s than the nondrug women ($p<.01$). The results for methadone male and female subjects are counter to expected effects due to age, which would lead to the expectation of longer r.t.'s for methadone groups than for the nondrug controls.

The reaction times for the MSSRT condition were similar to those found with simple r.t., although only the male methadone group differed from the male nondrug group ($p<.05$). The differences between the two female groups were significant ($p<.01$). There were no significant differences between groups on the MSMRT condition.

Examination of the urine samples revealed that all subjects tested were negative for the presence of agents such as barbiturates, amphetamines, and opiates other than those expected to be present.

CONCLUSIONS

The results of the present study indicate that methadone-treated subjects on an average daily dose of 100 mg of methadone show no evidence of impaired reaction time in relation to the control groups used in the present study. In fact, methadone patients appear to have superior simple reaction times, despite the fact that their average age is greater than that of nondrug subjects. It could be speculated that methadone male and female subjects, as well as heroin addicts in general, may consist of individuals who, through some process of natural selection, are more reactive than the general population. It is also possible that prolonged use of narcotics may have led to increased levels of arousal. There is a need to investigate further the nature of reaction-time performance as a function of prolonged tolerance to narcotic drugs. Specifically, it would be of interest to investigate the nature of responses at different times after daily dose administration while controlling for time-of-day effects.

Haffner, J.F.W., et al. Mental and psychomotor effects of diazepam and ethanol. Acta Pharmacologia et Toxicologia, 32:161-178, 1973.

DRUG	Alcohol; Tranquilizers
SAMPLE SIZE	8
SAMPLE TYPE	Students
AGE	Adults (24-29)
SEX	Male
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Oslo, Norway
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Laboratory/Examination; Psychological Tests Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	9

PURPOSE

In recent years, the consumption of sedatives and tranquilizers has increased considerably. It is well known that large doses of diazepam--one of the most commonly used tranquilizers--may produce intoxication and impairment of mental and psychomotor functions. Such impairment may be of great practical and legal importance in certain situations, such as driving cars and flying aircraft. It is therefore of interest to study the effects of varying doses of diazepam, and to compare them with the effects of other well known intoxicants. In order to determine the extent to which a single, large therapeutic dose of diazepam affects mental and psychomotor functions in man, a group of healthy young males were administered doses of 10 and 20 mg/70 kg body weight and tested with psychological and psychomotor instruments.

METHODOLOGY

Eight healthy male student volunteers, aged 24 to 29 years, were the subjects of the study. Before the investigation on the drug effects started, the students were allowed to familiarize themselves with the tests, and were allowed practice trials. Each subject was then tested on four different test days at intervals of 14 days, after the administration of either 10 mg diazepam per 70 kg body weight, 20 mg diazepam per 70 kg body weight, 1.22 ml 96% ethanol/kg body weight, or placebo tablets in a double-blind method. The drugs were taken in the morning after 10 hours of fasting. One hour after administration, the subjects were allowed to eat and to drink water. Twenty minutes later they completed a Letter-Cancellation Test, a Modified Osgood Test, and a Sorting Test. Venous blood samples were taken 1 hr 45 min after drug administration for the determination of both diazepam and alcohol. After this the subjects were sent to four different "stations" where each of them spent 15 minutes before circulating to another

station. The tests carried out at these stations were: (1) Flicker Fusion Frequency and Time Evaluation Ability; (2) Complex Coordination Test; (3) Mirror-Tracing Test; and (4) Clinical Examination. After one hour of rest, the entire procedure was repeated.

RESULTS

On the Modified Osgood Test, 1 hr 30 min after the administration of 10 mg diazepam, the test subjects indicated they felt moderately relaxed, at ease, pleasant, unconcentrated, inefficient and inattentive compared to their condition after placebo. Diazepam 20 mg also increased the feeling of relaxation and ease, reduced motivation, and made the subjects less concentrated, less efficient, and less attentive. Alcohol caused some relaxation, but otherwise had negative effects.

In the Time Evaluation Ability Test, the only statistically significant result was recorded after 20 mg diazepam in the first test, when the assessed time was 25 sec shorter than after placebo. In the Letter-Cancellation Test, alcohol administration was followed by a significant increase in the number of cancellations attempted, while after 20 mg diazepam there was a significant decrease in such attempts ($p<.05$). The reduction in the number of correct cancellations was statistically significant only for 20 mg diazepam in the first test.

In the Sorting Test, the score at 1 hr 30 min was reduced both by 20 mg diazepam and alcohol, the latter having the greater effect. Ten mg of diazepam also reduced the score, but the effect was not statistically significant. Neither diazepam nor ethanol influenced the scores in the second test (4 hr 10 min). In the Flicker Fusion Frequency Test, after the drugs were taken there was a reduction in the ability to recognize flicker. In the second test (5 hrs after drug) alcohol no longer reduced the FFF, while both doses of diazepam still produced this effect. In the Complex Coordination Test, both alcohol and 20 mg diazepam reduced the number of correct responses (2 hr 20 min) when the subjects tried to imitate a pattern of three lights displayed in front of them by moving three other lights with the use of a joystick and a foot-bar. After 5 hrs, the reduced score was only significant for alcohol.

In the Mirror-Tracing Test, the time required to complete the test increased after both alcohol and diazepam, although only significantly after the latter. The highest number of errors occurred after alcohol in the first test (2 hr 20 min). In the second test (5 hr) neither drug increased the number of errors.

In the clinical examination, the following were examined: gait, turning, balance, proprioception, speech, concentration, and memorizing. After 2 hr and 20 min, all drug doses significantly impaired performance compared to placebo (diazepam 10 mg, $p<.05$; diazepam 20 mg, $p<.01$; alcohol, $p<.01$). Five hours after drug and placebo, the subjects were obviously tired and at this time no significant differences from the placebo group could be recorded.

CONCLUSIONS

It is well known that alcohol impairs driving ability. This present investigation indicates that diazepam also has a negative influence on the results of a series of tests relevant to driving performance. In none of the tests was there any improvement in mean score after diazepam as compared with placebo. The tests used in the present investigation mimic only some of the performances involved during car or aircraft driving; however, since the results of the tests indicate that the effects of diazepam (especially in high doses) are in many respects comparable with those of alcohol, it would be expected that both driving and flying ability are also reduced under the influence of diazepam.

Heimann, Hans; Reed, Charles F.; and Witt, Peter N. Some observations suggesting preservation of skilled motor acts despite drug-induced stress. Psychopharmacologia, 13:287-298, 1968.

DRUG	Antidepressants
SAMPLE SIZE	20
SAMPLE TYPE	Graduate and Medical Students
AGE	Adults (20-25)
SEX	Both Sexes
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Not Specified
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Laboratory/Examination; Psychological Tests; Questionnaire
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	11

PURPOSE

It was hypothesized that a sampling of fine sensory motor coordinations of everyday occurrences could provide a basis for classifying severity of stress. But in the course of this investigation, it was observed that, rather than being good candidates for indices of subtle stress, ordinary skilled acts may be relatively immune from disruption. Measures of skilled motor performances were obtained and observations suggesting preservation of skilled motor acts despite drug-induced stress were gathered.

METHODOLOGY

The subjects of the experiment were 20 graduate and medical students of both sexes between the ages of 20 and 25. They were informed that effective psychopharmacological agents would be used; the identity of the substances was unknown both to the subjects and to the testers. Each series of tests took 45 minutes. Immediately following completion of the first series of tests, the subject was given a drug or placebo orally. A second series of tests was conducted one hour, three hours, and five hours after drug administration. Three kinds of measures were taken at each session: (1) objective measures of physiological function (heart rate, and systolic and diastolic blood pressure); (2) subjective measures (a 32-question inventory of the subjective state of the subject in categories such as perception, mood, and memory); and (3) performance measures (quantitative analysis of facial movements, eye movements, pattern recognition, Meili-cancellation test, word fluency, digit span, arm-hand steadiness, overcharge and recovery reaction, and eye-hand coordination).

The following drugs were administered in single, standard doses: perphenazine; imipramine; and opipramol. In order to obtain comparable psychological circumstances for the drugs, placebo was administered.

RESULTS

For performance changes (subjective and objective), regardless of the substances given, the main effects were attributed to the time of day. Pulse rate was significantly lower in the second session (mean 67) for all conditions as compared to the first session (mean 72). Objective measures showed the following changes: the total time taken for the Meili-cancellation test dropped significantly between the first (mean 243 sec) and second (mean 220 sec) testings; performance on the stimulus-reaction test improved significantly from the first session (mean 148.37) to the fourth (mean 154.34); subjects recalled more words in the word-recall task in the later testing session as compared to the first (mean of 16.2 to 14.6, respectively); the drawing test took a significantly longer time to perform in each initial morning trial (101 sec) than in subsequent trials; the movement quotient for the mouth corners became significantly smaller from the first to the third testings (means of 0.46, 0.43, and 0.41, respectively); and the symmetry coefficient of the corners of the mouth decreased significantly from the first session (mean 0.86) to the third (mean 0.78).

No objective changes in performance occurred specific to the placebo, nor were physiological measures altered. Two subjective reports that occurred significantly more often with placebo than with any of the three active substances were "better than usual" bodily feelings and "improved" memory, which was claimed for only the placebo. No objective changes occurred for perphenazine. However, subjects in significant number reported visual changes in the third testing session, although no evidence of change could be detected in the eye movement or perceptual measures. Opipramol produced a single objective change which was most apparent in the final session: analysis of variance measures of eye movement revealed a significant interaction between drug and testing period. Despite this significant alteration in the character of movement of the eyes, no change in the efficiency of perception appeared in the data. For imipramine, analysis of variance indicated change in the following objective indices: one hour after drug administration, the blood mean arterial pressure was higher (120) than for all other substances and placebo (114). This difference remained throughout the day (significant at the .01 level). There were also significantly more frequent reports of bodily and mental distress: illness, sleepiness, inability to concentrate, nausea, dizziness. With regard to performance measures, only the drawing test showed any effect.

To explore the possibility that there are degrees of sensitivity and differential response to the drugs, one additional test was performed internal to the data for each of the drugs: the number of reports of negative effects was correlated with motility of the corners of the mouth. A significant negative correlation (-0.73 rank-difference-correlation of Spearman at the .01 level) was found for imipramine, but not for any of the other substances.

CONCLUSIONS

The data indicate that disorders of intellect and emotion occur without necessarily disrupting the everyday efficiencies of skilled sensory-motor acts.

Holzman, Philip S.; Levy, Deborah L.; Uhlenhuth, Eberhard H.; Proctor, Leonard R.; and Freedman, Daniel X. Smooth-pursuit eye movements and diazepam, CPZ, and secobarbital. Psychopharmacologia, 44:111-115, 1975.

DRUG	Tranquilizers; Barbiturates
SAMPLE SIZE	5
SAMPLE TYPE	Volunteer
AGE	Adults (21-28)
SEX	Male
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Not Specified
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	18

PURPOSE

In order to resolve the question of the relationship of eye tracking to a person's emotional state, controlled observations of the effects on smooth-pursuit eye tracking of single and chronic drug dosages of chlorpromazine and other compounds in normals were undertaken. The study presented here examined the effects of single dosages of chlorpromazine, diazepam, and secobarbital.

METHODOLOGY

The subjects were five male volunteers, ranging in age from 21 to 28 years old. During the experiment the subjects had no knowledge of which drugs they were receiving or of the empirical question being investigated. The procedure and method required the subject to follow a moving pendulum with his eyes for 30 seconds. In addition to the pendulum tracking task, all subjects were tested for spontaneous and gaze nystagmus before and after drug ingestion. Each eye-tracking record was studied by two scorers who classified the tracking as qualitatively normal or deviant. The velocity arrest score was used as a quantitative measure of deviation of eye movement from smooth pursuit.

In Experiment I, diazepam (Valium) was administered orally in doses of 0.071, 0.142, and 0.284 mg/kg body weight, and each subject was tested under predrug and postdrug conditions. In Experiment II, chlorpromazine hydrochloride concentrate (CPZ, Thorazine) was administered orally in doses of 0.667 and 1.334 mg/kg. All subjects were tested under predrug and postdrug conditions. Both Experiments I and II used a 1-hour-and-45-minute separation between predrug and postdrug conditions. In Experiment III, sodium secobarbital (seconal sodium) was administered to the

subjects so as to compare its effect to that of diazepam and CPZ. It was administered orally in a standard sedative amount of 100 mg, not adjusted for weight differences, and subjects were tested at 10-minute intervals up to 80 minutes. For Experiment IV, serial testing was performed upon one representative subject who had shown no qualitative disruption of his tracking pattern after ingestion of 100 mg of secobarbital. In order to study the longitudinal course of drug effects for an extended period of time, the subject was administered, on successive weeks, 0.284 mg/kg of diazepam, 1.334 mg/kg of CPZ, and 130 mg of secobarbital.

RESULTS

Results for Experiment I showed that both before and after drug administration, at three dosage levels, there were no statistically significant effects of the drug on the velocity arrest score. The qualitative assessment of tracking performance remained normal for all subjects under all conditions 1 hour 45 minutes after drug ingestion, with one subject showing a tracking change from the predrug state in the 0.071 mg/kg condition.

In Experiment II, there was no significant drug effect, and no significant interaction. There was, however, a significant difference between the two dosages of CPZ ($p<.05$), although neither of these scores was significantly different from predrug performance, and both scores were well within the normal range of velocity arrests. The dosage effect was thus clinically insignificant.

Experiment III showed no detectable significant group difference in the velocity arrest score until 70 minutes after drug ingestion ($p<.01$), when testing was discontinued. All subjects considered individually showed a significant increase in velocity arrests when under the influence of secobarbital. Two of the four subjects on secobarbital demonstrated the expected barbiturate disruption of smooth pursuit according to the qualitative classification scheme. Evidence of spontaneous nystagmus was indicated 80 minutes after drug ingestion only in one subject. No spontaneous nystagmus was detected in the postdrug tests of diazepam and CPZ. The predrug velocity arrest score remained the same in all three experiments.

Experiment IV results showed that 0.284 mg/kg of diazepam increased the number of velocity arrests, although it did not produce an abnormal qualitative tracking pattern. Chlorpromazine trials in Experiment IV showed all of the qualitative tracking patterns to be normal. Although the number of velocity arrests remained well within normal levels and there were no significant qualitative disturbances in eye tracking, the number of velocity arrests increased at 90 minutes, subsided to a low at 210 minutes, and rose to a high point at 360 minutes. In this respect, the CPZ curve resembled that of diazepam and suggested that the behavioral effects in the form of velocity arrests may be correlated with changes in plasma concentrations of CPZ. Finally, secobarbital trials in Experiment IV showed that at 20 minutes there was a significant rise in velocity arrests, both for the 100 and 130 mg dosages. For the 130 mg trial, the velocity arrest score remained elevated even after 24 hours. Barbiturate-induced nystagmus was present in all recordings from 20 minutes to 24 hours, though in decreasing amounts over time.

CONCLUSIONS

It seems that the dysfunction of smooth eye tracking under barbiturates is not referable to their general sedative action or to attentional interference with task efficiency, but to the sites of action of the drugs and to the specific neurological pathways they involve. With respect to the effects of barbiturates on smooth-pursuit movements, the findings here are congruent with those of Rashbass (1961) who demonstrated the specificity of barbiturate action in respect to various oculomotor mechanisms. Conclusive statements concerning dosage effects cannot be made in the absence of drug blood-level data.

Kielholz. P.: Hobi, V.; Ladewig, D.; Miest, P.; and Richter, R. An experimental investigation about the effect of cannabis on car driving behaviour. Pharmakopsychiatrie Neuro-Psychopharmakologie, 6(2):91-103, 1973.

DRUG	Cannabis
SAMPLE SIZE	54
SAMPLE TYPE	Volunteer
AGE	Adults (mean 34)
SEX	Both Sexes
ETHNICITY	White
GEOGRAPHICAL AREA	Switzerland
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Laboratory/Examination; Psychological Tests; Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	46

PURPOSE

The effect of central nervous system stimulants on traffic safety is of increasing importance today, as drug abuse grows. Since 1967, Europe has been flooded with a hashish, LSD, and amphetamine wave. It has been shown that people, particularly adolescents, do not hesitate to drive a car under the influence of such drugs. In this study, the effect of delta-9-tetrahydrocannabinol (THC) on psychophysiological variables, psychological motor functions, perception, general feeling, and personality aspects, as well as their reciprocal action on driving behavior, was tested.

METHODOLOGY

Fifty-four healthy volunteers of both sexes consisting of doctors, psychologists, theologians, and educationists with an average age of 34 were tested in a strict double-blind test. In order to determine a possible dose response curve, 350, 400 and 450 micrograms of THC per kilogram body weight and a placebo were administered orally in capsules. The subjects were medically examined and tested with psychomotor and psychological tests prior to, and after, ingestion of the capsules. Tests included two-place tapping, line tracing, pin pointing, spiral rotor afterimage, critical flicker-fusion frequency, Muller-Lyer illusion, sign recognition and tracking. The subjects were also asked to relate their somatic complaints and general feeling state.

RESULTS

An increased pain sensitivity indicated the presence of a THC effect. Sublingual temperature remained unchanged under THC; however, there was an increased pulse rate, which was especially obvious with female subjects ($p<.01$). Systolic blood pressure remained within the normal range,

but there was a rise in pressure among the male subjects ($p<.05$). There was a statistically significant lengthening in the half relaxation time of the Achilles tendon reflex in the placebo group (probably a sign of fatigue), while no such effect could be established in the THC group, which might point to the slight stimulating effect of the drug.

Regarding general feeling, the placebo group exhibited no changes, but the THC group became more passive and less "vital" ($p<.01$). Whereas, before intake, the somatic complaints of the THC group and the control group showed no statistically detectable differences, 16 significantly increasing complaints could be observed in the THC group after intake. Eight complaints were still statistically detectable 22 hours after administration. The most important somatic changes were impairment of concentration, strong sensation of cold, tremor, disturbance of equilibrium, heat ebullitions, headache, inner tensions, dysphagia, and faintness. According to the Freiburg Personality Inventory, the THC group tended to be less critical, more self-confident, and more introverted on the operationally defined dimensions of "sociability," "frankness," "masculinity," and "extraversion."

In the tapping test (conducted 4 times), the placebo group showed a clear trend of improvement in performance from the first to fourth test while under stress, while the THC group showed a statistically significant and continuous diminution in performance from the first to the third test. Although the THC group improved in the fourth test, the subjects never again reached their initial performance level. In the spiral rotor test, which measures attention and vigilance as well as after-image, there were no significant changes detectable under THC. Using a compensation apparatus which tested eye/hand and hand/hand coordination, the THC group displayed retardation, less control, and an unsteadier performance. A tracking apparatus measured important components of specific performance of the kind required of the driver on the road. While actual steering ability survived in the THC group, in complex situations, as in phases of great information density, a prolongation of reaction time on the one hand and an accumulation of wrong reactions on the other became perceptible.

Kiplinger, Glenn F.; Manno, Joseph E.; Rodda, Bruce E.; and Forney, Robert B. Dose-response analysis of the effects of tetrahydrocannabinol in man. Clinical Pharmacology and Therapeutics, 12(4):650-657, 1971.

DRUG	Marihuana
SAMPLE SIZE	15
SAMPLE TYPE	Students
AGE	Adults
SEX	Male
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Indianapolis, Indiana
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Psychological Tests; Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	11

PURPOSE

In a study reported previously (Manno et al., 1970), objective performance deficits were demonstrated in normal subjects who had smoked a single marihuana cigarette calibrated to deliver 5 mg of THC. In another study with alcohol, an attempt was made to demonstrate a dose-response relationship between the quantity of THC delivered in the smoke and performance deficits using doses of 2.5 and 5 mg. It was found that there was little or no difference between the 2.5 and 5 mg doses, even though definite performance decrements could be demonstrated for both doses compared to placebo. As a result, further dose-response analysis was made of the effects of tetrahydrocannabinol in man.

METHODOLOGY

The subjects were male medical and graduate students. Of 15 chosen, 8 reported prior experience with marihuana and 7 claimed to be naive. Cigarettes were prepared for each subject individually with doses adjusted to 0, 6.25, 12.5, 25, and 50 mcg per kilogram of THC. Doses were administered at one-week intervals in five experimental sessions.

The parameters measured were: (1) physiologic (pulse rate and conjunctival injection); (2) subjective response (the Cornell Medical Index {CMI} for side effects, and the Addiction Research Center Inventory {ARCI} for marihuana effects); (3) motor performance (pursuit meter); (4) mental performance (verbal tasks on the delayed auditory feedback device, or DAF); and (5) stability of stance (Wobble Board).

RESULTS

Pursuit meter data showed that error scores for all tests increased with the dose of the drug, and there was a significant linear dose-dependent relationship (for each respective pursuit pattern, I-IV: $p<.001$; $p<.001$; $p<.01$; and $p<.05$).

Four of the 9 DAF tests showed linear dose-dependent decrements in performance: verbal output ($p<.05$), reverse count ($p<.01$), progressive count ($p<.05$), and color discrimination ($p<.05$). Wobble Board data indicated a significant relationship between dose of THC and the number of counts recorded, signifying decreasing stability with increasing amounts of THC ($p<.001$).

Both the CMI and ARCI instruments showed a significant dose-dependent increase in score ($p<.01$). Also, pulse rate 20 minutes after beginning the marihuana cigarette showed a significant dose-dependent increase ($p<.01$). Finally, when subjects were asked at the end of each session to guess whether they had received authentic marihuana, 80% of the subjects (12/15) correctly identified the lowest dose administered as active marihuana, while only 20% identified the placebo as marihuana.

CONCLUSIONS

It has been demonstrated that calibrated marihuana cigarettes are capable of producing quantifiable effects on motor performance (pursuit meter), mental performance (DAF), physiologic phenomenon (pulse rate), and subjective feelings (CMI and ARCI).

Klonoff, Harry. Marijuana and driving in real-life situations. Science, 186:317-324, October 25, 1974.

DRUG	Marihuana
SAMPLE SIZE	64
SAMPLE TYPE	Volunteer
AGE	Adults (mean 23.9)
SEX	43 Male; 21 Female
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Vancouver, Canada
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Laboratory/Examination; Driving Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	15

PURPOSE

There is a marked paucity of published research dealing with the effects of marihuana on driving in a real-life situation. An attempt was made to determine: (1) the effects of low and high doses of marihuana on driving performance in both a restricted, traffic-free area (driving course) and on the streets of Vancouver, Canada, during peak hours of traffic flow; and (2) the effects of marihuana and driving on heart rate.

METHODOLOGY

For the driving course portion of the study, 43 men and 21 women were assigned to one of three groups: a group given low doses of marihuana (13 men and 8 women); a group given high doses (14 men and 8 women); and a group given a placebo (16 men and 5 women). Of these, 25 men and 13 women also participated in the street driving portion and were assigned to one of four groups: a group given low doses prior to the first driving session and then placebo prior to the second session (5 men and 4 women); a group given placebo first and then low doses (7 men and 3 women); a group given high doses then placebo (6 men and 2 women); and a group given placebo then high doses (7 men and 4 women). The mean age of the volunteers was 23.9 years; they were highly educated, and all had prior driving experience (mean number of years, 6.9).

For the low doses of marihuana, standardized Cannabis sativa containing 0.70% THC was used; for high doses, 1.2%. The physical characteristics of the placebo were identical to those of the Cannabis sativa plant material, but there were no cannabinols. Both marihuana and placebo were administered in the form of cigarettes.

The driving course was made up of eight road tests. Trials were given in four blocks of five trials each. Blocks 1 and 2 were given on the same day; blocks 3 and 4 on the average of 7 days later. During the city street procedure, the subject was told to drive to the center of the downtown area, and then to a residential area. The procedure was repeated on the average of 7 days later. The score range was 11-77, where less than 44 reflected overall improvement and more than 44 indicated overall decline. In the laboratory course, the subjects smoked a cigarette containing marihuana or placebo only once. In the street course, subjects smoked before each session. The drug and placebo were counterbalanced, for each subject, for each session.

Before each driving session, heart rate was recorded for four minutes in a laboratory. On the course, heart rate was recorded during the five trials of each of blocks 2, 3, and 4; on the city streets, heart rate was recorded continuously during the two driving sessions.

RESULTS

Because learning was likely to occur while subjects were driving on the course, block 3 was used as the baseline measure and block 4 as the experimental measure. As a result of learning, total scores improved in the order of 15% between blocks 1 and 2, and again between blocks 2 and 3. Seventeen percent improvement was predicted from the linear regression for block 4, but intake of the drug impeded learning--scores worsened to the extent of 29% from that predicted for the low-dose group, and 54% for the high-dose group. Scores between blocks 3 and 4 improved significantly ($p<.05$) for the placebo group, while scores for the low-dose group showed some impairment in learning and scores for the high-dose group showed significant impairment in learning ($p<.01$). Also, both marihuana smoking groups showed significant mean declines in learning compared to the placebo group. Braking distance decreased significantly between blocks 3 and 4 for the placebo group ($p<.05$) but not for the groups on low or high doses of marihuana.

Data for the group given high doses prior to the first session were combined with those for the group given high doses prior to the second session. Likewise, the low-dose group data were combined. Results for driving on the city streets showed that for the groups on the high doses, the mean score was 47.5; for the combined group on the low doses it was 45.1. Significant findings were shown for the high-dose groups ($p<.05$), but not for the combined group on low doses. There was no appreciable difference between the subjects in cooperation and attitude; there was some difference in general driving skills, irritability, speed, confidence, tension, and aggression; and there was considerable difference in judgment, care while driving, and concentration. Eight emergent situations were recorded during the placebo session, and 18 during the drug session. The probability of emergent situations occurring in the drug session was significant beyond the .01 level. Whereas there was a significant difference of emergent situations, the mean magnitude of situations during the drug session (5.5) was slightly but not significantly higher than during the placebo session (5.2). There were no significant differences for the course or for the street for any of three variables which may produce differential effects on driving (sex, driving experience, and previous experience of driving under the influence of marihuana). Some unusual behavior was noted both on the course and on the street after the subjects had smoked marihuana (loss of set regarding order of tasks; loss of discrimination between internal and external course markers, driving off the course, missing of traffic lights or stop signs; engagement in passing maneuvers without sufficient caution; and poor anticipation or poor handling of vehicle with respect to traffic flow).

Compared with the laboratory baseline, heart rate on the course increased significantly during the baseline trials ($p<.01$) and increased further during block 4 trials conducted after the subjects had smoked marihuana, but not after they had smoked the placebo. For driving on the streets, compared with the baseline rate from the laboratory, the heart rates of subjects driving after they had smoked the placebo did not increase significantly. After subjects had smoked marihuana their heart rates increased significantly. Heart rates during the drug compared with the placebo condition increased significantly for the composite score and for all types of traffic patterns and events.

CONCLUSIONS

It is evident that the smoking of marihuana does have a detrimental effect on driving skills and performance in a restricted driving area, and that this effect is even greater under normal conditions of driving on city streets. Whereas the street portion approximated normal driving conditions, it should be emphasized that the context of the driving experience even on city streets was experimental. Recommendations are that driving under the influence of marihuana should be avoided as much as should driving under the influence of alcohol.

Landauer, Ali A.; Milner, Gerald; and Patman, J. Alcohol and amitriptyline effects on skills related to driving behavior. Science, 163:1467-1468, 1969.

DRUG	Alcohol; Antidepressant
SAMPLE SIZE	21
SAMPLE TYPE	Medical Students
AGE	Adults (mean 22)
SEX	18 Male; 3 Female
ETHNICITY	White
GEOGRAPHICAL AREA	Australia
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Laboratory/Examination; Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	8

PURPOSE

Drugs which act on the central nervous system are being prescribed with increasing frequency. Since animal studies indicate that antidepressants may add to the effects of alcohol, the effects of amitriptyline and alcohol on some skills related to driving behavior were tested in humans.

METHODOLOGY

Twenty-one healthy medical students, 18 men and 3 women, volunteered as subjects. Their mean age was 22 years. The subjects were randomly placed in one of three groups of seven subjects each; one woman was placed in each group. Group A received amitriptyline twice, the first dose on the night before and the second on the morning of the testing day. Group B received placebo at night and amitriptyline on the test day. Group C received placebo on both occasions. A double-blind technique was used for drug administration and for the recording and scoring of test results. The dose of amitriptyline was 0.8 mg per kg body weight. Tests began two hours after the second administration of the drugs or placebo. The tests used were a simulated driving task, a dot-tracking test, and pursuit-rotor test. The proportion of errors to total recorded responses was used as the score in the simulated driving task; the number of dots tracked accurately was the score in the dot-tracking test; and the total time on target was the score in the pursuit-rotor task. After completing the tests, subjects were asked to drink their preferred alcoholic beverage over a period of 30 to 45 minutes. Alcohol was given so that blood alcohol would be at the .08% level. Fifteen minutes later, the tests were repeated.

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RESULTS

Results of the simulated driving test showed that when the subjects were sober, the means of the proportions of errors did not differ significantly between the three treatment groups. Alcohol consumption did not affect Group C, but did interact significantly with amitriptyline ($p<.01$). Group B had a mean proportion of errors of 0.064 when sober and 0.280 after alcohol ($p<.05$). Group A had a mean error score of 0.113 when sober and 0.434 after alcohol ($p<.01$).

In the dot-tracking test, the mean scores of the three groups did not differ significantly when sober. Subjects in Group C showed a practice effect, making a higher mean score after alcohol. Subjects given amitriptyline showed a reversal of this trend; the amitriptyline-alcohol interaction completely overcame the practice effect. The mean score for Group B was 130.2 when sober and 94.3 after alcohol, and for Group A the mean scores were 118.0 and 82.9, respectively. The interaction effect was significant for both Group A and Group B ($p<.01$).

In the pursuit-rotor rest, mean time on target differed significantly between the three groups ($p<.05$) and between conditions of alcohol intake ($p<.05$). The interaction effect approached statistical significance ($p<.10$).

CONCLUSIONS

The results indicate that amitriptyline, a tricylic antidepressant commonly prescribed for outpatients, potentiates the effects of alcohol as judged by performance of subjects on three motor-skill tasks related to driving. However, it seems likely that the patient's chief hazard is during the first day or two of therapy; another study (Patman, 1968) found that after three or four days of medication, the combined effect of amitriptyline and alcohol did not seriously affect motor skills.

Lawton, M. Powell, and Cahn, Burton. The effects of diazepam (Valium) and alcohol on psychomotor performance. Journal of Nervous and Mental Disease, 136:550-554, 1963.

DRUG	Tranquilizers
SAMPLE SIZE	20
SAMPLE TYPE	Volunteer
AGE	Adults (23-57)
SEX	Male
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Philadelphia, Pennsylvania
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Psychological Tests; Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	2

PURPOSE

Clinical studies of new drugs which act on the central nervous system should include an assessment of the interaction of the drug and alcohol. In this investigation, an attempt was made to determine whether diazepam (Valium) significantly effects psychomotor function, and whether there is a potentiation liability of the drug on alcohol ingestion as measured by the same psychomotor tests.

METHODOLOGY

Subjects were 20 men, ranging in age from 23 to 57 years, who had no clinical manifestation of physical or emotional disease. Each subject was randomly assigned to one of four treatments: placebo tablet and liquid placebo; placebo tablet and alcohol; diazepam and liquid placebo; and diazepam and alcohol. The study was conducted for a total of 16 days. The psychological tests given were: cancellation of all letter e's in a paragraph of meaningful material (speed and number of errors were judged separately); a digit symbol test; an addition test; and a pegboard test.

RESULTS

Mean raw scores on the test indices and their standard deviations showed that differences among the four conditions of medication were small, and that variances within any one set of four test scores did not differ significantly. The rank order for the four medication groups showed the two diazepam groups having consistently poorer performance than the two placebo pill groups, while alcohol had no consistent effect on performance ($p<.05$).

For cancellation speed scores, there was no significant effect due to order of medication, but there were statistically reliable effects of practice ($p<.01$) and medication ($p<.05$). When pairs of medication groups were considered, the placebo-placebo group was superior to the diazepam-placebo group ($p<.10$), and the placebo-alcohol group was superior to the diazepam-alcohol group ($p<.10$). Neither order of medication, nor practice, nor type of medication had any effect on number of cancellation errors. For digit symbol scores, practice was again a factor in adequacy of performance ($p<.01$), and type of medication was of marginal significance ($p<.10$). Only the practice effect had any effect on performance for the addition scores ($p<.01$). For the pegboard scores, order of medication had a significant relationship on performance ($p<.05$), practice had a significant effect ($p<.01$), and type of medication was associated with differential performance ($p<.01$). Individual t-tests for pegboard scores showed the placebo-alcohol group was superior to the drug-placebo group ($p<.01$), the placebo-placebo group was superior to the drug-placebo group ($p<.02$), and the diazepam-alcohol group was superior to the diazepam-placebo group ($p<.02$).

CONCLUSIONS

A regularity in the pattern of mean values for performance in the five tests under the four drug conditions led to the conclusion that performance under diazepam medication, whether with placebo drink or alcohol, was slightly poorer than performance with placebo pill. This finding was apparent, however, in only two of the five tests measuring psychomotor performance, and appeared only when the results were grouped together. There was no evidence to suggest a potentiating decrement of performance with a combined dosage of diazepam and alcohol.

Linnoila, M. Drug effects on psychomotor skills related to driving: Interaction of atropine, glycopyrrhonium and alcohol. European Journal of Clinical Pharmacology, 6:107-112, 1973.

DRUG	Anticholinergics; Alcohol
SAMPLE SIZE	170
SAMPLE TYPE	Students
AGE	Adults (19-23)
SEX	Not Specified
ETHNICITY	White
GEOGRAPHICAL AREA	Helsinki, Finland
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	13

PURPOSE

Anticholinergics are generally used for the treatment of gastric disorders, often for long periods, and many outpatients drive while under their influence. In this study, the psychomotor effects of atropine, which in addition to its strong peripheral action, has a central antimuscarinic effect, were investigated. Atropine was compared with glycopyrrhonium, a more peripherally acting anticholinergic, and the interaction of these agents with alcohol was examined.

METHODOLOGY

The subjects were 170 student volunteers aged 19-23 years. The subjects were divided into seven groups, each containing 20 subjects, which were tested on choice reaction and coordination tests; another 10 subjects were added to each group for an attention test. The groups were treated in the following ways: no drug + no drink (zero group); placebo drug + placebo drink (placebo group); placebo drug + alcohol 0.5 g/kg body weight (A5 group); atropine 0.5 mg + placebo drink (At group); atropine 0.5 mg + alcohol 0.5 g/kg (AtA group); glycopyrrhonium 1 mg + placebo drink (G group); glycopyrrhonium 1 mg + alcohol 0.5 g/kg (GA group). Subjects were asked to assess their feelings about their own performance after every test period by means of a rating scale; they were also asked to assess the nature of their drug and drink. The tests were repeated at 30, 90, and 150 minutes after administration of the agents.

RESULTS

Subjective Assessments

Anticholinergics alone did not alter subjects' feelings about their performances as compared with the zero and placebo groups. However, in combination with alcohol they felt impaired at 30 minutes; this effect disappeared at 90 minutes. The subjective feelings about performance were similar in the AtA and GA groups, although more than 60% of the GA subjects considered their treatments as tranquilizing, compared to only 40% in the AtA group.

Psychomotor Skills

Alcohol 0.5 g/kg shortened reaction times significantly at 30 minutes, while the accuracy of reactions remained unaltered. Atropine 0.5 mg and glycopyrrhonium 1 mg both had qualitatively stronger effects on reaction times than alcohol. After atropine, the reactions were faster than those in the zero group, even in the 150-minute test period. When a combination of an anticholinergic and alcohol was administered, no shortened reaction times were found.

Coordinative skills in the A5, At, and AtA groups were the same as in the zero and placebo groups. The mistake percentages in coordination test I (fixed-speed driving) at 90 minutes were significantly smaller in the G ($p<.05$) and GA ($p<.01$) groups, and the driving times at 150 minutes were significantly shorter in the G group than those in the zero group ($p<.05$). The driving times in the AtA group were significantly shorter in the 90-minute test period than in the GA group ($p<.05$).

Attention Test

The numbers of correct responses during the first minute of every experiment were significantly smaller in the A5 group than in the zero group. A similar effect was also observed after anticholinergics. The only agent impairing the total number of responses significantly as compared with the zero group was alcohol ($p<.05$) in the 90-minute test period. At 30 minutes the total number of responses in the AtA group was significantly larger than in the AG group ($p<.05$).

CONCLUSIONS

Anticholinergics had a relaxing effect on the subjects, while simultaneously impairing their attention to a degree that could be considered dangerous for driving. No discrepancy between the subjective assessment of performance and objectively measured performance was observed with the anticholinergics.

Linnoila, M., and Mattila, M.J. Drug interaction on driving skills as evaluated by laboratory tests and by a driving simulator. Pharmakopsychiatrie Neuro-Psychopharmakologie, 6:127-132, 1973.

DRUG	Alcohol; Tranquilizers; Barbiturates; Antihistamines; Anticholinergics
SAMPLE SIZE	1,600
SAMPLE TYPE	Military; Students
AGE	Adults (19-22)
SEX	Male
ETHNICITY	White
GEOGRAPHICAL AREA	Finland
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Interviews; Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	3

PURPOSE

The ultimate objective of any research in the field of drugs and driving must be to improve road safety. Every time a new pharmaceutical is registered, health authorities are anxious to get information concerning the interaction of the drug and alcohol on driving skills. The actions and interactions of alcohol and tranquilizers, hypnotics, sedatives, and anticholinergic drugs were examined using laboratory tests and a driving simulator.

METHODOLOGY

The laboratory tests included a choice reaction test that measured concentrated attention; a coordination test in which the subject had to keep a black ball on a narrow illuminated track by turning a steering wheel; and an attention test in which the subject had to follow two central and two lateral dials with revolving pointers. Driving behavior was assessed using a Sim-L-car with one point system shadow projection. Clutch, brake, gears, flashing lights, as well as changes in steering and speed were recorded in a number of individual movements.

Subjects consisted mainly of male students and conscripts aged 19-22. In addition to performing the assigned tasks, they were asked for their opinion as to their capacity of performance. The laboratory tests were done 30, 90, and 150 minutes after drug intake. Both placebo and "no treatment" groups were included. The driving period was 40 minutes, starting 30 minutes after drug intake.

RESULTS

Laboratory Tests

Ethyl alcohol (0.5 and 0.8 g/kg body weight) slightly shortened reaction time in comparison with no treatment or placebo. It did not modify coordination, but strongly deteriorated attention performance at 90 and 150 minutes after intake.

Among minor tranquilizers, diazepam (5 and 10 mg) shortened reaction time and reduced the number of mistakes in the choice reaction test, without modifying coordination and attention test performances. Most subjects said their performance improved. When diazepam and alcohol (0.5 or 0.8 g/kg) were given together, any combination impaired all parameters measured, without similar loss in subjective capacity of performance. One might consider this dangerous for driving. Among major tranquilizers, thioridazine (25 mg) shortened reaction time without modifying coordination, and it strongly deteriorated attention performance. In combination with alcohol, reaction time remained unaltered, coordination deteriorated most clearly at 90 minutes, and attention performance was not affected.

Among hypnotics, nitrazepam (10 mg) did not modify reactive or coordinative skills. In combination with alcohol, it still left reaction and coordination unaltered, but attention performance was impaired at 30, 90, and 150 minutes. Among anticholinergic drugs, atropine (0.5 mg) shortened reaction time at 30 and 90 minutes, left coordination unaltered, and impaired attention. Alcohol further impaired attention, while reaction time and coordination remained on the placebo level.

Simulated Driving

Alcohol alone increased the collision frequency and made the subjects prone to ignore instructions and traffic rules. Diazepam alone increased the collision frequency, as did codeine. Diazepam in combination with alcohol resulted in an increased number of collisions, negligence of rules, and deviations from the road. Codeine acted similarly to diazepam in combination with alcohol. Generally, the most sensitive variables to drug effects were changes in steering direction, flashing lights, brakes, and clutching.

Linnoila, M., and Mattila, M.J. Drug interaction on psychomotor skills related to driving: Diazepam and alcohol. European Journal of Clinical Pharmacology, 5:186-194, 1973.

DRUG	Alcohol; Tranquilizers
SAMPLE SIZE	400
SAMPLE TYPE	Students
AGE	Adults (mean 22)
SEX	371 Male; 29 Female
ETHNICITY	White
GEOGRAPHICAL AREA	Helsinki, Finland
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Laboratory/Examination; Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	24

PURPOSE

In the 1960's, consumption of minor tranquilizers increased rapidly; the quantity sold in Finland doubled between 1965 and 1967. Since diazepam has come into common use, its interactions with alcohol deserve attention. In this study, the effects of combinations of diazepam and alcohol on skills related to driving were studied in 200 volunteer students.

METHODOLOGY

The sample consisted of 200 volunteer students whose mean age was 22. The sex ratio of men to women was 14:1. The subjects were divided into 10 groups of 20 persons each as similar as possible with regard to sex, age, weight, educational level, and district of residence. Drug administration was double-blind, with each subject taking two capsules and two drinks (except for the zero group, which took nothing). The capsules contained diazepam (5 mg or 10 mg) or placebo; the drinks contained alcohol 0.5 or 0.8 g/kg or placebo. Each subject was tested 30, 90, and 150 minutes after taking the capsules. All subjects were tested with a choice-reaction test (reacting to light stimuli by pushing either of two foot pedals, and to auditory stimuli by pushing a button) and a coordination test (keeping a black ball on the track by turning a steering wheel) conducted at a fixed speed and then at a speed chosen by the subjects themselves. The subjects were also asked to estimate their own performances by means of a rating scale.

RESULTS

Members of the zero group estimated their performances as slightly lower than normal; the placebo group estimated their performances as less depressed from normal than the zero group subjects. The psychomotor variables measured for the placebo group were generally slightly impaired in

comparison with the zero group, the greatest effect of this type occurring in driving time at 30 minutes. On average, the alcohol group (0.5 g/kg) estimated their performances as slightly better than the zero group. Usually, the psychomotor variables measured were slightly better than those of the zero group; however, the only significant difference ($p<.05$) was in reaction time at 30 minutes. The 0.8 g/kg alcohol group estimated their performances as worse than the subjects in the zero group. Their reaction times were shorter than those in the zero group at 30 minutes ($p<.01$). Also at 30 minutes, their driving times were significantly ($p<.05$) longer than those of the zero group.

The diazepam 5 mg group considered their performances to be definitely better than the zero group. About half the subjects believed that they had received a stimulant and the other half a tranquilizer. Driving time after drug administration was longer ($p<.05$) than that of the zero group. Almost all the variables measured were slightly improved over those in the zero group, but none reached statistical significance. The diazepam 10 mg group estimated their performances as slightly better than the zero group, although this effect appeared late. Most felt they had been given a tranquilizer, and about half felt that they had been given alcohol also. Generally, the diazepam 10 mg group had improved performances in almost all variables measured in comparison with the zero group. Their reaction times at 30 and 90 minutes were significantly shorter ($p<.05$).

The combined diazepam 5 mg/alcohol 0.5 g/kg group estimated their performances as slightly better than the zero group. Overall, the results for this group were worse than for the alcohol 0.5 g/kg group for many variables, particularly the coordination tests. The diazepam 10 mg alcohol 0.5 g/kg group estimated their performances as similar to those of the zero group. They did significantly worse than the zero group in the coordination tests ($p<.05$), and their driving time was significantly longer ($p<.05$). The diazepam 5 mg/alcohol 0.8 g/kg group felt that their performances were slightly worse than the zero group. They did worse on the fixed speed coordination test ($p<.05$) and their driving time was longer ($p<.01$). This group also did worse than the diazepam 10 mg group on the coordination tests. The diazepam 10 mg/alcohol 0.8 g/kg group estimated their performances as definitely worse than the zero group. They did worse on all the tests than the zero group. This group also did worse than the diazepam 10 mg group in most of the variables measured.

CONCLUSIONS

The various combinations of drug and alcohol impaired psychomotor skills and, in general, larger doses were more harmful than lower doses. Psychomotor performance appeared to reach its maximum with low doses of diazepam, as with alcohol. Of the tests employed, the fixed-speed coordination test has the best correlation with real driving. The results on this test did not improve significantly after single drugs, whereas it showed first and most clearly the harmful effects of drug combinations. It would seem reasonable, therefore, to consider that single doses of diazepam or alcohol would not improve actual driving, despite the apparent improvement shown in the various tests.

Linnoila, M.; Saario, I.; and Mäki, M. Effect of treatment with diazepam or lithium and alcohol on psychomotor skills related to driving. European Journal of Clinical Pharmacology, 7:337-342, 1974.

DRUG	Alcohol; Tranquilizers
SAMPLE SIZE	20
SAMPLE TYPE	Students
AGE	Adults (20-23)
SEX	Male
ETHNICITY	White
GEOGRAPHICAL AREA	Helsinki, Finland
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Laboratory/Examination; Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	16

PURPOSE

It has been demonstrated that single doses of 5 or 10 mg of diazepam slightly facilitate the psychomotor performance of normal subjects, but that in combination with alcohol they impair these skills. Since diazepam is used for the long-term treatment of neurotic outpatients, it was decided to determine whether such results from acute experiments were also valid for long-term therapy. Accordingly, a double-blind, cross-over study of the subacute effects of diazepam alone and in combination with alcohol was conducted on psychomotor skills related to driving. Lithium was also included in the study because of its increasing use in the prolonged treatment of depressive patients.

METHODOLOGY

Twenty male students, aged 20 to 23 years, volunteered for the study. Diazepam 5 mg t.i.d. was administered in gelatine capsules; lithium carbonate was administered as sustained release tablets in doses adjusted to give serum concentrations of 0.75 meqw/l; and the placebo was administered as capsules or tablets. The drugs were administered either with alcohol 0.5 g/kg body weight or a placebo drink. The duration of each treatment was two weeks. The tests employed were the choice-reaction test, two coordination tests, and an attention test. Subjects were trained on the apparatus before the experiments began; the tests took place on the 7th and 14th days of each treatment. Each session consisted of three tests, at 30, 90, and 150 minutes after administration of the drug and drink. Half of the subjects received alcohol and half the placebo drink at each session. Blood samples were taken from each subject at the end of each test session. Subjects were also asked to assess their own performances by means of a rating scale.

RESULTS

On the psychomotor tests, there were no statistically significant differences between the results observed at the 7th and 14th days of any treatment. Regarding subjective assessments, placebo and lithium subjects considered their performances to be about normal on the 7th day, while on the 14th day subjects felt that their performances were impaired in the 150 min test. Alcohol produced slight impairment of subjective estimates of performance at 30 and 90 min, but diazepam had no definite effect. The combined effects of alcohol and diazepam or lithium on subjective assessments of performance were generally of impairment, particularly on the 14th day.

On the choice-reaction test, neither the reaction times nor the cumulative number of mistakes differed significantly between the placebo and alcohol groups. The diazepam group had short reaction times and small numbers of mistakes, while the diazepam/alcohol group had longer reaction times and a larger number of mistakes than the placebo group, in particular at 30 min. Lithium prolonged reaction times and increased inaccuracy of responses throughout the sessions. The lithium/alcohol group showed short reaction times and accurate responses, and their performances were stable at all test times.

In the first coordination test the speed was fixed. Alcohol increased the numbers of mistakes, and particularly mistake percentage on every occasion. Diazepam subjects had small numbers of mistakes, but a slightly increased mistake percentage as compared to the placebo group. The mistakes were observed in the diazepam/alcohol subjects at every test time, and their mistake percentage was of the same magnitude as that of the alcohol group. Lithium subjects had increased mistakes but a low mistake percentage; lithium/alcohol subjects had small numbers of mistakes but a high mistake percentage. The second coordination test was at free speed. The placebo group generally had shorter driving times and a lower mistake percentage than the other groups, but their numbers of mistakes were high. The alcohol group showed low numbers of mistakes, increased mistake percentages, and prolonged driving times as compared with the placebo group. At 30 min, the results of the placebo and diazepam groups were similar, but at 90 and 150 min, the mistake percentage of the diazepam group was increased and the driving time slightly prolonged, as compared with the placebo group. In the diazepam/alcohol group, mistake percentage was increased and the driving times prolonged at 30 min as compared with the placebo group, but thereafter, they increased their speed with a moderate reduction in mistake percentage. Lithium increased mistake percentage and prolonged driving times at 150 min; and lithium/ alcohol prolonged driving times and increased mistake percentage at every test time as compared with the placebo group.

On the attention test, the total numbers of cumulative responses were increased after alcohol compared with the placebo group. Diazepam subjects showed similar total numbers of responses and correct responses in the attention test to the placebo group. In the diazepam/alcohol group, correct responses were significantly reduced ($p<.05$) at 30 and 90 min. At 30 min, the lithium group had significantly decreased numbers of correct responses ($p<.05$); similar results were obtained for the lithium/alcohol group.

CONCLUSIONS

The effect of alcohol on psychomotor performance in the present study was more deleterious than in previous acute experiments. A slight deterioration of eye/hand coordination was evident after 7 and 14 days of diazepam 5 mg t.i.d. Lithium significantly impaired information retrieval and response orientation. The combined effects of diazepam and alcohol were deleterious on response orientation and information retrieval, especially at 30 min, and on coordination at 90 and 150 min. Of all the agents examined, diazepam appeared to be the least harmful; lithium and alcohol may create certain extra risks. The combined effects of diazepam and alcohol on psychomotor performance were particularly serious.

Macavoy, Michael G., and Marks, David F. Divided attention performance of cannabis users and non-users following cannabis and alcohol. Psychopharmacologia, 44:147-152, 1975.

DRUG	Alcohol; Marihuana
SAMPLE SIZE	32
SAMPLE TYPE	Volunteer
AGE	Adults (mean 25)
SEX	16 Male; 16 Female
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	New Zealand
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Laboratory/Examination; Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	31

PURPOSE

There is evidence that people use cannabis and alcohol simultaneously in social situations (LeDain Commission, 1972; McFerran, 1973) and while driving (Caswell, 1974). An attempt was made to determine the nature of the interaction of the two drugs on a visual divided attention task.

METHODOLOGY

A total of 32 male and female volunteers were divided into 4 groups, each containing 4 experienced cannabis smokers (mean consumption, 3 joints per week) and 4 subjects naive to cannabis use. Half of each group was female; mean age of the subjects was 25; and users and nonusers were matched for age and educational background. In four testing situations, subjects were required to press a key every time a central light signal was detected, and to press a second key in response to a peripheral light signal. Dose levels of marihuana cigarettes were 0, 2.62 mg, and 5.24 mg of THC, and alcohol intoxication levels were 50 and 100 mg/ml. A placebo drink was also prepared. Each group received the same alcohol treatment (no drink, placebo, 50 or 100 mg/100 ml for the 4 occasions of testing), and a single-blind was used. Four levels of cannabis were administered (no cigarette, placebo, 2.62 and 5.24 mg THC), in a double-blind, one week apart. In each session, the drink was taken first and 20 minutes later the cigarette was smoked. A pulse reading was taken three times during the experiment (on entering the laboratory, prior to smoking, and 5 minutes following the cigarette); breath analyses were taken 30 minutes after alcohol intake and again 70 and 110 minutes later.

RESULTS

Central Signals

A highly significant decrement in the number of correct responses to the center signal was recorded following cannabis ($p<.001$), and for all subjects the increase in misses was dose-related. Alcohol did not affect the performance in any statistically significant way. There were no significant interactions between alcohol, sex, cannabis usage history, and cannabis. A significant increase occurred in the number of false alarms ($p<.05$) with the high dose of alcohol; this was accentuated by the addition of a low dose of cannabis. Analysis of variance on indices of sensitivity revealed an interaction between alcohol and cannabis usage ($p<.025$). Cannabis users showed a 13% improvement in sensitivity with increased dosage of alcohol, while nonusers showed a 26% reduction ($p<.05$). The difference in sensitivity between users and nonusers at the high dose of alcohol was significant ($p<.01$).

Under the combined intoxication of cannabis and the high dose of alcohol, there was a large reduction for nonusers in sensitivity to the central signals. Differences in sensitivity between the placebo alcohol and the 96 blood alcohol level groups at 2.6 and 5.2 mg THC were significant ($p<.02$ and $p<.01$, respectively). The placebo alcohol group showed an improvement (nonsignificant) in sensitivity under the two cannabis conditions, and a cannabis placebo effect was evident under the low dose of alcohol. There was a trend among users for alcohol and cannabis to act antagonistically, although this was not statistically significant.

Peripheral Signals

The number of correct responses to the peripheral signals was also significantly reduced following cannabis administration ($p<.005$). The number of misses was highest in the group receiving no drinks under the high dose of cannabis. A significant number of false alarms also occurred following cannabis ($p<.01$), and a high dose of alcohol with a low dose of cannabis produced the greatest increase in false alarms. Sensitivity was significantly reduced following cannabis ($p<.01$); alcohol had no effect. In users, alcohol and cannabis acted antagonistically on sensitivity, while in the nonusers the two drugs behaved synergistically.

CONCLUSIONS

The results confirm previous experiments (Casswell and Marks, 1973) showing a cannabis-related impairment on the ability to detect central and peripheral signals when the operator has to divide his attention between two signal sources. This experiment has since been repeated using a within-subjects design for both cannabis and alcohol. Both alcohol and cannabis were found to be significant main effects, but no significant interactions occurred between any of the factors (alcohol, cannabis, sex, and cannabis usage history), and there was a trend for the two drugs to act antagonistically among cannabis users at low dose levels.

Manno, Joseph E.; Kiplinger, Glenn F.; Haine, Susan E.; Bennett, Ivan F.; and Forney, Robert B. Comparative effects of smoking marihuana or placebo on human motor and mental performance. Clinical Pharmacology and Therapeutics, 11:808-815, 1970.

DRUG	Marihuana
SAMPLE SIZE	8
SAMPLE TYPE	Students
AGE	Adults (23-29)
SEX	Male
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Indianapolis, Indiana
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Laboratory/Examination; Cornell Medical Index; Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	15

PURPOSE

Several studies have been conducted on the pharmacologic, toxicologic, and psychologic effects produced by smoking marihuana cigarettes or ingesting relatively pure samples of delta-9-tetrahydrocannabinol (THC). Other studies have shown that the pursuit meter and auditory feedback (DAF) can demonstrate decrements in performance after alcohol intake. The purpose of this study was to evaluate the sensitivity of these testing systems to effects produced by marihuana.

METHODOLOGY

Eight male volunteer medical and graduate students, aged 23 to 29, who were either experienced cigarette or marihuana smokers, were used. Subjects were tested on each of two occasions at least one week apart. Cigarettes were administered in a random double-blind fashion, with each subject receiving active marihuana one week and placebo the other. The marihuana cigarette contained about 10 mg of THC. Performance was tested with a pursuit meter consisting of a dual beam oscilloscope and a steering device; it was programmed to display patterns of varying complexity with one beam while the subject tried to track these patterns with a second beam. The test consisted of ten sweeps of each pattern across a screen, and error scores were calculated as total millimeters of deviation from a perfect score. (Thus, the higher the score, the poorer the performance.) A second set of tests used delayed auditory feedback to measure mental performance in a condition of self-induced anxiety. Nine different tests, each lasting two minutes, were used; errors were enumerated as total output divided by mistakes. The Cornell Medical Index was administered 30 minutes after treatment; blood samples were taken 30 minutes after the start of the marihuana smoking and at the end of the experimental period, and urine was analyzed.

RESULTS

Error scores after smoking a marihuana cigarette were significantly higher than after placebo (significant differences being $p<.01$ for the first test pattern and $p<.05$ for the remaining three). For the delayed auditory feedback procedure, there was a higher percent of error after smoking marihuana for all nine tests in the series. The increased error was significant for only five of the nine tests (verbal output, $p<.05$; reverse verbal, $<.02$; progressive count, $p<.02$; addition +7, $p<.05$; subtraction, $p<.05$; subtraction +7, $p<.05$). There was a marked and significant increase in pulse rate after smoking marihuana ($p<.001$), but only a slight and not significant increase after smoking placebo. There were no significant changes in blood glucose concentrations after smoking either marihuana or placebo, but there was a slight and significant decrease in plasma potassium levels after smoking placebo ($p<.02$) and after marihuana ($p<.01$). Symptom scores from the Cornell Medical Index showed more symptoms and a greater symptom intensity after marihuana (placebo, 78; marihuana, 227). Results of subjects' guesses as to whether they had smoked marihuana or placebo indicated that those who guessed that they had smoked marihuana, when they actually had placebo, were those who smoked placebo first.

CONCLUSIONS

Smoking a calibrated marihuana cigarette produced significant decrements in human motor and mental performance. It is suggested that doses of THC can be calculated on the basis of the amount of drug delivered in the smoke. Finally, marihuana that is to be used for smoking experiments should be analyzed so that all cannabinols can be differentiated and quantitated; for instance, by using gas-liquid chromatography.

Milner, Gerald, and Landauer, Ali A. Alcohol, thioridazine and chlorpromazine effects on skills related to driving behaviour. British Journal of Psychiatry, 118:351-352, 1971.

DRUG	Alcohol; Tranquilizers
SAMPLE SIZE	21
SAMPLE TYPE	Students
AGE	Adults (mean 24)
SEX	Male
ETHNICITY	White
GEOGRAPHICAL AREA	Australia
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Questionnaire; Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	6

PURPOSE

The environment of most outpatients involves driving and also drinking. Tranquilizers alone or in conjunction with alcohol may contribute to the road toll (Milner, 1969), and studies on animals and humans indicate that a variety of drugs may potentiate the effects of alcohol. In order to assess the effects of chlorpromazine and thioridazine on driving skills, alone and together with alcohol, a group of volunteers were given the drugs and then tested with three motor skill tests.

METHODOLOGY

Twenty-one male students, whose mean age was 24, were randomly assigned to three equal groups receiving either thioridazine, chlorpromazine, or placebo, under blind conditions. A dose of 1 mg/kg body weight was given at night, and a second dose the next morning. Two hours after administration of the second dose, the subjects were tested on a dot-tracking task, a pursuit-rotor test, and a simulated driving test. Subjects were also asked to assess how they felt after drug administration. After these tests, the subjects drank 0.8 ml/kg body weight of diluted ethanol; 30 minutes later, the test battery was repeated.

RESULTS

On the dot-tracking test, alcohol consumption significantly affected performance for the drug and placebo groups. Subjects normally perform better when repeating the task, but in this case the placebo group did not significantly change its performance, and both drug groups showed a significant deterioration ($p<.05$). On the pursuit-rotor test, there was a significant difference

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in performance between the two drug groups and the placebo group ($p<.01$). The interaction between medication and alcohol consumption was significant ($p<.05$), indicating a positive joint drug effect. Previous practice facilitated performance even after alcohol, except in those who had received chlorpromazine. On the simulated driving test, both the drug ($p<.01$) and alcohol ($p<.01$) significantly slowed reaction time. Chlorpromazine produced a significantly slower reaction time than did thioridazine or placebo. Alcohol slowed reaction time in all groups, but there was no synergistic effect. Regarding percentage of errors, a highly significant effect of alcohol was observed ($p<.001$).

In regard to subjective assessments, chlorpromazine users gave a significantly high fatigue rating ($p<.001$). After alcohol consumption, both drug groups reported themselves as more sleepy ($p<.001$), less energetic ($p<.05$), and more fatigued ($p<.01$) than the placebo group. Subjects on chlorpromazine felt more confused ($p<.01$), more intoxicated ($p<.01$), and more amnesic ($p<.05$) than those on thioridazine or placebo.

CONCLUSIONS

The data indicate that alcohol, chlorpromazine and thioridazine affect performance on motor skill tests. The tranquilizers tended to slow reaction times, especially chlorpromazine. Both drugs adversely affected pursuit-rotor performance, and chlorpromazine potentiated alcohol effects on this test. Overall, all tests under the influence of alcohol yielded scores in the same rank order: the placebo group did best, and the chlorpromazine group performed least well. Patients should be warned against drinking alcohol when undergoing treatment with these drugs.

Milstein, Stephen L.; MacCannell, Keith; Karr, Gerry; and Clark, Stewart. Marihuana-produced impairments in coordination. Journal of Nervous and Mental Disease, 161:26-31, 1975.

DRUG	Marihuana
SAMPLE SIZE	32
SAMPLE TYPE	General Population
AGE	Adults (21-59)
SEX	16 Male; 16 Female
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Western Canadian City
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	10

PURPOSE

Several studies have indicated that marihuana can produce acute impairments in perceptual-motor coordination as measured by a pursuit-rotor or tracking task (Kiplinger et al., 1971; Manno et al., 1970; Meyer et al., 1971). The experiment undertaken here compared the effects of marihuana and a placebo on perceptual-motor coordination, motor ability, and visual perception in cannabis-experienced and naive subjects.

METHODOLOGY

Sixteen males and females who were experienced in the use of cannabis and 16 who had never used cannabis received 600 mg of 1.3% delta-9 THC marihuana (M) and a placebo (P) of THC-extracted marihuana double-blind, on two different occasions 7 days apart. Each group of 16 subjects was selected at random on the basis of age and education from a pool of 1,500 normal volunteers from a large western Canadian city. The experienced subjects had an age range of 25 to 59 years, and an education range of 10 to 13 years.

Two practice sessions were held on each occasion; total test time for each test session was 25 minutes. The tests included: perceptual-motor tasks (horizontal and vertical groove task, and hand maze task); motor tasks (finger and toe tapping); visual recognition task (visual recognition threshold, indicating speed of recognition of a stimulus); and subjective measures. For the subjective measures, on each smoking occasion the drug administrator made an appraisal of whether the subject was intoxicated, slightly intoxicated, or not intoxicated; immediately following the performance tests, the Primary Affect Scale (PAS) was administered, and after the second testing session the subjects were asked to identify the substances they received on each occasion.

RESULTS

For each of the perceptual-motor measures, the results showed a statistically significant difference between the change in performance after smoking M and after smoking P. There were also significant interactions between the drug and experience factors for both number of errors and total contact time on the maze task (both at $p<.01$), and number of errors on the steadiness task ($p<.01$). On all four tests, subjects under the M condition showed a postsmoking decrement in performance relative to their performance on the P control. This decrement was almost always greater in the experienced than in the nonexperienced group. A posteriori tests on the maze and steadiness measures showed a statistically significant change ($p<.01$) in performance in the experienced group; the nonexperienced groups showed a trend toward impairment on these measures. There were no statistically significant changes in performance on either measure of motor performance or on the visual recognition task. M did produce an observable state of intoxication in 11 experienced and 9 nonexperienced subjects. According to a Fisher Exact Probability Test, the ability of the subject to make a correct a posteriori identification of the drug condition (experienced subjects, 16/16; nonexperienced, 12/16) appeared related to having had some previous cannabis experience ($p<.05$). Tests confirmed that both the experienced ($p<.01$) and nonexperienced ($p<.02$) subjects correctly identified the M condition significantly better than was possible by chance.

CONCLUSIONS

These data strongly support the conclusion that a moderate dose of marihuana produces an acute impairment in perceptual-motor tasks, which is greater in experienced than nonexperienced subjects, and which is greater for more difficult tasks than for easier tasks. These data, in conjunction with the previously well-documented observations of impairments in cognitive functioning, suggest that behaviors requiring higher-order integration or processing are greatly impaired by acute marihuana intoxication, while simpler behaviors requiring limited processing are minimally affected. Another important observation is that the levels of impairment and intoxication produced were less in the nonexperienced than in the experienced subjects. It can be concluded that the degree to which perceptual-motor performance is affected is such that intoxicated individuals should avoid tasks that require good coordination or cognitive processes.

Moskowitz, Herbert, and McGlothlin, William H. Effects of marihuana on auditory signal detection. Psychopharmacologia, 40:137-145, 1974.

DRUG	Marihuana
SAMPLE SIZE	23
SAMPLE TYPE	College Students
AGE	Adults (mean 24)
SEX	Male
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Los Angeles, California
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Laboratory/Examination; Questionnaire; Sensory Perception Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	13

PURPOSE

A number of studies have reported on the effect of marihuana on vision and hearing. Caldwell et al. (1969) found no effect on auditory absolute, differential frequency, and amplitude thresholds under conditions where subjects controlled the amount of marihuana consumed. In the present study, the effect of marihuana on a more complex auditory perceptual function was examined. Performance changes in auditory signal detection were examined for conditions of both concentrated and divided attention under four dose levels of marihuana. The auditory task was designed to enable the use of a signal detection theory, which permits changes in performance due to a criterion shift to be differentiated from variations in discrimination or sensitivity.

METHODOLOGY

A total of 23 male college students between 21 and 32 years of age, with a mean age of 24, were included in the study. They were screened for emotional or health abnormalities, drug use, and cooperative attitudes by an interview and the MMPI. Applicants were excluded if they had used marihuana less than ten times, were currently using it more than three times per week, or had a history of extensive use of other drugs.

Subjects were seated in a comfortable chair inside a sound isolation chamber. They wore earphones and their instructions were presented by tape recorder. The test tapes contained a digit recall task on one channel, presented to the right ear, and a signal detection task on the other channel, presented to the left ear. The signal detection task presented a series of random noise bursts of 3-second duration each, separated by a 7-second silent intertrial interval. The digit recall task presented a series of lists of six random digits. These occurred at ½-second

intervals during the same three seconds that the noise burst occurred in the other channel. Each subject participated in one training and five experimental sessions. The five experimental days included one with no treatment and four in which marihuana containing 0, 50, 100 and 200 micrograms of delta-9-THC per kg body weight was smoked. The no-treatment test day was included in an effort to measure any marihuana placebo effect.

Two attention conditions were presented. The first was concentrated attention; the tape demonstrated the noise bursts and the tones in the left ear, and digits were presented to the right ear. Subjects were instructed to ignore the digits and attend only to the presence or absence of the tone. The second was divided attention; the subjects were instructed to attend to both ears, reporting the presence or absence of the tone in the noise burst and also repeating the six random digits. Both tests presented 20 training trials with immediate feedback as to the correct response. Test tapes each contained 100 trials. Smoking required 20 minutes, and immediately afterward the subject entered the sound isolation chamber, and experimental testing began. Following the test, subjects were asked to complete a questionnaire describing their subjective state during the test period.

RESULTS

A clear dose-response relationship was evident in the ratings of level of intoxication and the subjective drug effects questionnaire scores. In addition, the placebo condition evoked positive subjective responses. Of the 23 subjects, 19 stated they believed the placebo to be marihuana; however, all but one rated it weaker than the dosage normally smoked.

In contrast to the subjective effects data, the performance scores showed no differences between the no-treatment and placebo conditions. The data did indicate, however, that marihuana produced a significant decrement in auditory signal detection under both attention conditions. This differed from results found earlier for alcohol on the same task (Moskowitz et al., 1968). Alcohol, at a dose level of 0.69 g/kg body weight, produced impairment under conditions of divided attention, but not of concentrated attention. In contrast, marihuana impaired single as well as two-source information processing. The degree of impairment by marihuana was greater under the more complex demands of divided attention conditions ($p<.01$). On the other hand, digit recall in the divided attention task was only minimally affected by marihuana. Two types of errors--false alarms and misses--were significantly affected by marihuana. The drop in signal detection performance was produced by an increase in both possible errors; however, the rate of increase of false alarms was almost twice as rapid as that of misses.

The results for subjects using marihuana less than two times per week (N=11) were compared with those using it two or more times per week (N=12). For the four performance measures (signal detection under concentrated and divided attention conditions, and digit recall and joint task performance under divided attention conditions) there was a slight trend toward more impairment among the low-use group, but none of the differences approached statistical significance. The high-use group rated its level of intoxication substantially higher than did the low-use group.

CONCLUSIONS

The signal detection performance which declined under the effects of marihuana was due, at least in part, to an effect upon perceptual discrimination sensitivity, independent of a change in subject criterion. The change in scores was clearly dose-dependent for both concentrated and divided attention, and this was confirmed by an analysis of variance for linear trend. This does not imply that marihuana necessarily affects sensory transducer or transmission mechanisms; the locus of the effect is very likely on attention or the central processing of the input data. There is no evidence to suggest that auditory sensory processes are affected by marihuana.

Moskowitz, Herbert; Hulbert, Slade; and McGlothlin, William H. Marihuana: Effects on simulated driving performance. Accident Analysis and Prevention, 8:45-50, 1976.

DRUG	Marihuana
SAMPLE SIZE	23
SAMPLE TYPE	Volunteer; College Students
AGE	Adults (21-32)
SEX	Male
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	California
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Driving Simulator; Visual Test
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	10

PURPOSE

Two previous studies have measured the effects of cannabis and alcohol on simulated driving performance, with conflicting results regarding the effects of marihuana (Crancer et al., 1969; Rafaelson et al., 1973). To shed further light on the effect of marihuana on simulated driving performance, a more complex simulator was used.

METHODOLOGY

Subjects were 24 male college student volunteers between 21 and 32 years of age. Applicants were excluded if they: (1) reported less than 10 marihuana experiences, (2) were currently using marihuana more than three times per week or had an extensive history of other drug use, (3) did not have a driver's license and a minimum of 2 years' driving experience, or (4) gave evidence of emotional or health abnormalities at the initial interview. One subject did not complete the experiment; the results are for 23 subjects.

The experiment utilized a driving simulator which had an actual car mounted on a chassis dynamometer facing a 20-foot-wide cylindrical screen. The subject was required to manipulate the steering wheel as the projected scene moved laterally to follow the contours of the road. The study utilized three films: a training drive, and two test drives. Analysis was restricted to 36 segments of the drive which occurred in both test films. For the 36 segments, the following 25 performance scores were examined: 7 speed scores, 6 accelerator scores, 3 brake scores, 5 steering wheel scores, and 4 tracking scores. In addition, subjects were required to respond to a visual subsidiary task in order to present the driver with an information processing demand

similar to that found in actual driving, where attention is divided between a tracking task and a search and recognition of the environment task.

The subsidiary task required one of four lever responses to four corresponding light signals. The measures recorded were number of incorrect responses, and reaction time for correct responses regardless of whether or not it was preceded by an incorrect response.

The 4X4 Latin square experimental design required four test days for each subject. Both placebo and active marihuana treatments were administered. The delivered doses were 0, 50, 100, and 200 micrograms delta-9 tetrahydrocannabinol (THC) per kilogram body weight. Treatment sessions for an individual subject occurred at weekly intervals and at the same time of day.

RESULTS

The pulse rates for the four treatments showed the characteristic cannabis-induced increments. There was also an unexplained pulse rate increase following the placebo administration (before smoking, 76.7; after smoking, 87.6). None of the analyses of variance was statistically significant for treatment effects. Of the 150 paired comparisons, only 7 (4.7%) were statistically significant for treatment effects. Thus, the data provide no evidence that marihuana significantly affects car control performance as measured by the driving simulator. For the subsidiary light task, there was only one incorrect response in the entire experiment which was not corrected, and it was dropped from the analysis. The data suggested a dose-related impairment of reaction times to the subsidiary task. For the category of all responses, including omissions, the three active drug treatments produced increases of mean reaction times of 5.3, 10.6, and 11.6% (significant at the .05 level). Relative changes in the category of all responses, excluding omissions, were 5.3, 10, and 11.1% (significant at the .01 level). Initially correct responses had increased reaction times of 3.0, 10.3, and 9.1% (significant at the .01 level). While there appeared to be a trend toward increasing within-subject reaction time variability as a function of marihuana dose, this did not prove to be statistically significant.

CONCLUSIONS

The results of the present experiment are consistent with those found in the two earlier studies of the effect of cannabis on driving simulator performance. Both reported the impairment of a perceptual or attentional task performed while attending to the steering or compensatory tracking requirement. It appears highly probable that these cannabis-induced deficits are primarily related to attention or perception and not to an impairment of motor responsiveness. The fact that the present study did not find an impairment of car handling or tracking does not eliminate this aspect as a possible driving hazard related to marihuana consumption. Overall, the available evidence from the present and other relevant studies appears to indicate that any marihuana-related impairment of driving ability is more likely to be associated with perception and attention deficits than with the motor skills involved in car handling.

Moskowitz, Herbert; Sharma, Satanand; and Shapero, Max. A comparison of the effects of marijuana and alcohol on visual functions. In: Current Research in Marijuana. New York: Academic Press, Inc., 1972. pp. 129-150.

DRUG	Marihuana; Alcohol
SAMPLE SIZE	60
SAMPLE TYPE	Volunteer
AGE	Adults (21-30)
SEX	Male
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	California
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Laboratory/Examination; Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	13

PURPOSE

Three sets of experiments were designed to compare alcohol and marihuana effects on visual functions. The first set examined drug influences on the detection of peripheral lights under three levels of central visual information processing demands. The second set studied drug effects on autokinesis. The third set examined drug effects on visual acuity adaptation and ocular motor control. Results dealing with marihuana effects will be presented here.

STUDY I.

METHODOLOGY

Twelve male college students between the ages of 21 and 29, who had at least 10 previous experiences with marihuana but were currently not using it more than once a week, were used. At each test session, peripheral light detection was examined under three conditions of central visual information processing demand: (1) central fixation light remaining on continuously, (2) blinking conditions at 0.4 blinks per second, and (3) 0.8 blinks per second. In the blinking conditions, the subjects were required to respond to the stimuli and to count the blinks and report them. There were 36 trials under each of the three central load conditions, of which 2 were placebo trials with no peripheral light presentation. At the test sessions, each subject smoked two cigarettes containing either detoxified marihuana or active marihuana assayed at 1.4% THC. Pulse rates were obtained before and after smoking.

RESULTS

Marihuana produced a large decrement in peripheral signal detection under all conditions of central visual information processing, including that condition where no central information processing was required. The increase in misses under marihuana averaged 46.5%, and was statistically significant ($p<.01$). Within each of the central load conditions the marihuana treatment effect was statistically significant beyond the $p<.01$ level. There was a small effect in mean reaction times to the peripheral signals due to marihuana ($p<.01$), but no influence of central loads upon reaction time was found. Errors in counting the blinking central fixation light increased under marihuana: at the slow rate, errors increased from 6.25 under placebo to 10.9 under marihuana; at the fast blink rate, from 8.42 to 12. The effects of blink rate and marihuana upon counting errors were statistically significant (both at the .05 level).

STUDY 2.

METHODOLOGY

Autokinesis refers to the phenomenon of the apparent movement of a stationary point source of light viewed in the dark. Twelve male subjects received doses of 0, 50, 100, and 200 mcg THC per kilogram of body weight, and twelve male subjects received alcohol doses of 0 and 0.69 g/kg body weight. Subjects were asked to identify the square in a grid into which a light appeared to fall. In essence, the subject located the fixation point of the light afterimage on the grid.

RESULTS

The marihuana treatments produced 15%, 108%, and 209% increases in mean distance of apparent movement. In comparison with the placebo condition, the two highest doses were significant. For the 50, 100, and 200 mcg THC treatments, there were 7, 11, and 12 subjects, respectively, showing an increase in apparent movement as compared to the placebo treatment.

STUDY 3.

METHODOLOGY

Visual functions examined were dark adaptation, visual acuity, fusion, and vergence. Twelve male subjects between the ages of 21 and 30 served in a replicated 3X3 Latin square design. All subjects had a minimum of 10 prior marihuana experiences but were not currently using marihuana more frequently than twice a week. Three treatments were used: placebo, 0.69 grams alcohol per kilogram body weight, and 310 mcg THC per kilogram body weight.

In the dark adaptation test, the Goldmann-Weekers adaptometer was used. For the visual acuity test, a Bausch & Lomb Clayson projecter with a modified Koenig Bars test target was used, and the angular substance of the width of the separation bar when the subject correctly identified angular orientation was defined as the measure of visual acuity. The Worth four dot test assessed binocular vision. The test of lateral and vertical phoria tested the position the eyes assume, relative to each other and to a fixation target, when fusion of the fixation target is rendered impossible. Finally, duction tests measured the lateral and vertical range of fusional vergence eye movements.

RESULTS

In the dark adaptation test, compared to the placebo, marihuana had the effect of reducing the time required by the subjects to dark adapt. Mean times were: placebo, 7.562 minutes and marihuana, 6.662 minutes. This difference, however, did not approach statistical significance. For the visual acuity test, the mean minimum angles of resolution in minutes of arc were: placebo 1.579 and marihuana 1.651. For the Worth four dot test, the marihuana treatment had no significant effect upon vertical phoria, but there were significant effects of the treatment upon lateral phoria. The mean prism readings increased under marihuana by 2.5 diopters. The differences between marihuana and placebo were statistically significant ($p<.01$).

Finally, for the duction tests, treatment effects on supraduction, infraduction, and abduction were nonsignificant. However, for the abduction condition, the range within which subjects could see singly was smaller as a result of the drug treatments. Thus it required smaller prisms to cause the subjects' vision to blur, break fusion, or permit fusion recovery. Differences between placebo and marihuana were statistically significant: blur ($p<.05$), break ($p<.01$), recovery ($p<.01$).

CONCLUSIONS

The data indicate that marihuana creates a large and statistically significant impairment of peripheral signal detection, which appears independent of the level of information processing required for sensory input from central vision. Marihuana has only a small effect on reaction time. The reported effects of marihuana on reaction time may often be an artifact of the experimental situation, in which a delay in perception of the stimulus is mistaken for an effect on a motor component of behavior. Marihuana also appears to significantly influence autokinesis, and to a much greater extent than has been reported for alcohol.

Marihuana influences visual transducing or sensory transmission mechanism very little, as evidenced by the resistance to impairment of visual acuity and dark adaptation at relatively strong dose levels. However, the drug does produce an impairment of ocular motor control. These results are very similar to those reported for alcohol.

Although it has been reported that alcohol impairment appears to be larger than marihuana impairment, it is clear that marihuana does impair visual perceptual performance to a large degree, and potential users should be warned that is likely to lead to accidents.

Mould, G.P.; Curry, S.H.; and Binns, T.B. Interaction of glutethimide and phenobarbitone with ethanol in man. Journal of Pharmaceutical Pharmacology, 24:894-899, 1972.

DRUG	Alcohol; Depressants
SAMPLE SIZE	15
SAMPLE TYPE	Volunteer
AGE	Adults
SEX	10 Male; 5 Female
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	London, England
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Laboratory/Examination; Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	4

PURPOSE

Interactions between ethanol and other drugs in man have been documented, but few reports have included documentation of drug concentrations in body fluids, in spite of the fact that many drug interactions can be explained in terms of modifications of such concentrations. In this study, the interactions of ethanol with two depressant drugs--glutethimide and phenobarbitone--were examined by means of psychomotor tests and measurement of ethanol and glutethimide in body fluids.

METHODOLOGY

Experiment 1

This experiment measured glutethimide in urine and ethanol in whole blood, and the effect of these drugs on psychomotor performance. Four male and two female subjects in good health fasted for a minimum of 4 hours before receiving one of four treatments: A + B, A + D, C + B, and C + D, where (A) equaled 100 ml vodka (40% w/v ethanol) diluted with an equal volume of water, (B) equaled capsules containing 250 mg glutethimide, (C) equaled a "placebo" drink consisting of 10 ml vodka floated on the surface of 190 ml water, and (D) equaled placebo capsules, containing lactose. Each subject attended four sessions, and the treatments were allocated in a double-blind fashion. The psychomotor tests consisted of a three-minute tracking test, a two-minute reaction-time test, and a one-minute finger-tapping test. Urine and blood samples were taken before and after drug administration.

Experiment 2

Subjects consisted of two males and one female who fasted for a minimum of 4 hours before receiving either glutethimide alone (250 mg) or in combination with 50 ml of whisky (39% w/v ethanol). Venous blood samples were collected every half hour up to 2½ hours after dosing.

Experiment 3

Two preparations were used: (1) 50 ml vodka diluted with an equal volume of flavored water and (2) capsules containing 30 mg phenobarbitone. In each session, four male and two female subjects in good health fasted for a minimum of 4 hours before receiving the ethanol alone or with 60 mg phenobarbitone. Capillary blood samples were collected at 5, 15, 30, 60, and 90 min after commencement of the ethanol dose.

In the experiments, plasma and urinary glutethimide were measured in 5 ml aliquots by extraction of unmetabolized drug, concentration of the extracts, and gas chromatography of the concentrates.

RESULTS

Regarding the effect of glutethimide on blood ethanol concentrations in experiment 1, two contrasting phenomena were observed. At 15, 45, and 75 min, the ethanol concentrations were not significantly different from each other. At 105, 135, and 165 min there was a significantly higher ethanol concentration after the combination treatment ($p<.01$). The difference in the overall mean concentrations was 11%. In experiment 2, the overall mean blood ethanol concentration following whisky alone was very low at 1.2 mg/100 ml; the concentration after combination treatment was increased to 11.4 mg/100 ml.

Urinary glutethimide (μg/ml) after 1.75 hours was 0.24 ± 0.03 for the drug alone, and 0.11 ± 0.01 after the drug and ethanol. Thus there was a lower concentration of glutethimide in the urine after the combination treatment than after the drug alone. This difference was significant ($p<.001$), and was similarly significant after 2.75 hours.

Regarding psychomotor tests, analysis of variance indicated that mean changes in reaction time for the four treatments in experiment 1 were significant ($p<.005$), but this was due to the combination treatment producing the largest overall slowing of reaction time; the time was significantly different from that following the other treatments at 105 and 135 min ($p<.01$).

A significant deterioration in ability on the tracking test was caused only by the glutethimide alone ($p<.01$ at 105 and 135 min). Again, glutethimide alone produced a significantly lower number of finger taps at 75 and 135 min compared with the other treatments ($p<.005$).

In contrast to the results above, 60 mg phenobarbitone produced an overall decrease in blood ethanol concentrations. Although the decrease was not significant, the differences in the blood concentrations due to ethanol treatment alone and in combination were significant at 30 and 90 min ($p<.01$).

CONCLUSIONS

These data contribute to the understanding of interactions between ethanol and depressant drugs in several ways. They demonstrate the occurrence of several interactions, they illustrate the possibility of the interactions resulting from changes in drug concentrations, and they point to a possible difference in behavioral tests: reaction time is apparently most sensitive to ethanol, and tracking and finger tapping are apparently most sensitive to glutethimide.

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Palva, E.S.; Linnoila, M.; and Mattila, M.J. Effect of active metabolites of chlordiazepoxide and diazepam, alone or in combination with alcohol, on psychomotor skills related to driving. In: Mattila, J.J., ed. Alcohol, Drugs and Driving. Modern Problems of Pharmacopsychiatry. Vol. 11. Basel: S. Karger, 1976. pp. 79-84.

DRUG	Tranquilizers
SAMPLE SIZE	40
SAMPLE TYPE	Students
AGE	Adults (20-29)
SEX	17 Male; 23 Female
ETHNICITY	White
GEOGRAPHICAL AREA	Helsinki, Finland
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Laboratory/Examination; Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	11

PURPOSE

Several benzodiazepines with similar pharmacological properties are widely used in medical practice, and some of them, as well as their metabolites, accumulate in tissues during treatment. Many of the metabolites are pharmacologically active and have a long halflife. In the study presented here oxazepam, methyloxazepam, N-desmethyldiazepam and chlordiazepoxide lactam were investigated in regard to their actions and interactions on psychomotor skills related to driving.

METHODOLOGY

Forty students (17 male, 23 female) aged 20 to 29 years volunteered for a subacute double-blind crossover experiment. Two female subjects had to discontinue the experiments, and their results were excluded. The subjects were divided into two groups of 20 persons each. One group received oxazepam (O) 15 mg, methyloxazepam (MO) 20 mg, and placebo t.i.d. for two weeks each. The other group received similarly N-desmethyldiazepam (DMD) 5 mg, chlordiazepoxide lactam (ChL) 10 mg, and placebo t.i.d. In the beginning of each test session, 30 minutes before the first test time, the subjects received alcohol (A) 0.5 g/kg body weight or placebo drink with their drugs.

The psychomotor test battery included a choice reaction test, two coordination tests, an attention test, and two tests measuring hand and foot proprioception. Flicker fusion and horizontal nystagmus were measured as well. At every test time the subjects were asked to assess their feeling of performance and the nature of their treatment. The tests were carried out after taking the first capsule (acute test), and after 1 and 2 weeks' treatment (subacute tests), each time 30, 90, and 150 minutes after drug and drink administration. Blood samples were collected

on the first, seventh, and fourteenth day of each treatment three hours after the administration of the drug. One group was tested in the morning (9 a.m.) and the other in the late afternoon (4 p.m.).

RESULTS

The results obtained on the seventh and fourteenth days did not differ from each other, and were therefore pooled for statistical handling. None of the drugs significantly modified cumulative choice reaction times and errors when compared with placebo. In the acute test, DMD and O increased the reaction time of some subjects, but this result was not statistically significant. In coordination test I (fixed-speed driving), ChL was the only drug which impaired coordination. In all groups receiving alcohol, the coordination mistakes were significantly increased. In coordination test II (free-speed driving), the mistakes were increased in ChL + A and O + A groups. After the first single dose, O prolonged the driving time significantly as did the ChL + A group. Of the single agents, only ChL impaired attention after a single dose, but this effect was not measurable after a week's treatment. ChL was also the only drug that showed significant interaction with alcohol in this task. In the ChL + A group, the number of correct responses was significantly lower than that in the placebo group. Flicker fusion was the only test in which the morning and afternoon groups had different baseline performance: the threshold was significantly higher in the afternoon group. In the acute test, DMD increased the threshold while O tended to lower it. After one or two weeks of treatment, all drug affects disappeared. After the first single dose of MO, a significant impairment of proprioception was found. The ChL + A and MO + A groups showed poor results in later tests. The proprioceptions of hand and foot were equally deteriorated during these treatments. Finally, in the placebo groups, 13% of the subjects had horizontal nystagmus whereas 47% showed nystagmus after alcohol. The DMD + A, ChL + A, and MO + A groups had nystagmus even more often than those receiving alcohol only.

In the acute tests, all treatments improved the feelings of performance, ChL having the least effect. In subacute tests, the subjects receiving alcohol felt their performance to be impaired; of the drugs, only O improved the feeling of performance, and all other treatments impaired it.

CONCLUSIONS

In interpreting these results, the following reservations are necessary. The time of day did not significantly affect reactive coordinative and attentive skills under laboratory conditions. However, the results from the groups tested in the morning (ChL and DMD) may not be fully comparable with those of the groups O and MO tested in the afternoon. Also, in previous acute studies (Linnoila and Mattila, 1973; Linnoila, 1973), the subjects were tested after a short warmup period on the test apparatus, whereas in the present study the subjects were well trained. This difference might be significant, particularly concerning the benzodiazepine interactions with alcohol. However, it is concluded that the diazepam/alcohol interaction on psychomotor skills is mainly due to the parent compound, and no correlations between the serum levels of the agents and the changes of performance were found.

Patman, J.; Landauer, Ali A.; and Milner, Gerald. The combined effect of alcohol and amitriptyline on skills similar to motor-car driving. The Medical Journal of Australia, 2:946-949, 1969.

DRUG	Antidepressants; Alcohol
SAMPLE SIZE	24
SAMPLE TYPE	Volunteer
AGE	Adults (over 21)
SEX	12 Male; 12 Female
ETHNICITY	White
GEOGRAPHICAL AREA	Western Australia
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Driving Simulator; Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	18

PURPOSE

Because of the continued social use of alcohol and the increasingly wide prescription of other psychotropic drugs, it is important to test for interaction between these agents. Landauer et al. (1969) found that, within the first 15 hours of medication, effects of alcohol intoxication on psychomotor skills related to driving behavior were enhanced by amitriptyline. The study presented here was designed to test the effects of five days of this medication on normal subjects, and to examine how similar motor skills are affected when relatively small amounts of alcohol are ingested.

METHODOLOGY

Twenty-four volunteers (12 male and 12 female) aged over 21 years who were on no medication and had no history of psychiatric illness were drawn from among the nursing staff of Clarement Hospital, Western Australia. Each subject was assigned to one of four experimental groups, each group consisting of an equal number of men and women roughly matched for age.

A controlled measure of the combined effect of alcohol and amitriptyline on skills related to driving was obtained by having every subject complete a battery of psychomotor tests, including a short clerical test, a dot-tracking test, pursuit-rotor test, and a simulated driving task. The drug dosage consisted of a total of 400 mg of amitriptyline taken at an average of 50 mg per 12 hours. The alcohol dosage varied between 105 and 195 ml, calculated on the basis of body weight so as to obtain a blood alcohol level of approximately .05 gm/100 ml. All subjects were tested individually, with the order of presentation of the four tests systematically varied over subjects and testing days. A double-blind technique was used.

RESULTS

On the first three tests, subjects in the placebo group performed better than those in the drug group, and improved performance applied both when subjects were sober and when they had consumed alcohol. However, these results were not significant. On the simulated driving tests, the drug group performed better than the placebo group. Alcohol administration significantly altered performance on the pursuit-rotor test ($p<.01$) and the simulated driving task ($p<.05$). In the other tests, no significant decrement in performance due to alcohol intake was noted. In none of the tests did drug administration significantly affect test performance, nor was there a significant interaction effect between drug administration and alcohol.

CONCLUSIONS

The results confirm those obtained by Baker (1968), who reviewed some of the literature on the interaction of drugs. While the results obtained here cannot be generalized to apply to an age group beyond that used in the sample, or to depressed patients, amitriptyline has been used for such a variety of symptoms that its investigation in conjunction with alcohol administration is fully justified. Further research involving other commonly prescribed psychotropic agents, in normal and depressed volunteers and with various dose combinations, is needed before one can be certain that alcohol ingestion does not add to the risks of drug therapy.

Rafaelsen, O.J.; Bech, P.; and Rafaelsen, L. Simulated car driving influenced by cannabis and alcohol. Pharmakopsychiatrie Neuro-Psychopharmakologie, 6(2):71-83, 1973.

DRUG	Cannabis; Alcohol
SAMPLE SIZE	8
SAMPLE TYPE	Volunteer
AGE	Adults (21-29)
SEX	Male
ETHNICITY	White
GEOGRAPHICAL AREA	Denmark
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Laboratory/Examination; Psychological Tests; Simulated Driving Test
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	24

PURPOSE

The effects of cannabis on simple and complex reaction time have been investigated with contradictory results. This may be due to differences in methodology, including cannabis administration. In this study, simulated car driving as influenced by cannabis and alcohol was examined. The research design included principles of placebo, double-blindness, dose response, test for reproducibility, and training effects.

METHODOLOGY

The eight volunteers were male, 21-29 years old, college graduates or skilled workers; none were alcohol or cannabis abusers. Three types of measurements were taken: behavioral (brake time, start time, number of gear changes, mean speed, variation of speed); phenomenological (subjective and objective estimations of time and estimations of distance); and physiological (pulse rate). The procedure included a pretest, a drug test and a posttest. Subjects were given oral cannabis resin containing 4% THC in three doses (200, 300, and 400 mg), alcohol in one dose of 70 g, and placebo. Drug administration was in a double-blind fashion. The car simulator was a Redifon Auto-Tutor.

RESULTS

Both cannabis and alcohol increased brake time and start time (alcohol, brake time, $p<.05$). The effect of both cannabis and alcohol on start time was less marked, and only the increase after 400 mg cannabis obtained statistical significance ($p<.05$). Total number of gear changes was increased by 10% on alcohol, and was statistically significant, while on cannabis there was a decrease with increasing dose, with no statistical significance. Mean speed was not changed

on cannabis or on alcohol. Finally, variation of speed was affected both on cannabis and alcohol; however, the change was only statistically significant for 400 mg of cannabis ($p<.05$).

Cannabis had a pronounced influence on estimates of time and distance (after driving with fixed speeds of 40 and 70 km/h). On cannabis, subjective estimates were often increased by 100%, the maximal increase being 300% on subjective estimate of time interval after driving at a speed of 70 km/h under the influence of 400 mg cannabis ($p<.05$). This indicates a dose-response type of effect.

Pulse ratings were influenced both by cannabis and by alcohol: for cannabis, the higher doses caused higher pulse rates and for a longer duration (400 mg registered 92 beats/minute lasting for 2 hours; $p<.05$).

CONCLUSIONS

Three conclusions are apparent. First, cannabis and alcohol produce two different kinds of intoxication phenomenologically. Second, dose-response effects of cannabis are seen both behaviorally and phenomenologically. And, third, cannabis has pronounced effects on some skills and judgments essential for driving.

Reid, L.D.; Ibrahim, M.K.F.; Miller, R.D.; and Hansteen, R.W. "The Influence of Alcohol and Marijuana on a Manual Tracking Task." Technical Paper No. 730092, Society of Automotive Engineers Congress. Detroit, Michigan, January 1973. 9 pp.

DRUG	Marihuana; Alcohol
SAMPLE SIZE	25
SAMPLE TYPE	College Students
AGE	Adults (over 21)
SEX	Male
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Canada
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Psychomotor Test
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	4

PURPOSE

Using linear mathematical models (describing functions), the effect of alcohol and marihuana on the dynamic characteristics of human operators performing a manual tracking task was assessed.

METHODOLOGY

Two complete programs were carried out, one involving both alcohol and marihuana, and the other alcohol alone. The task employed was a single degree-of-freedom compensatory tracking task. The subject was seated in front of a cathode ray tube on which was displayed the tracking error. The tracking error was indicated by the vertical motion of a 0.125-inch diameter circle about a fixed reference line. The subject attempted to null this error by fore and aft motion of a control stick coupled to the vehicle dynamics programmed on a general purpose analog computer. The input signal was continuous and random in nature and acted to introduce tracking error into the system. Each individual tracking run lasted 3 minutes and there was a 2-minute rest between two consecutive runs.

Subjects consisted of 25 volunteer male university students over the age of 21 years. Twenty-two of the subjects took part in the alcohol and marihuana project (experiment 1); they had alcohol experience, were casual marihuana users, and were not heavy tobacco smokers. Three subjects participated in the alcohol project (experiment 2); they were selected on the basis of alcohol experience and consistently good tracking performance. The overall performance of the subjects was measured by tracking score. In experiment 1, a double-blind procedure was used in the administration of alcohol (0, 0.03, and 0.07% BAL) and marihuana (0, 21, and 88 mcg of THC/kg body weight). Any single subject normally had his different doses separated by a one-week period. Two tracking runs were performed at 70, 110, and 310 minutes following drug administration.

In experiment 2, the amount of alcohol was selected to produce a peak BAL of either 0, 0.04, 0.07, or 0.10%. Each subject received each dose on two occasions. The doses were assigned in random fashion. On any one day, a subject was given one alcohol condition and performed 10 tracking runs. In both experiments, performance after drug administration was compared to performance prior to drug administration.

RESULTS

At the .05 level of significance, only tracking scores for cases involving alcohol were significantly altered. The linear modeling technique was capable of detecting the influence of drugs on the dynamic characteristics of the human operator. The difference in performance between the two subject populations was quite evident. Only 2 of the 22 subjects of experiment 1 achieved scores as low as those obtained in experiment 2. For highly skilled human operators exhibiting a strong neuromuscular resonance, the influence of a high BAL percentage was to shift it to a lower frequency. For less skilled operators exhibiting no strong resonance, their describing function exhibited a noticeable increase in time delay in the presence of alcohol. The presence of alcohol tended to reduce the bandwidth of the man/machine system with only a slight effect on the phase margin. The only marihuana influence detected in the describing function data was a slight resonance at high frequency for the high dose case.

Roth, Walton T., et al. The effect of marihuana on tracking task performance. Psychopharmacologia, 33:259-265, 1973.

DRUG	Marihuana
SAMPLE SIZE	41
SAMPLE TYPE	Volunteer
AGE	Adults (mean 19.8)
SEX	Male
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	California
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	15

PURPOSE

An important point of interest in the effect of drugs on tracking tasks is the obvious similarity between these tasks and the steering of a moving vehicle. The effects of marihuana on tracking are becoming especially relevant, since there is evidence that people sometimes drive when intoxicated with marihuana. The present study examined the effects of marihuana on a paced contour tracking task in which the pattern of errors sampled at frequent intervals (0.3 sec) could be analyzed statistically. Subjective intoxication was rated concurrently, so that correlations between performance and subjective state could be calculated.

METHODOLOGY

The subjects were 41 men with a mean age of 19.8 years. They were all social users of marihuana whose frequency of use was not more than once a week. Subjects were required not to eat breakfast the morning of the experiment. Marihuana was taken orally in the form of brownies. For subjects who received the active drug, the brownies contained NIMH marihuana extract calibrated to 20 mg of delta-9-tetrahydrocannabinol. For the placebo subjects, the brownies were identical in taste and appearance, but contained no drug.

The tracking task was presented on the display screen of a PDP-12 laboratory computer (Digital Equipment Corporation, Maynard, Mass.). The subject sat in front of the display and held a knob, the rotation of which controlled the position of a cross. His task was to keep the cross centered between two parallel vertical lines that moved from side to side under the control of a random number generator. Each subject was given a five-minute trial of the tracking test once on a practice day, and then on the experimental day before and after the brownies were eaten.

Subjects were given the drug in groups of three or four with a total of 20 subjects receiving marihuana brownies and 21 receiving placebo. The final trials began 30 minutes after the brownie was eaten. Immediately after the trial, each subject was asked to rate his subjective intoxication on a scale from 0 to 100. Zero was defined as "no intoxication" and 100 as "the highest you have ever been on marihuana." The tracking test took up to 30 minutes. Error on the tracking task was calculated every 0.3 seconds as the difference between the position of the cross and the true center point between the two lines at that moment in time. Each of the 1,000 error scores for each drug day trial was analyzed for mean, standard deviation, skew, and kurtosis. Four of the subjects with the most extreme kurtoses were excluded from analysis. Since all these occurred on trials before the drug was given, exclusion of these subjects did not bias the results.

RESULTS

The error scores were approximately normally distributed both before and after treatment. None of the differences between groups in the before treatment means for any statistic was significant; thus, the placebo and marihuana groups were approximately equivalent in the skills required for this task. As would be expected, the means of the means were not significantly altered by marihuana, since a change in this statistic would have the unlikely implication that marihuana makes the subject consistently deviate more to the right or left of the mid-point. Skews and kurtoses, which like the mean of means are measures of tracking strategy rather than of tracking error, were also unaffected by the drug. Marihuana significantly decreased the before-treatment/after-treatment differences for both the standard and absolute deviations, indicating that marihuana intoxication increased tracking error. The placebo subjects had a tendency to improve on retesting on the treatment day, while the performance of marihuana subjects deteriorated.

The mean subjective high for the marihuana group was 39.1, compared to 13.7 for the placebo group ($p<.02$). Contrary to expectation, the intensity of subjective high failed to correlate significantly with before/after treatment differences in the standard deviations ($r= -0.34$) or in the absolute deviations ($r= 0.37$), although these correlations were in the expected direction.

The effects of the drug over time were also analyzed statistically. Autocorrelation of individual trials showed a decline in the correlation from a mean across trials of 0.234 at 0.3 sec (a lag of 1 point) to 0.003 at 3.0 sec (a lag of 10 points). At 3.0 sec, 7% of the rhos were significant at the .05 level, a result attributable to chance. The autocorrelation functions were similar regardless of whether the trials were before or after treatment, and regardless of which type of brownie was given. At each point during the five-minute trial, the performance of the marihuana group was inferior. There was no significant difference in variability between these difference scores for the two groups. The mean standard deviation of the difference scores was 0.90 for the marihuana group and 0.78 for the placebo group.

CONCLUSIONS

The results confirm those of the Manno and Kiplinger studies that marihuana produces a deficit in tracking performance. This impairment was present even though the subjects reported being on the average only 39% as intoxicated as they had been in social settings. The expectation that there would be more variability in performance across time with marihuana than with placebo was not confirmed. It is suggested that such fluctuations may be more prominent in a social setting when no particular effort is demanded. The low correlations between the subjective effect of marihuana and the degree of impairment on the tracking task may be related to difficulties subjects have in quantifying that effect by introspection. The findings indicated that steering may likely be impaired at moderate dose levels. This type of experiment provides convincing evidence for advising marihuana users not to drive after taking the drug.

Salvendy, Gavriel, and McCabe, George P., Jr. Marijuana and human performance. Human Factors, 17(3):229-235, 1975.

DRUG	Marihuana
SAMPLE SIZE	40
SAMPLE TYPE	Volunteer
AGE	Adults (18-23)
SEX	Male
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	West Lafayette, Indiana
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	45

PURPOSE

The experimental evidence on the effects of marihuana intake on various subhuman species and on human behavior has not been conclusive. The impact of marihuana on human manipulative and coordination skills was explored.

METHODOLOGY

Forty male subjects ranging in age from 18 to 23 years participated as volunteers. At the time of the experiment, half of the subjects used no drugs and half smoked marihuana habitually. There were four groups of 10 subjects each: I. = subjects who had never smoked marihuana (control group); II. = subjects who in the past had smoked marihuana between two and five times a week, but had stopped smoking 11 to 19 months prior to the experiments; III. = subjects who had smoked marihuana habitually for the previous 2 to 4 years (these formed a placebo group, smoking oregano instead of marihuana during the experiments); and IV. = habitual smokers who smoked marihuana during the experiment.

Two tests were utilized in the experiment: (1) the one-hole test (placing pins into holes with close tolerance), and (2) the Rotary Pursuit test. The marihuana smoked was 1.4% delta-9 tetrahydrocannabinol (THC), and each item smoked contained 13 mg of delta-9 THC. Effects of marihuana were measured 30 to 50 minutes after the termination of the smoking.

RESULTS

For the one-hole test, the group effect was highly significant ($p<.01$), and there were significant differences in performances between Group IV and Group I ($p<.01$). Marihuana smoking was

associated with a 15% decrease in the initial performance level, and a 21% decrease in the final performance score, on the one-hole test relative to Group I. Group III had significantly ($p<.05$) lower performance scores than Group I.

The results of the Rotary Pursuit test (Time) showed superior performance for Group I ($p<.01$) relative to those subjects who used marihuana. During the later trials, Group I had a 37% higher performance score than Group IV. The results of the Rotary Pursuit test (Error) showed that only the trial effect was significant; the superior performance of Group I over the smokers was suggested for the final performance but not for the initial performance. The 59% lower performance of Group IV versus Group I at the final performance stage was statistically significant ($p<.01$).

CONCLUSIONS

The study clearly demonstrates that marihuana smokers (both those who smoked in the past and those who currently smoke) have significantly lower performances on manipulative and coordination tasks than those who have never smoked marihuana.

Schroeder, D.J.; Collins, W.E.; and Elam, G.W. Effects of secobarbital and d-amphetamine on tracking performance during angular acceleration. Ergonomics, 17(5):613-621, 1974.

DRUG	Stimulants; Depressants
SAMPLE SIZE	30
SAMPLE TYPE	College Students
AGE	Adults (20-30)
SEX	Male
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Oklahoma City, Oklahoma
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Laboratory/Examination; Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	12

PURPOSE

Most studies of the effects of drugs on performance have been conducted under stationary conditions. Since alcohol acts primarily as a central nervous system depressant, it seems likely that other drugs which have depressive effects may similarly affect an individual's visual fixation ability and, consequently, his psychomotor performance during vestibular stimulation. The attempt was made to extend the knowledge of the interaction of tracking performance, angular acceleration, and drugs to include the effects of both a commonly used depressant other than alcohol (secobarbital) and a commonly used analeptic (d-amphetamine).

METHODOLOGY

Thirty male college students (20 to 30 years of age) were randomly assigned to three groups: placebo (lactose), secobarbital (100 mg), or d-amphetamine (10 mg). The drugs or placebo were administered in capsules in a double-blind procedure following practice at a tracking task, and baseline determinations of tracking performance levels in both static (stationary) and dynamic (angular acceleration) conditions were made. Tests were scheduled 1, 2, and 4 hours after capsule ingestion. A predrug session, three postdrug sessions, and a practice session were all identical. Blood pressure and heart rate were monitored immediately prior to each of the test sessions.

All tests were conducted inside a Stille-Werner rotator in total darkness, with the exception of the illuminated tracking display. The subject's task was one of keeping a needle in a center or null position by compensatory movements of a joy stick. Electrodes were taped beside the outer canthus of each eye to record horizontal eye movements. For each group and each measure, the mean score for the predrug session was plotted as a zero base, and the percentage of increase or decrease in subsequent scores for a given measure was plotted as percent increase or percent decrease.

RESULTS

A rise in both heart rate and blood pressure occurred for the d-amphetamine group after administration of the drug, but the changes were not statistically significant; nor were the measures of heart rate or blood pressure for the secobarbital or control groups significantly changed across sessions.

Subjects in the placebo and the secobarbital groups showed little change in static tracking error from the predrug session through the postdrug session. In contrast, subjects in the d-amphetamine group showed a steady decrease in tracking error from the predrug session through the four-hour postdrug tests. While most of the improvement in tracking performance for the d-amphetamine group occurred during the session conducted one hour after drug administration, only the two-hour and the four-hour postdrug scores were statistically lower than the predrug level ($p<.05$ and $<.01$, respectively). Comparisons of static tracking behavior among the three groups were made using analysis of covariance. The only statistical differences ($p<.05$) occurred between the placebo and d-amphetamine groups for the two-hour and four-hour postdrug sessions; the d-amphetamine group performed with less error during these sessions.

Both the d-amphetamine and control groups exhibited steady improvement in dynamic tracking performance across sessions, and this improvement was statistically significant two hours and four hours after drug administration ($p<.001$ and $<.05$, respectively) for the d-amphetamine group, and four hours postadministration ($p<.01$) for the placebo group. Subjects in the secobarbital group showed an increase in tracking error one hour after receiving the drug; during subsequent sessions their tracking error was reduced, but the error scores four hours after administration were still above the predrug levels. This deterioration in tracking performance was statistically significant for the one-hour and two-hour postdrug sessions ($p<.01$ and $<.001$, respectively). Performance of subjects in the secobarbital group was significantly poorer than that of subjects in both the placebo and d-amphetamine groups for all of the postdrug sessions ($p<.01$).

With regard to both the slow-phase velocity and the number of nystagmic eye movements, there was a steady decline from the predrug through the postdrug sessions in the placebo and d-amphetamine groups. For subjects in the secobarbital group, both slow-phase nystagmus and number of nystagmic beats increased significantly during the one-hour postdrug session ($p<.01$ and $<.001$, respectively), and both measures of nystagmus for this group remained significantly above the predrug levels through the four-hour postdrug session ($p<.01$).

Scores for the slow-phase velocity measures and the number of nystagmic beats were significantly higher ($p<.01$ in every case) for secobarbital subjects than for the placebo and d-amphetamine groups during each of the postdrug testing sessions.

CONCLUSIONS

The data support previous findings (Collins et al., 1971; Gilson et al., 1972; Schroeder et al., 1973) with alcohol--i.e., the effect of at least some depressant drugs on performance may not be evident in a stationary environment, but may be substantial during angular stimulation of the vestibular system. Future evaluations of effects of drugs on performance should take into account the influence of motion.

Schwin, Robert; Hill, Shirley Y.; Goodwin, Donald W.; and Powell, Barbara. Marihuana and critical flicker fusion. Journal of Nervous and Mental Disease, 158(2):142-144, 1974.

DRUG	Marihuana
SAMPLE SIZE	31
SAMPLE TYPE	Volunteer
AGE	Adults (21-30)
SEX	Male
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	St. Louis, Missouri
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Critical Flicker Fusion Test
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	15

PURPOSE

Critical flicker fusion (CFF) (the minimal number of successive flashes of light per second that produces a sensation of steady light) has been used extensively in studying the physiology of vision. The effects of marihuana on the excitability of the visual system, and on the central nervous system as a whole, were studied using the CFF test.

METHODOLOGY

Thirty-one male subjects between the ages of 21 and 30 were used; all were experienced smokers. The subjects were randomly assigned to a marihuana group (marihuana containing 1.5% THC) or a placebo group (marihuana with THC removed). Using the method of limits, stimuli were presented in alternating ascending and descending series (ten pairs were obtained). Subjects were asked to report "stop" as soon as the light stopped flickering on ascending trials, and "start" on descending trials. A pre-post design was employed, both groups being tested 15 minutes before smoking and within one hour following smoking.

RESULTS

Analysis of scores revealed a significant drug effect ($p<.05$). Marihuana enhanced the CFF threshold: an increase in the flash frequency was necessary to produce fusion. The mean increase in flicker frequency was 1.33 cycles per second.

CONCLUSIONS

The increase in CFF threshold suggests that smoking of marihuana is associated with increased excitability of the visual system. This increased ability to discriminate successive exposures of light is consistent with previous clinical reports of "perceptual sharpening" (Hollister, 1971). To the extent that marihuana raises the CFF threshold, it differs from other drugs classified as CNS depressants.

Seppälä, T.; Linnoila, M.; Elonen, E.; Mattila, M.J.; and Mäki, M. Effect of tricyclic antidepressants and alcohol on psychomotor skills related to driving. Clinical Pharmacology and Therapeutics, 17(5):515-522, May 1975.

DRUG	Alcohol; Antidepressants
SAMPLE SIZE	40
SAMPLE TYPE	Students
AGE	Adults (20-25)
SEX	Not Specified
ETHNICITY	White
GEOGRAPHICAL AREA	Helsinki, Finland
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Laboratory/Examination; Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	20

PURPOSE

Tricyclic antidepressants are generally used in the long-term management of outpatients' depressive states. This raises the question of their potential harmful effects on psychomotor skills in driving and occupational performance. In order to determine the effects of amitriptyline, doxepin, nortriptyline, and chlorimipramine, alone and in combination with alcohol, on psychomotor functioning, a group of forty subjects was studied.

METHODOLOGY

Subjects included forty students of normal weight, 20 to 25 years of age. All used alcohol occasionally, and none was on drugs or had a history of mental disorder. Twenty of the subjects took amitriptyline (AMI), doxepin (D), and placebo (P) for two weeks each in a double-blind crossover trial, and another 20 subjects similarly took nortriptyline (N), chlorimipramine (CIP), and placebo. The antidepressants were given three times daily in doses generally used for neurotic patients. The presence of antidepressants in tissues was checked with the tyramine pressor test. On the seventh and fourteenth days of the testing period, psychomotor skills (choice reaction, coordination, and attention) were measured after the administration of drugs in combination with an alcoholic or placebo drink. The subjects were also asked to give their subjective assessment of their performance and the nature of the treatment.

RESULTS

Subjective Assessment

In the first trial, A, D-A, and AMI-A subjects felt their performances slightly impaired, but the differences between groups were not statistically significant. In the second trial, A, N-A, and CIP-A subjects felt their performances slightly impaired in every test situation, whereas subjective performance was slightly elevated in the P, N, and CIP groups. The placebo was experienced as placebo by a majority of the subjects. Amitriptyline and chlorimipramine were experienced on the 14th day more often as a tranquilizer and more infrequently as a placebo. None of these differences was significant. Alcohol was generally recognized. Fatigue was the most common complaint.

Psychomotor Performance

Performances in the choice reaction test on the 7th and 14th days did not differ significantly from each other within any test group. However, the A subjects had slightly longer reaction times (not significant), and the D-A and AMI-A subjects had longer reaction times ($p<.05$) than the placebo group.

In the coordination tests, when driving at a free speed, the D-A subjects at 90 and 150 minutes and the AMI-A subjects at 30 and 150 minutes made more ($p<.01$) mistakes than the placebo group on the 7th day, but the number of mistakes was reduced ($p<.05$) in the AMI-A group at 90 minutes on the 14th day. On the 7th day, the A and D-A groups drove fast, but at 90 minutes the AMI group drove significantly slower ($p<.05$) than the P group. On the 14th day, the AMI-A group drove slower ($p<.05$) at 30 and 90 minutes than the P subjects.

In the attention test, there was no noticeable alteration due to any of the treatments. The psychomotor performances of the subjects with high tissue levels of an antidepressant, as assessed by the tyramine pressor test, did not differ significantly from those of subjects having low tissue levels.

CONCLUSIONS

No drug alone impaired psychomotor skills to an important degree. Amitriptyline in combination with alcohol increased cumulative choice reaction times, and doxepin in combination with alcohol increased both cumulative choice reaction times and inaccuracy of reactions. Coordination was impaired after both of these combinations on the 7th day. It seems as if doxepin and amitriptyline, but not nortriptyline or chlorimipramine, in combination with alcohol, may be especially dangerous in driving.

Seppälä, T.; Saario, I.; and Mattila, M.J. Two weeks' treatment with chlorpromazine, thioridazine, sulpiride, or bromazepam: Actions and interactions with alcohol on psychomotor skills related to driving. In: Mattila, M.J. Alcohol, Drugs and Driving. Modern Problems of Pharmacopsychiatry. Vol. 11. Basel: S. Karger, 1976. pp. 85-90.

DRUG	Psychotropics
SAMPLE SIZE	37
SAMPLE TYPE	Students
AGE	Adults
SEX	Male
ETHNICITY	White
GEOGRAPHICAL AREA	Helsinki, Finland
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	2

PURPOSE

Different laboratory tests demonstrate that many psychotropic drugs, in acute experiments, impair psychomotor skills to varying extents. Subacute or long-term effects on the same parameters are not as well known, since these trials are laborious and require good cooperation. In two double-blind crossover trials, the effects of two weeks of treatment with thioridazine (T), chlorpromazine (C), sulpiride (S) or bromazepam (B) on psychomotor skills were examined. The interaction of these drugs with alcohol was also studied.

METHODOLOGY

Twenty healthy male student volunteers participated in the first trial, which tested the effects of C and S, and 17 participated in the second which tested the effects of T and B. The doses of C and T were 10 mg t.i.d. daily for the first 7 days, and 20 mg t.i.d. for the next 7 days; the doses of S (50 mg t.i.d.) and B (6 mg t.i.d.) were fixed over the entire two-week period. All the subjects were well trained in the testing apparatus before starting the study. The actual test procedure took place on the 7th and 14th days of each treatment. At every session, half of the subjects received 0.5 g/kg of ethyl alcohol (A), and the other half received a placebo drink. On every test day, all tasks were done three times--30, 90, and 150 minutes after the intake of capsule and drink. The tests included a choice-reaction test, a fixed-speed and free-speed coordination test, an attention test, and a flicker-fusion test.

RESULTS

In the first trial, the active agents were C and S. Regarding the reactive skills, drugs alone had no significant effects on the 7th day when compared with placebo. On the 14th day C impaired

reaction accuracy, especially 90 and 150 minutes after drug intake ($p<.05$). Combinations of either drug with alcohol prolonged cumulative reaction times and increased the number of mistakes, most remarkable alterations being in the C+A group.

In the fixed-speed coordination test, the results with C were different on the 7th and 14th days, so that the number of mistakes and the mistake percentage were elevated only on the 14th day. In the C+A group, both parameters measured were significantly increased ($p<.05$) on both the 7th and 14th days. After S, alone or with alcohol, no impairment of skills was observed. In the free-speed coordination test, the trend of impairment was significant in the C+A group ($p<.01$) and in the S+A group ($p<.05$) at every test time. Attention and ability to discriminate the fusion of flickering light were not affected after any treatment in the first trial.

In the second trial, the active agents were T and B. Because the test week had no influence on any variable, the data from the two test days were combined. B was the only agent which increased the number of mistakes ($p<.05$) in the choice reaction test. Regarding the coordination tests, the mistake percentage was very high in the B+A group, decreasing gradually up to 150 minutes. The mistake percentage was also significantly ($p<.05$) elevated in the B group after 30 minutes. T did not differ from placebo.

In the attention test, the numbers of correct responses were significantly smaller ($p<.05$) in the B and B+A groups than in the placebo group. Flicker fusion discrimination was unaltered by any treatment in the second trial.

CONCLUSIONS

Sulpiride and thioridazine alone seem to be inactive in the doses used in the subacute study, while chlorpromazine after two weeks of treatment may be harmful for driving. Bromazepam caused the most effects in this study, which may in part be a result of the dosage, which was relatively higher than that of the other drugs. Overall, the antipsychotics exerted an additive, and bromazepam a true synergistic, interaction with alcohol.

Sharma, Satanand. Marihuana effects on a critical tracking task. In: Hueike, D.F. ed. Proceedings of the 19th Conference of the American Association for Automotive Medicine, San Diego, Calif., Nov. 20-22, 1975. Lake Bluff, Ill.: the Association, 1975. pp. 285-291.

DRUG	Marihuana
SAMPLE SIZE	12
SAMPLE TYPE	Volunteer
AGE	Adults (21-32)
SEX	Male
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Not Specified
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Laboratory/Examination; Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	8

PURPOSE

The consumption of marihuana has increased considerably in recent years, suggesting that such behavioral tasks as driving automobiles and operating machinery are probably performed under its influence. Recent studies have shown that marihuana produces peak behavioral impairment in humans one hour after smoking. Since two studies by Sharma and Moskowitz tested subjects for only one hour, a further investigation was made that extended the time period of testing to four hours, using another behavioral task more demanding of attention and requiring a more complex response.

METHODOLOGY

Twelve subjects aged 21 to 32, all of whom were social users of marihuana, were divided into two groups: six subjects in one group smoked a placebo in the first test session and 200 mcg THC in the second; the other six smoked the 200 mcg THC in the first session. A critical tracking task (CTT) was used in which a bright horizontal line was displayed to the subject and then moved; the subject was required to return it to center by using a control stick. The task was made more and more difficult. A total of sixteen 15-minute blocks (192 trials) were completed. Pulse rates were taken before and after smoking marihuana, and then at 15-minute intervals up to four hours after smoking.

RESULTS

The mean pulse rate increases were 32 under the 200 mcg THC dose and 8 under the placebo. All subjects returned to baseline levels at the end of half an hour under 200 mcg THC. The mean performance on the CTT for each block showed essentially no differences between placebo and active

marihuana for the first two (pretest trial) blocks. There were differences between the two doses for the rest of the blocks. The mean percentage decline for the 16 testing blocks under active marihuana as compared to placebo was 8%. Pretreatment (baseline) scores were subtracted from posttreatment scores for all the subjects; the difference scores were larger for the 200 mcg THC treatment than for the placebo treatment. Matched t-tests between placebo and active marihuana groups were performed for each of the blocks based on the mean difference scores; the tests were statistically significant for each of the 15-minute blocks. There was a significant decline in performance after marihuana, which was sustained for four hours.

CONCLUSIONS

The results suggest that behavioral task performance is impaired under marihuana for a considerable period of time. Although it is not clear what mechanism accounts for this, the findings are important for safety considerations when driving and operation of machinery are performed under marihuana.

Sharma, Satanand, and Moskowitz, Herbert. Effects of two levels of attention demand on vigilance performance under marihuana. Perceptual and Motor Skills, 38:967-970, 1974.

DRUG	Marihuana
SAMPLE SIZE	12
SAMPLE TYPE	Students
AGE	Adults (21-34)
SEX	Male
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	California
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Laboratory/Examination; Psychomotor Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	2

PURPOSE

An earlier study of the effects of marihuana upon perception reported increasing performance decrements in successive time periods (Sharma and Moskowitz, 1973). Another experiment was designed to examine the relationship between the marihuana-induced decline in vigilance over time and the arousal demands of the experimental task.

METHODOLOGY

Subjects consisted of twelve male students, aged 21 to 34, who were marihuana users. Two treatment levels were used: 200 mcg THC/kg body weight and a placebo. There were five testing sessions (one training and four experimental), and a 2X2 repeated measures factorial design was used with two levels of marihuana dose and attention demand. Each subject was tested under both the active marihuana and the placebo dose with low-attention and with high-attention demands. The test required the subjects to respond to randomly presented lights by pressing a telegraph key. Pulse rates were taken before and after smoking.

RESULTS

The average increase in pulse rate at the conclusion of smoking was 26 for the 200 mcg THC dose and 10 for the placebo. Overall marihuana effects were significant ($p<.01$), with marihuana producing perceptual impairment under conditions of low attention ($p<.01$) and high attention ($p<.01$). An overall linear trend analysis for time effects for all treatments and attention-demand conditions showed statistical significance ($p<.01$). The vigilance decrement found for the high-attention performance under the placebo showed an initial impairment after which performance stabilized, while under the 200 mcg THC, performance continued to decline over time.

The statistically significant marihuana x time interaction supported this finding ($p<.01$). The main effect of attention demand in preventing detection errors was also statistically significant ($p<.01$). Under high attention, signal detection errors were reduced for 200 mcg THC and the placebo, the differences in the average number of detection errors between conditions of low and high attention being 1.7 for the placebo, and 1.5 for the 200 mcg THC.

CONCLUSIONS

This study supports a previous finding that marihuana produces an initial impairment in signal detection followed by a further decline in performance over time. The results suggest that the effect of marihuana is not upon arousal, if that is the underlying basis of difference in the attention-demand levels which were used in this study.

Smiley, A.; LeBlanc, A.E.; French, I.W.; and Burford, R. The combined effects of alcohol and common psychoactive drugs: II. Field studies with an instrumented automobile. In: Israelstam, S., and Lambert, S., eds. Alcohol, Drugs, and Traffic Safety. Proceedings of the Sixth International Conference on Alcohol, Drugs, and Traffic Safety. Toronto, September 8-13, 1974. Toronto, Canada: Addiction Research Foundation of Ontario, 1975. pp. 433-438.

DRUG	Multi-Drug
SAMPLE SIZE	8
SAMPLE TYPE	Volunteer
AGE	Adults (19-27)
SEX	6 Male; 2 Female
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Ontario, Canada
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Driving Tests
DATE(S) CONDUCTED	Not Specified
NO. OF REFERENCES	5

PURPOSE

While much research has been done on the effects of alcohol and other drugs on performance in driving simulators or on tasks requiring skills related to driving (Hamilton and Copeman, 1970; Linnoila and Mattila, 1973; Moskowitz, 1971), very little work has been done on the effects of these drugs on performance while driving a real car. Such an experiment was performed in Ontario, Canada, and the changes in driver behavior under various drug conditions are described.

METHODOLOGY

Eight subjects (six male and two female) aged 19-27 participated. All had used both alcohol and marihuana previously, and all had at least two years of driving experience. The site for the experiment was an 8.5 mile stretch of new highway in Ontario, Canada, which was not open to the public at the time of the experiment. In addition to the one car driven by the subject, two other cars were used to act as opposing traffic in order to increase the realism of the driving task. Stop lights were placed on the highway, and 500 pylons were used to set up a slalom course.

The drug conditions examined were: placebo, alcohol at the .06% level, alcohol at the .06% level in combination with diphenhydramine (an antihistamine), alcohol at the .06% level in combination with diazepam (a minor tranquilizer), and alcohol at the .06% level in combination with marihuana. Each subject made one run under one of the drug conditions each day.

The following measures of driver performance were made: steering amplitude and frequency in the 60 mile per hour (mph) zone, steering amplitude in the 25 mph zone, speed and speed variation in both the 60 and 25 mph zones, reaction time to a peripheral light on the dash, number of pylons knocked down, and distance between the front tires and white line adjacent to the traffic signal.

RESULTS

The average speed maintained by the subjects was dependent on the drug condition. Subjects on the placebo drove at a significantly higher speed than under any other condition (levels of significance ranging from .10 to .01). On alcohol alone, the subjects drove at a significantly higher speed (.05 level of significance) than on alcohol with diazepam or on alcohol with marihuana. The slowest average speeds recorded were for subjects on alcohol and marihuana. The measure of steering movement used in the 60 mph region was a power spectral density function of steering wheel angle, calculated for each subject and drug condition. One subject made the largest amplitude movements under the alcohol and diphenhydramine condition and the lowest under the alcohol and diazepam condition. The drug conditions for steering movement in order of decreasing mean area were alcohol and marihuana, alcohol and diphenhydramine, alcohol, placebo, and alcohol and diazepam. Reaction time to the secondary task light under the alcohol condition was significantly faster than for the placebo or for the alcohol and marihuana conditions (at the .01 level). For the alcohol and marihuana condition, reaction time was significantly slower than for the placebo (.10 level), alcohol alone (.05 level), or alcohol and diazepam (.05 level) conditions. A trend was observed towards a faster reaction time on alcohol and diazepam than on alcohol alone or on the placebo. For each subject and condition, a pylon score was calculated in which both the speed through the pylon area and the number of pylons knocked over were considered. The observed trend was that the best scores occurred for the placebo condition and the worst for the alcohol and marihuana condition. Scores for the other three conditions fell between these two extremes.

CONCLUSIONS

The results show that alcohol alone, and in combination with other drugs, affects driving performance in different ways. Further research in this area will be needed before the manner in which driving behavior is affected by a drug can be related to physiological action of that drug.

Weil, Andrew T.; Zinberg, Norman E.; and Nelsen, Judith M. Clinical and psychological effects of marihuana in man. Science, 162:1234-1242, December 13, 1968.

DRUG	Marihuana
SAMPLE SIZE	17
SAMPLE TYPE	Volunteer
AGE	Adults (21-26)
SEX	Male
ETHNICITY	Not Specified
GEOGRAPHICAL AREA	Boston, Massachusetts
METHODOLOGY	Experimental
DATA COLLECTION INSTRUMENT	Laboratory/Examination; Psychological Tests; Psychomotor Tests
DATE(S) CONDUCTED	1968
NO. OF REFERENCES	28

PURPOSE

The clinical and psychological effects of marihuana were investigated. Physiological parameters measured included heart and respiratory rates; psychological measures included attention tests and a pursuit-rotor test.

METHODOLOGY

Subjects consisted of nine healthy male volunteers who had never tried marihuana, and eight chronic marihuana smokers. The ages of the subjects ranged from 21 to 26. Marihuana was administered in the form of cigarettes; in any given experimental session, each person was required to smoke two cigarettes in succession. Cigarettes were either placebo, low-dose THC (0.25 mg), or high-dose THC (0.50 mg), administered in double-blind fashion. After subjects smoked the cigarettes, testing began. Chronic users were tested only on high doses of marihuana with no practice sessions. Each naive subject was required to come to four sessions, spaced about a week apart; the first was a practice session, and the remaining three were experimental sessions, with administered drug changing each time.

Physiological tests included measures of heart rate, respiratory rate, pupil size, blood glucose level, and conjunctival vascular state. These tests were taken before and after drug administration. The psychological test battery consisted of: (1) the Continuous Performance Test (CPT)--5 minutes; (2) the Digit Symbol Substitution Test (DSST)--90 seconds; (3) CPT with strobe light distraction--5 minutes; (4) self-rating bipolar mood scale--3 minutes; and (5) pursuit-rotor--10 minutes. The CPT measured sustained attention, by requesting the subject to press a button each time a specified letter appeared on a screen; six letters were flashed rapidly and in random order while the subject sat in a darkened room. The DSST measured cognitive function.

The pursuit-rotor test measured muscular coordination and attention; the subject's task was to keep a stylus in contact with a small spot on a moving turntable. In a verbal test before and after drug administration, the subject was told to tell a story; after five minutes he was told to stop and estimate how long he had been talking, thus giving an indication of his ability to judge time.

RESULTS

Regarding heart rate, in the naive subjects marihuana in low or high dose was followed by increased heart rate 15 minutes after smoking, but the effect was not demonstrated to be dose-dependent. High dose caused a statistically greater increase in the heart rates of chronic users than in those of the naive subjects 15 minutes after smoking. Regarding respiratory rate, in the naive group there was no change in rate before and after smoking marihuana. Chronic users showed a small but statistically significant increase in respiratory rate after smoking, but this was not regarded as clinically significant. There was no significant change in blood sugar levels after smoking marihuana in either group.

On the psychological tests, performance on the CPT with and without strobe distraction was unaffected by marihuana for both groups of subjects. However, there were significant differences ($p<.05$) in scores on the DSST. Decrements in performance of naive subjects following low and high doses of marihuana were significant at 15 and 90 minutes after smoking. Also, the decrement following marihuana was greater after high dose than after low dose at 15 minutes after administration, giving preliminary evidence of a dose-response relationship. Lastly, chronic users started with good DSST baseline performance and improved slightly after smoking 2 mg of marihuana, whereas performance of the naive subjects was grossly impaired.

On the pursuit-rotor test, decrements in performance of naive subjects after both low and high doses of marihuana were significant at 15 and 90 minutes ($p<.05$). The chronic users started from good baselines and improved on the pursuit-rotor after smoking marihuana; however, this may have been largely a practice effect. Regarding time estimation, before drug administration all naive subjects estimated the 5-minute verbal test to be 5 ± 2 minutes. After placebo, no subject changed his guess; after low dose, 3 subjects raised their estimates to 10 ± 2 minutes; after high dose, 4 subjects similarly raised their estimates.

Asked to state their perception of the effects of marihuana, persons who had never smoked the drug reported minimum subjective effects after smoking it. In contrast, chronic smokers rated themselves as being high after drug administration; on a scale of 1 to 10, 10 representing "the highest you've ever been," all subjects placed themselves between 7 and 10.

CONCLUSIONS

Marihuana-naive persons demonstrate impaired performance on simple intellectual and psychomotor tests after smoking marihuana; in some cases, the impairment is dose-related. Regular users of marihuana do get high after smoking the drug but do not show the same degree of impairment of performance on the tests as do naive subjects. In some cases, their performance even appears to improve slightly after drug administration. This reinforces the argument advanced by chronic users that maintaining effective levels of performance for many tasks--driving, for example--is much easier under the influence of marihuana than under that of other psychoactive drugs.

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Indexes

When terms reflect the content of the abstract as a whole, they are indexed only to the first page of each abstract. Otherwise, terms are indexed to the specific page.

DRUGS

The general and specific names of drugs mentioned in each abstract, as used by the author of the document.

GEOGRAPHIC LOCATORS

Organized by state, includes the cities, counties, or regions where the study was carried out, or any references to geographic locations within an abstract.

INSTITUTIONS

The actual institution where research was conducted, or to which an author was affiliated.

INSTRUMENTS

The specific instruments or scales used in the research reported by the study.

INVESTIGATORS

All authors named in the citation to each abstract and in the supplementary bibliography. Also included are the names of persons mentioned in the abstracts.

SAMPLE TYPES

Terms which describe as specifically as possible the sample populations studied.

SUBJECTS

Terms which describe the subjects or concepts of the studies.

DRUGS

DRUGS (cont.)

GEOGRAPHIC LOCATORS

INSTITUTIONS

INSTRUMENTS

INVESTIGATORS

INVESTIGATORS (cont.)

INVESTIGATORS (cont.)

SUBJECTS (cont.)

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