

DRIVER FATIGUE AND STIMULANTS

Prepared by

Narelle L Haworth

Monash University Accident Research Centre

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Author(s)

Narelle L Haworth

Performing Organisation(Name and Address)
Monash University Accident Research Centre
CLAYTON VIC 3168

Sponsor

Federal Office of Road Safety
GPO Box 594
CANBERRA ACT 2601

Available from

Federal Office of Road Safety
GPO Box 594
CANBERRA ACT 2601

Abstract

The relationship between driver fatigue and the use of stimulants is reviewed. While little information is available about stimulant use by car drivers, Australian and overseas surveys have shown that about 40-60% of long distance truck drivers have recently used stimulants for the purpose of keeping awake while driving. The pharmacology of the most widely used stimulants is discussed, as are effects of these stimulants on driving behaviour. There is currently insufficient evidence to enable conclusions to be drawn about the role of stimulants in road crashes.

Keywords

DRUGS, DRIVER BEHAVIOUR, FATIGUE, ROAD CRASHES

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EXECUTIVE SUMMARY

The relationship between driver fatigue and the use of stimulants is reviewed in the four sections of this report. While little information is available about stimulant use by car drivers, Australian and overseas surveys have shown that about 40% to 60% of long distance truck drivers have recently used stimulants for the purpose of keeping awake while driving.

Amongst car drivers, caffeine is probably the most widely used stimulant. The stimulants used locally by some truck drivers include amphetamine and two amphetamine derivatives, Tenuate Dospan and Duromine. There is also some evidence that ephedrine, another class of stimulant, is used. The pharmacology of these drugs is discussed in the second section of the report.

The effects of a single administration of a stimulant on driver alertness are likely to be positive. In the laboratory and on the road, caffeine has been shown to lead to improvements on a number of measures of driver alertness, including reaction time to changes in the distance to the simulated vehicle in front. A large number of studies have investigated whether the stimulant effects of caffeine can be used to counteract the depressant effects of alcohol. The results of these studies have been mixed and it appears that any effects may be dose-specific.

The effects of amphetamine and amphetamine derivatives on many behaviours have been studied, some of which are relevant to driving. Vigilance performance is improved with ingestion of d-amphetamine (but not l-amphetamine). Amphetamine derivatives may improve attention and partly restore performance affected by alcohol. Amphetamines may affect driving by a direct effect on visual perception. Administration of amphetamines may lead to an increase in risk taking in driving and a deterioration in accuracy of judgement of speed.

It is likely that the prolonged use of amphetamine and amphetamine derivatives may result in an increased risk of a road crash because of the occurrence of visual hallucinations and the massive onset of fatigue experienced by amphetamine-dependent drivers who are unable to secure sufficient dosages.

An estimation of the contribution of stimulant abuse to road crashes cannot be made as yet because of the paucity of information about the frequencies of crash-involved and non-crash-involved drivers who had used stimulants. A very rough estimate from local and overseas studies is that about three percent of drivers in fatal accidents had taken stimulants. One study showed that amphetamine abusers had poorer driving histories than other drivers but this may have been due to another characteristic of the sample.

In summary, caffeine is the stimulant most widely used by drivers and few detrimental effects have been reported. The effects of stimulants on driver fatigue depend largely on dose and prior history of usage. Further investigation of possible differences in magnitude of response as a function of time of day is needed. There is insufficient evidence to enable conclusions to be drawn about the role of stimulants in road crashes.

1 Introduction

The relationship between driver fatigue and the use of stimulants is reviewed in the four sections of this report. The extent of usage is outlined from surveys conducted in Australia and overseas and the drugs used locally are identified. The pharmacology of these drugs is then discussed in the second section. Studies of the effects of stimulants on driving and evidence of the role of these drugs in road crashes are presented.

2 Extent of usage

The extent of usage of caffeine by car drivers is likely to be similar to that of the general adult population. A US study (Graham, 1978) estimated the mean adult intake of caffeine to be 186 mg per day (227 mg/day when those who took no caffeine were excluded). These intakes are equivalent to 2.2 and 2.7 cups of coffee, respectively. Eighty-two percent of the adults surveyed consumed caffeine. The usage of caffeine may be a little lower in Australia but is likely to be similar.

Australian and North American surveys of drug use by truck drivers have been published. In the US state of Tennessee, Lund, Preusser, Blomberg and Williams (1987) found that 29 percent of the tractor-trailer (semi-trailer) drivers in their survey had evidence of alcohol, marijuana, cocaine, and/or prescription or nonprescription stimulants in either blood or urine. Nonprescription stimulants (phenylpropanolamine, ephedrine, pseudoephedrine) were found in 12 percent and prescription stimulants such as amphetamine were found in five percent.

In a Canadian study, 37% of tractor-trailer drivers knew drivers who used stimulants other than tea or coffee to keep alert while driving a truck (Transport Canada, 1987). Detailed analyses of responses suggested that the drivers were to some extent reporting their own behaviour when asked about that of other drivers. Owner drivers were more likely to report knowing drivers who used stimulants than were employee drivers (43% vs. 34%).

Usage of stimulants by other drivers was also reported by many of the 878 articulated vehicle drivers who completed the 1988 Regular Common Carrier Conference Safety Survey (cited in Insurance Institute for Highway Safety, 1989).

Guinn (1983) asked a sample of Texas owner drivers to estimate their frequency of drug use while trucking. As Table 1 shows, 62.5% of drivers responded "Sometimes", "Often" or "All the time" when asked "How often in the past year have you used drugs (except vitamins, aspirin, No-Doz and similar over-the-counter preparations) for the purpose of remaining awake and alert while trucking?".

Table 1. Self-reported frequency of drug use in the past year for the purpose of remaining awake while driving. From a survey of Texas owner-drivers by Guinn (1983).

Frequency	Number of drivers	Percent of drivers
Never	22	19.6
Rarely	20	17.9
Sometimes	38	33.9
Often	21	18.8
All the time	11	9.8

The study found that drug use by truck drivers was not correlated with job dissatisfaction, contrary to a common view in work psychology (Mangione and Quinn, 1975; Perone, DeWaard and Baron, 1979). Drug use by truck drivers appears to be motivated by the desire to remain awake, not boredom as found in other occupations.

The incidence of drug usage by truck drivers is likely to be similar in Australia. Nix-James (1977) presents self-report data on usage of alcohol and alerting medications by long-distance heavy vehicle drivers in NSW. When asked how often they take "stay-awake pills", 14% responded that they "often use them" and 27% answered that they "sometimes use them".

Whilst these surveys give an indication of the extent of drug use by truck drivers, they give little information about the exact preparations taken, dosages and time factors involved. In order to gain more detailed information, a number of agencies were contacted.

The Victorian Drug Information Centre (VDIC) provided information that the two amphetamines legally available in Victoria are amphetamine and dexamphetamine. These are scheduled as drugs of addiction by the Victorian Department of Health and are only available for the treatment of narcolepsy and hyperkinesis, and then only by applying to the Department for permission to prescribe. The VDIC suggested that truck drivers might use amphetamine derivatives, rather than amphetamine itself and that Direct Line, who advise on aspects of illicit drug use, be contacted.

Direct Line were not sure that truck drivers used amphetamines per se. They recalled that Fedrine (ephedrine hydrochloride) was said to be used. This drug is most commonly used for the treatment of asthma and is easier to obtain than amphetamines because it is not scheduled as a drug of addiction. Interestingly, in the analysis of Coroners reports of fatal crashes involving trucks (Haworth, Heffernan and Horne, 1989), one driver stated that he was a regular user of Fedrine but had not taken any in the last 24 hours. This is in accord with the view that withdrawal from stimulant drugs may impair performance.

The Alcohol and Drug Foundation suggested that Durophet, a mixture of amphetamine and dexamphetamine sulphate, is used by truck drivers.

Information from another source (reliable but anonymous) indicated that truck drivers in Victoria most commonly use amphetamine derivatives which are prescribed as appetite suppressants. The dosages and drugs taken depend on the length of time the driver has been taking stimulants. This results from the build-up of tolerance to the drug, a decreased response to a constant dosage of the drug. Some drivers begin taking Tenuate Dospan tablets, which are referred to colloquially as "briquettes". As tolerance develops, the dosage is likely to be increased from one up to five tablets. When increased tolerance results in Tenuate Dospan losing the desired stimulant effect, drivers are said to change to Duromine. The degree of dependence on such drugs is underlined by reports that dependent drivers will take them for short trips as well as long ones.

3 Pharmacology of some stimulants used by drivers

This section begins with a description of the pharmacology of the most widely taken stimulant, caffeine. Amphetamine and amphetamine derivatives, including Tenuate Dospan and Duromine are then described. The pharmacology of ephedrine (Fedrine) is also outlined.

3.1 Caffeine

Caffeine, theophylline and theobromine are three xanthine compounds that are obtained from plants. Caffeine is 1,3,7-trimethylxanthine; theophylline, 1,3-dimethylxanthine; and theobromine, 3,7-dimethylxanthine. Tea contains caffeine and theophylline, coffee and cola

drinks contain caffeine only and cocoa contains caffeine and theobromine. Caffeine is the most important and widely used of the three related stimulants.

The traditional view is that caffeine and theophylline act by inhibiting phosphodiesterase, the enzyme that breaks down cyclic AMP. However, recent work suggests that there is little inhibition of phosphodiesterase at the maximal therapeutic concentrations of drug in plasma and that the drugs function by blocking adenosine receptors.

The half-life of caffeine is about 3 to 4 hours but this is affected by a number of factors. The half-life is approximately doubled in women during the later stages of pregnancy and with the chronic use of oral contraceptive steroids (Patwardhan, Desmond, Johnson and Schenker, 1980). Caffeine is metabolised more quickly by individuals who smoke (Parsons and Neims, 1978).

Caffeine is rapidly absorbed and maximal plasma concentrations are achieved within an hour. The ingestion of 250 mg of caffeine leads to concentrations in plasma of about 10 micrograms/millilitre. About 1% of administered caffeine is recovered in the urine unchanged. The principal metabolites are 1-methyluric acid and 1-methylxanthine.

The xanthines relax various smooth muscles other than those of blood vessels. This includes the muscles of the bronchi and theophylline, particularly, has been used in the treatment of bronchial asthma. Caffeine increases the capacity for muscular work in man by increasing muscle tension.

Both caffeine and theophylline stimulate mental activity; thought is more rapid and fatigue is removed or its onset delayed. The effects on mental and physical performance vary according to the state and personality of the subject. Reaction-time is decreased. Performance that is inferior because of excessive anxiety may become worse (Laurence and Bennett, 1980).

Whilst caffeine produces an increased capacity for sustained intellectual effort and decreases reaction time, tasks involving delicate muscular coordination may be adversely affected. These effects may be produced by the administration of 85 to 250 mg of caffeine, the amount contained in 1 to 3 cups of coffee.

Caffeine and amphetamine have been said to have similar effects on performance and mood. They both improve physical performance in tasks like athletics or monitoring controls. It is unclear whether the improvement is due to reduction in impairment by fatigue or boredom or to improvement on normal maximum performance. Hand steadiness is decreased by caffeine and increased by amphetamine, however. The drugs also differ in the degree of dependence which develops: amphetamine dependence may result in psychosis (Ellinwood, 1969; Ellinwood and Kilbey, 1980) whereas tolerance to the stimulant effects of caffeine does not develop but withdrawal produces headache (Graham, 1978).

Both caffeine and amphetamine cause increased cardiac output, tachycardia and sometimes ectopic beats and palpitations. This effect occurs almost at once after i.v. administration and lasts half an hour. Changes in blood pressure are not always predictable but 250 mg caffeine usually causes a transient increase in blood pressure of about 14/10 mm Hg. Caffeine has been reported as producing mutations in DNA but the concentrations at which this occurs are well above those commonly found in plasma (Rall, 1985).

3.1.1 No Doz. No Doz is the brand name of caffeine tablets available over-the-counter. Each tablet contains 100 mg of caffeine which is equivalent to one to two cups of tea or coffee. It is likely that they are considered not strong enough stimulants by truck drivers.

Pharmaceutical guides state that No Doz may be used in cases of "mental fatigue", drowsiness and general inertia (Craig, 1986). The dosage recommended is one tablet with no

repeats given within three hours of administration and a maximum of six tablets in 24 hours. It is suggested that this dosage be reduced if the individual drinks tea, coffee or cola drinks.

3.2 Amphetamine

Amphetamine is the common name for 1-phenyl-2-aminopropane. The chemical has two forms: dextro and levo, of which the former is the most powerful central nervous system stimulant. For pharmaceutical purposes dextramphetamine and a racemic mixture, commonly termed amphetamine, are available.

Amphetamine acts by releasing noradrenaline stored in nerve endings in both the central nervous system and the periphery. Its psychological effects vary with mood, personality and environment as well as dose. Both amphetamine and ephedrine are stimulants for adults but sedatives for children, hence the use of amphetamines in the treatment of hyperkinesis (Laurence and Bennett, 1980).

Amphetamine is usually given orally, but it can be injected. The plasma half-life of amphetamine is ordinarily about 12 hours. Amphetamine sulphate is a white, water-soluble powder. The toxic dose of amphetamine varies widely. Toxic manifestations are rare with doses of less than 15 mg. Larger doses can be tolerated after chronic use of the drug. The use of amphetamine is inadvisable in patients with anorexia, insomnia, asthenia, schizophrenia, psychopathic personality, or a history of homicidal or suicidal tendencies.

The effects of amphetamine differ markedly with dose and history of administration. The effects of small, acute doses will be described, followed by the effects in prolonged administration.

Amphetamine has both peripheral and central nervous system effects. Small doses of amphetamine raise blood pressure and slow heart rate. Increases in motor and speech activity are often observed. Side-effects may include anxiety and a feeling of nervous and physical tension and the subject may show tremors and confusion, and feel dizzy.

In general, studies of the alerting effects of small acute doses of amphetamine have shown smaller effects for interested, motivated, fresh subjects than for fatigued subjects (Kornetsky, 1969). A slight improvement in physical performance is found in athletic performance when amphetamine is administered but the magnitude of this improvement is small. The greatest improvement occurs when performance of physical or mental tasks has been reduced by fatigue and loss of sleep (Weiner, 1985). Such improvement may be partly due to alteration of unfavourable attitudes toward the task. However, amphetamine reduces the frequency of attention lapses that impair performance after prolonged sleep deprivation, and thus improves execution of tasks requiring sustained attention.

Amphetamine administration may impair the subject's judgement of his/her performance, however (Laurence and Bennett, 1980). The subject may be more confident and better satisfied with a performance which has, in fact, deteriorated in accuracy as well as being more speedily accomplished.

As long as they are taken irregularly and in low or moderate doses, amphetamines do not appear to pose any behavioral or psychological problem. As with most other psychoactive drugs, the problems arise from high doses and habitual use. And once use becomes habitual, tolerance develops, and accordingly higher doses become necessary. It is unclear whether amphetamine produces true physical dependence but withdrawal effects have been observed. Kornetsky (1969) has remarked that "upon abrupt termination after chronic use, depression is often seen accompanied by fatigue and lassitude, and there is evidence of EEG changes" (p.234).

Amphetamine psychosis may develop as a result of continued high doses (or perhaps from a single high dose). The features of the syndrome are delusions of persecution, ideas of

reference, visual and auditory hallucinations, change in body image and hyperactivity and excitation, but without disorientation or clouding of memory (Ellinwood, 1969).

3.3 Amphetamine derivatives

Dexamphetamine (Dexedrine in the US) is similar to amphetamine (Benzedrine) and is available in Australia. It is three or four times as powerful in eliciting central nervous system effects as l-amphetamine. Methamphetamine (Methedrine) is similar to amphetamine but its effects on the central nervous system are greater. Other amphetamines are phenmetrazine (Preludin), phentermine (Duromine), diethylpropion (Tenuate), methylphenidate (Ritalin, often used in hyperkinesis), pemoline (Kethamed) and meclofenoxate (Lucidril).

3.3.1 Tenuate Dospan. Tenuate Dospan is diethylpropion hydrochloride (75 mg) in a hydrophilic colloid gum designed to release the ingredient over a 10 hour period. Its chief action is the reduction of food intake but it results in "some CNS stimulation" (Craig, 1986). The excretion half-life for diethylpropion hydrochloride and its metabolites is about 10 hours.

Craig (1986) recommends that one tablet should be taken midmorning and that doses may be given over periods up to 12 weeks, with intervening periods of one month without treatment. This dosage appears to be exceeded by most truck drivers using Tenuate Dospan as a stimulant. It is also interesting to note that a warning is given that the drug may interfere with operating machinery or driving a motor vehicle in some patients and that the patient should be cautioned accordingly.

It is reported that cases of abuse have been uncommon and that most abusers had previously abused other stimulants (Craig, 1986). Tenuate does not seem to give rise to pleasurable sensations and rarely leads to hallucinations, even when high doses are administered. There are some reports of anxiety and agitation as the drug wore off. In overdosage fatigue and depression usually follow the central stimulation.

3.3.2 Duromine. Duromine is the trade name for phentermine, an amphetamine derivative. It is prepared as capsules containing an ion-exchange resin for sustained release. The recommended use of Duromine is for management of obesity as a short term adjunct to calorie restriction in weight loss.

The drug comes in 15, 30 and 40 mg capsules and the recommended dose is one daily at breakfast. The strength administered depends on the body weight of the individual and any evidence of side effects. A warning is given not to exceed the recommended dose.

The drug should not be taken by persons with hypertension or other cardiac disorders, or glaucoma.

3.4 Ephedrine

The central nervous system effects of ephedrine are less pronounced than those of the amphetamines. The drug stimulates the release of norepinephrine and also has direct effects on receptors. Ephedrine elevates systolic and diastolic blood pressure by some vasoconstriction and a greater amount by increasing the force of myocardial contraction, resulting in augmented cardiac output. The relaxation of the bronchial muscle brought about by ephedrine has led to its use in the treatment of mild and chronic asthma.

Ephedrine sulphate is the l isomer and is available in capsules and syrups, the oral dose varies from 15 to 50 mg. For continued medication, small doses are given at 3 to 4 hour intervals.

4 Studies of the effects of stimulants on driving

Studies of the effects on driving of caffeine and amphetamine and its derivatives are presented. Those studies which considered previous history of usage are likely to be more valid than others which did not. In addition, the generalisability of results of the studies depend on a number of factors including conditioned responses and time of day effects.

Stimulants may be like other drugs in exhibiting conditioned response effects. For example, the effect of caffeine taken by drinking caffeine may be composed of the pharmacological effects of the drug and the conditioned effect of relaxing and drinking coffee. The conditioned effect may be quite strong and thus studies which administer caffeine by tablet may not be sensitive to the conditioned response effect. In general, studies which administer stimulants by the usual route and in the usual environment are more likely to produce valid results.

Time of day effects have been little studied in relation to stimulant use. There may be some interaction between circadian rhythms and drug effect that leads to differences in the response to a drug depending on time of day. This has been suggested by some research currently underway at Monash University (Redman, personal communication) into the effect of caffeine at different times of day.

4.1 Caffeine

The effects of caffeine have been studied in on-road driving and in the laboratory.

In an on-road study, Lisper, Tornros and van Loon (1981) examined the effects of caffeine or diazepam on subsidiary reaction time in a three-hour driving task. Caffeine gave shorter reaction times during the first half of the trip.

Regina, Smith, Keiper and McKelvey (1974) gave subjects 200 mg of caffeine before 90 minutes of operation of a driving simulator and then another 200 mg before another 90 minutes on the simulator. They allowed 30 minutes between ingestion of caffeine and commencement of the task. They note that blood caffeine was likely to have been higher in the second half of the study.

Both the initial and supplemental doses of caffeine significantly enhanced performance compared to the placebo on four measures of alertness (response time to lead car decelerations, lead car accelerations and presentations of the high beam signal and number of missed high beam signals).

The effects of caffeine on a four hour visual monitoring task similar to an aspect of night-time driving were examined by Baker and Theologus (1972). Subjects monitored two red lights that moved apart at random intervals. This simulated the rear lights of a car being followed at night. Reaction time measures showed that caffeine significantly reduced attention lapses. No differences were found between administration of 200 and 400 mg of caffeine.

The magnitude of the behavioural effects of caffeine may depend on the everyday consumption rate of the user. Childs (1978) demonstrated that subjects who drank less than three cups of coffee per week experienced an increase in reaction time in short-term visual scanning when administered 400mg of caffeine. In contrast, subjects who commonly drank larger amounts reacted to the 400mg dose with a decrease in RT. Childs concludes that a large dose of caffeine may disrupt visual attention in subjects who are low caffeine users but may be beneficial for high caffeine users. American estimates of daily intake of caffeine show that 82% of the population consume caffeine and the mean daily intake is markedly larger than three cups of coffee per week (Graham, 1978), putting most people into the high caffeine user group.

A number of studies of whether caffeine can counteract the performance decrements induced by alcohol have been conducted (see Mattila, 1981 and Moskowitz, 1981 for reviews).

Franks, Hagedorn, Hensley, Hensley and Starmer (1975) studied the effect of caffeine alone or in combination with alcohol on cognitive, perceptual and motor functions. Caffeine led to a significant increase in body sway and a decrease in manual dexterity 40 minutes after ingestion. Ingestion of caffeine did not reverse the ethanol-induced decrement in performance except in the reaction time tests.

The effects of different doses of caffeine and/or ethanol was investigated by Moskowitz and Burns (1981). In Experiment 1 they administered 4.4 mg of caffeine per kg of body weight (average dosage 325 mg). In Experiment 2 the dosages were 0, 2.93 and 5.87 mg caffeine/kg of body weight (mean doses 0, 211 and 423 mg, respectively). Low levels of caffeine counteracted effects of low levels of alcohol on attention, perception and tracking, but higher level of caffeine were relatively less effective in offsetting higher levels of alcohol. At no level was caffeine able to counteract alcohol's impairment of information processing as measured by backward masking.

4.2 Amphetamine and amphetamine derivatives

The effects of amphetamine and amphetamine derivatives on many behaviours have been studied, some of which are relevant to driving.

Collins (1977) administered 10 mg of d-amphetamine to young men who had been deprived of sleep for 55 hours. This led to reduced tracking error in both static (no motion) and dynamic (whole-body angular acceleration) conditions. This study also pointed out that effects of stimulants may differ when testing occurs in static and dynamic situations. Most laboratory investigations of stimulants have used a static environment while driving itself takes place in a dynamic environment.

The effect of l- and d-amphetamine on vigilance performance, waking EEG patterns and mood were studied by Hartmann, Orzack and Branconnier (1977). Performance of the 50-minute vigilance task was significantly better for subjects who had taken d-amphetamine than those who had taken l-amphetamine. Performance with l-amphetamine and placebo groups did not differ. EEG alpha-band activity after sleep deprivation was decreased for subjects in the placebo and l-amphetamine groups but not for the d-amphetamine group. No effects of d- or l-amphetamine on mood (as measured by the POMS scale) was evident.

The effects of phentermine and methamphetamine have also been studied. In the research conducted by Truijens, Trumbo and Wagenaar (1976), 20 mg of phentermine HCl was self-administered by suppository 90 minutes before testing. Subjects were medically examined in the two days prior to testing. There were three sessions, each comprising 33 120-second trials. Administration of phentermine led to better performance in a randomization task (a test of memory and attention) and lower integrated error scores on a pursuit tracking task.

The effect of methamphetamine on ethanol-induced driving impairment was investigated by Rutenfranz and Jansen (1959, in Mattila, 1981). Administration of 9 mg of methamphetamine restored simulated driving performance after 0.5g/kg ethanol but only partially restored performance after 1.0 g/kg.

Amphetamines may affect driving by a direct effect on visual perception. Westheimer (1963) studied the effects of dextroamphetamine sulphate (Dexedrine) and racemic amphetamine sulphate (Benzedrine: 15 mg) and barbiturates on accommodation/convergence. The two amphetamines activated the accommodation mechanism to the same degree and tightened the accommodation/convergence synkinesis. Tests were conducted for eight hours or longer.

Some concern exists about the effects of amphetamine on decision-making aspects of driving. Amphetamines may produce a misjudgement of speed (Ashworth, 1975) and an increase in risk taking (Hurst, 1962 in Hurst, 1976).

5 The role of stimulants in road crashes

Certain stimulant drugs are used by some drivers to help them keep awake. Regular use of stimulant drugs to stay awake for long periods of time may lead to hallucinations and impaired performance, which increases crash risk.

In addition the repeated use of some stimulants, such as amphetamines, leads to tolerance of the drug, so increasing amounts are required to maintain alertness (Milner, 1972). The problem of drug dependency in this situation means that driving performance could be expected to reduce dramatically when sufficiently high levels of amphetamines were not available to meet the body's increased demand for them. The body would not be able to function with a normal (i.e., drug free) level of performance unless some level of amphetamines were present. This need for increased dosages of amphetamines to maintain even normal alertness levels means that amphetamine-dependent drivers who are unable to secure sufficient dosages may actually become more fatigued than would normally be the case if no drugs were used (Goodman and Gillman, 1965).

The development of dependence on stimulant drugs means that their use may result in increasing the possibility of a fatigue-related crash, rather than the reverse.

There is very little information about the usage of stimulants by crash-involved drivers. They cannot be detected by breath testing and urine testing is not commonly conducted. The likely true rates of incidence are low (markedly less than 10%) which means that test refusal rates may lead to large errors in estimating the incidence of amphetamines in crashes. If only 1% of the tested drivers are positive for amphetamines, and the test refusal rate is 5%, then the true incidence may be nearly 5 times as great as the observed value (Hurst, 1976). Terhune (1986) has reviewed the problems and methods in studying drug crash effects.

In one of the earliest examinations of the role of drugs in crashes, Davis and Fisk (1966, cited in Hurst, 1976) investigated fatal single vehicle crashes in Dade County, Florida. Only 8 of the 179 victims had taken a drug other than alcohol and 4 of these had ingested alcohol as well.

A study of the incidence of drugs in road crash fatalities in England and Wales was reported by Everest, Tunbridge and Widdop (1988). The stimulants which were tested for were caffeine, amphetamine, amphetamine derivatives and ephedrine. The incidence in which caffeine was detected was not reported. Amphetamine was detected in three of 116 fatalities tested.

Hendtlass (1985) has reported a study of drug involvement in fatal crashes in Melbourne. Of 178 drivers, motorcycle riders or pedestrians who were found to have used drugs other than alcohol, caffeine or nicotine, amphetamines had been used by 4 operators (2.2%). Three of these operators were under 25 and the other was aged between 25 and 44. In 15 cases ephedrine had been used by the person killed. Caffeine was present in 64.4% of fatalities analysed.

Studies conducted in metropolitan areas may underestimate the role of stimulants in road crashes. The use of stimulants is likely to be primarily to remain awake during long distance travel, which is by its nature largely rural.

An alternative approach to determining the role of drugs in road crashes was taken by Smart, Schmidt and Bateman (1969). They examined the crash records of eight amphetamine abusers (and abusers of other drugs). Drivers who abused amphetamine alone had over four

times as many crashes as would be expected on the basis of age, sex, mileage and driving experience. Drivers who abused other drugs in addition to amphetamines had about twice the expected crash frequency. These results suggest that amphetamine abuse increased crash risk but there may have been some other characteristic of the sample which led to the greater frequency of crashes.

REFERENCES

- Ashworth, B. M. (1975). Drugs and driving. Journal of Hospital Medicine, 13, 201-204.
- Baker, W. J. and Theologus, G. C. (1972). Effects of caffeine on visual monitoring. Journal of Applied Psychology, 56, 422-427.
- Childs, J. M. (1978). Caffeine consumption and target scanning performance. Human Factors, 20, 91-96.
- Collins, W. (1977). Some effects of sleep deprivation on tracking performance in static and dynamic environments. Journal of Applied Psychology, 62, 567-573.
- Craig, S. (Ed.). (1986). MIMS Annual. Crows Nest, NSW: IMS Publishing.
- Ellinwood, E. (1969). Amphetamine psychosis: A multidimensional process. Seminars in Psychiatry, 1, 208-226.
- Ellinwood, E. H., Jr., and Kilbey, M. M. (1980). Fundamental mechanisms underlying altered behavior following chronic administration of psychomotor stimulants. Biological Psychiatry, 15, 749-757.
- Everest, J. T., Tunbridge, R. J. and Widdop, B. (1988). The incidence of drugs in road accident fatalities in England and Wales. Paper presented to the 11th World Congress of the International Association for Accident and Traffic Medicine. Dubrovnik, Yugoslavia. May 1988.
- Franks, H. M., Haggdorn, H., Hersley, U. R. and Starmer, G. A. (1975). The effects of caffeine on human performance, alone or in combination with ethanol. Psychopharmacologica, 45, 177-181.
- Goodman, L. S. and Gilman, A. (Eds.). (1965). The pharmacological basis of therapeutics. New York: Macmillan.
- Graham, D. M. (1978). Caffeine - its identity, dietary sources, intake and biological effects. Nutrition Review, 36, 97-102.
- Guinn, B. (1983). Job satisfaction, counterproductive behavior and circumstantial drug use among long-distance truckers. Journal of Psychoactive Drugs, 15(3), 185-188.
- Hartmann, E., Orzak, N. H. and Branconnier, R. (1977). Sleep deprivation deficits and their reversal by d- and l-amphetamine. Psychopharmacologica, 53, 185-189.
- Haworth, N. L., Heffernan, C. J. and Horne, E. J. (1989). Fatigue in truck accidents. Melbourne: Monash University Accident Research Centre.

- Hendtlass, J. (1985). Drug involvement in fatal crashes in Melbourne (CR41). Canberra: Federal Office of Road Safety.
- Hurst, P. M. (1976). Amphetamines and driving behavior. Accident Analysis and Prevention, 8, 9-13.
- Insurance Institute for Highway Safety. (1989). 'At least 20 percent of fellow truckers using illegal drugs'. IIHS Status Report, 24(7), 4.
- Kornetsky, C. (1969). The pharmacology of the amphetamines. Seminars in Psychiatry, 1, 227-235.
- Laurence, D. R. and Bennett, P. N. (1980). Clinical pharmacology (5th edn). Edinburgh: Churchill Livingstone. Ch 20. Sympathomimetics, asthma, shock, hypotension.
- Lisper, H., Tornros, J. and van Loon, J. (1981). Effects of caffeine or diazepam on subsidiary reaction time in a long-term driving task. In L. Goldberg (Ed.), Alcohol, drugs and traffic safety. Vol. 3 (pp.1024-1033). Stockholm: Almqvist and Wiksell.
- Lund, A. K., Preusser, D. F., Blomberg, R. D. and Williams, A. F. (1987). Drug use by tractor trailer drivers. Journal of Forensic Sciences, (in press).
- Mangione, T. W. and Quinn, R. P. (1975). Job satisfaction, counterproductive behavior, and drug use at work. Journal of Applied Psychology, 60, 114-116.
- Mattila, M. J. (1981). The possibilities of counteracting alcohol inebriation. In L. Goldberg (Ed.), Alcohol, drugs and traffic safety. Vol. 3 (pp.909-923). Stockholm: Almqvist and Wiksell.
- Milner, G. (1972). Drugs and driving: A survey of the relationship of adverse drug reactions, and drug-alcohol interaction, to driving safety. Sydney: Australasian Drug Information Services.
- Moskowitz, H. (1981). Alcohol-drug interactions. In L. Goldberg (Ed.), Alcohol, drugs and traffic safety. Vol. 3 (pp.881-894). Stockholm: Almqvist and Wiksell.
- Moskowitz, H. and Burns, M. (1981). The effects of alcohol and caffeine, alone and in combination, on skills performance. In L. Goldberg (Ed.), Alcohol, drugs and traffic safety. Vol. 3 (pp.969-983). Stockholm: Almqvist and Wiksell.
- Nix-James, D. R. (1977). Self-reported alcohol and amphetamine usage by long-distance heavy-vehicle drives in New South Wales. In I. R. Johnston (Ed.), Proceedings of the Seventh International Conference on Alcohol, Drugs and Traffic Safety (pp.49-57). Canberra: Australian Government Publishing Service.

- Parsons, W. D. and Neims, A. H. (1978). Effect of smoking on caffeine clearance. Clinical Pharmacological Therapy, 24, 40-45.
- Patwardhan, R. V., Desmond, P. V., Johnson, R. F. and Schenter, S. (1980). Impaired elimination of caffeine by oral contraceptive steroids. Journal of Laboratory and Clinical Medicine, 95, 603-608.
- Perone, M., DeWaard, R. J. and Baron, A. (1979). Satisfaction with real and simulated jobs in relation to personality variables and drug use. Journal of Applied Psychology, 64, 660-668.
- Rall, T. W. (1985). The methylxanthines. In A. G. Gilman, L. S. Goodman, T. W. Rall and F. Murad (Eds.), Goodman and Gilman's The pharmacological basis of therapeutics. New York: Macmillan. (pp.589-603)
- Regina, E. G., Smith, G. M., Keiper, C. G. and McKelvey, R. K. (1974). Effects of caffeine on alertness in simulated automobile driving. Journal of Applied Psychology, 59, 483-489.
- Smart, R. G., Schmidt, W. and Bateman, K. (1969). Psychoactive drugs and traffic accidents. Journal of Safety Research, 1, 67-73.
- Terhune, K. W. (19). Problems and methods in studying drug crash effects. Alcohol, Drugs and Driving, 2(3-4), 1-13.
- Transport Canada. (1987). Driving behaviour and characteristics of heavy duty truck operators in Canada. Ottawa: Transport Canada.
- Truijens, C. L., Trumbo, D. A. and Wagenaar, W. A. (1976). Amphetamine and barbiturate effects on two tasks performed singly and in combination. Acta Psychologica, 40, 233-244.
- Weiner, N. (1985). Norepinephrine, epinephrine and the sympathomimetic amines. In A. G. Gilman, L. S. Goodman, T. W. Rall and F. Murad (Eds.), Goodman and Gilman's The pharmacological basis of therapeutics. New York: Macmillan. (pp.145-180)
- Westheimer, G. (1963). Amphetamines, barbiturates, and accommodation convergence. Archives of Ophthalmology, 70, 830-836.