

EDUCATION, PUBLICITY AND
TRAINING IN ROAD SAFETY:

A LITERATURE REVIEW

by

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Education, Publicity and Training in Road Safety: A Literature Review

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Abstract:

The objectives of this review were as follows: to identify those publications in the worldwide literature on education, publicity and training in road safety that have been based on the results of good research, and to come to conclusions applicable to the Australian context. The important relationship between performance and behaviour was identified: performance relates to skills that can be taught, and behaviour to what a road user actually does on the road. In Australia and elsewhere, education and publicity have been most successful in modifying behaviour when combined with laws that are themselves directly related to safety, and that are strictly enforced. Other good results from education have come from efforts directed at high-risk and receptive groups such as children. Training of controlled groups such as the drivers of heavy vehicles appears to have given some good results. However, no methods of training for drivers or riders have consistently been shown to be better than others, and the results in general have been disappointing. Perception and understanding are likely to be emphasised in training in the future, together with an integrated approach that brings together individual problems.

Key Words:

Driver licensing, driver training, public education, young drivers, assessment

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EXECUTIVE SUMMARY

In recent years there has been a resurgence of interest in behavioural countermeasures. They have gained strength through their *combination* with other advances, including those based on technology. For example, the use of better and more effective child restraint systems can be encouraged by education and enforced by law. Another set of behavioural changes that have had a beneficial effect on traffic accident losses in Australia are those aimed at drinking and driving. In this case, vigorous and tightly targeted mass media campaigns have been combined with a research-based set of drink driving laws, embracing what is known as 'random' breath testing, or RBT. The result has been a hastened fall in drink related traffic accidents.

The interacting roles of performance and behaviour

Measures centred on changing human behaviour through education and publicity must, if they are to be successful, be based on a proper appreciation of how and why people act as they do on the roads.

The traffic system places high demands on all road users. If such demands are not mastered, or dealt with wrongly, then the system is 'failing' and a collision becomes possible. The way we cope with all the demands imposed upon us by the traffic system depends not only on the way we *perform*, but also on the way we behave.

'Performance' relates to our abilities to perceive and react to circumstances in an appropriate and timely manner. It is the manifestation of what we call 'skill'. 'Behaviour', although closely related, is different. It refers to what we actually do, not what we are *able* to do, and thus includes factors such as the perception and acceptance of risk, cultural and peer-group pressures, and so on.

The distinction between performance and behaviour helps us to examine road user education critically, because at least, in our adult lives we perform at a level that depends on how we *choose* to cope with the task demanded of us.

A skilled driver, for instance, may choose to negotiate a complicated driving task faster than another who is less skilled, and in so doing, trades increased speed against increased safety. Those drivers who choose a wide margin of safety, on the other hand, are able to cope more easily with the errors of others, including the children, the elderly, the drunk and the incompetent. This view of the driving task has important implications, and could account for some disappointing outcome studies of driver training. It could also account for differences in the reported success rates for the training of professional as opposed to 'amateur' drivers.

There is still no effective complete model of how people drive or how they learn to do so. If driver education and training is to progress, it will be in association with the results of carefully-designed human factors and educational research.

Mass communications

Research indicates that people are most likely to change their behaviour following mass education that has the following characteristics:

- includes specific detailed recommendations of the behaviour in question and how to modify it;
- perceived as coming from a highly credible source;
- balances the pros and cons of an argument rather than being purely one sided;
- draws the conclusions clearly for the audience;
- is combined with the enforcement of effective laws.

Road safety campaigns are most likely to be successful if advertising is only one element in a total campaign, with specific tasks to be undertaken. Usually, behaviour changes will not be among the outcomes that can be accomplished by the campaign by itself. Road safety mass media campaigns can achieve, and have achieved, the following:

- an increased awareness of a problem or a behaviour;
- a raise in the level of information about a topic or issue;
- help in the formation of beliefs, especially where beliefs are not held formally;
- the establishment of a topic as more salient;
- sensitisation of the audience to other forms of communication.

These are objectives that are supplementary to accident reduction, but that have effects without which safer behaviour is unlikely to be achieved.

An important target group for education is drinking drivers. The successes of public education in helping to reduce the incidence of drink-driving and alcohol-related crashes lie primarily in the unique way which, in Australia particularly, they have been combined with tightly-enforced legislation. The education helps to build support for laws and their enforcement, it helps to explain what the laws mean, and it helps to maintain a high visibility for the laws so that a high perceived risk of apprehension is maintained. Both in New South Wales and, more recently, in Victoria, good studies have shown how public educational efforts can be integrated with other aspects of random breath testing with the aim of maximising the effects of RBT legislation.

The results of evaluations of a selection of public education campaigns are tabulated at the conclusion of this summary.

Driver Training

Proponents of driver education, particularly of children while still at school, hold that instruction then is crucial. It reaches young people at a time they attain legal licensing age and are thus highly motivated to learn. They argue that it is only common sense that driver education is helpful in reducing the rate of accidents and injuries, because such courses teach proper driving manoeuvres and the rules of the road.

The evaluation of driver training programs, however, has been fraught with many problems, and most early studies that showed benefits to flow from such training were deficient. Later studies have not shown that training novice drivers in American schools is effective in reducing accidents. It encourages more young people to use the roads, with a net effect that can be negative. Other studies have not been able to show that any single

form of training is more effective than another. Training which relies solely on imparting the skills of car control has not been shown to reduce subsequent accident rates.

It is certainly true to say that just because an approach has not worked in the past does not mean that it would not work in the future if was to be undertaken differently. It may have been that the importance of improving skills as part of training has been overestimated, or that more research is required into what skills are most germane to safe road use and to training. Further, an approach worth investigating (and evaluating) is that skills training should be more closely integrated with other educational and promotional approaches to road safety, so that it might better be placed in a social and environmental context by those being trained.

The drivers of heavy vehicles are commonly singled out for special training, and it appears that in a well-managed and safety-conscious company, training can reduce accident rates. The performance and behaviour of motorcyclists have also long been a matter of especial concern, with local research indicating some benefits from the combination of new training and test methods. Overseas studies have not been so optimistic.

Evaluation of measures is an essential step towards making education more effective, and outcomes may validly embrace goals that are wider than accident prevention alone. Table 1 summarises evaluation studies of a selection of educational measures and publicity campaigns that have been undertaken throughout the world in recent years. Reference to the text of the full review is essential for a proper understanding of the importance of each of these studies.

The basic task of road safety education is to help people recognise and select a safe environment and situations. To act safely on the roads is a goal that is related to lifestyle and environmental awareness, and in turn to public health for all.

Table 1 Summary of evaluations of education, publicity and training programs

Authors	Target Group	Measure	Findings
The Wearing of Seat Belts			
Johnston and Cameron (1979)	Drivers and passengers (Aust)	Television campaign	Good change in behaviour
Lane et al (1984)	Rear seat passengers and child restraint users (Victoria)	All media, police blitz	Large and significant changes in behaviour
Child Pedestrians			
Elliott (1984) (review)	Child pedestrians generally	Various educational programs	10% improvement at best
Blomberg (1983)	Children darting out mid-block (US)	Television, classroom	Big improvements in behaviour and knowledge
Schreiber and Lukin (1978)	Safe crossing behaviour (NSW)	Classroom, television, film	Improved behaviour
Limbourg and Gerber (1981)	Children and parents (West Germany)	Educational package	Significant improvements in parents and children
Van der Molen (1983)	Children and parents (The Netherlands)	Training with parents	Improved behaviour all groups

Authors	Target Group	Measure	Findings
Fortenberry and Brown (1982)	Safe crossing behaviour (US)	Classroom, on-road instruction	Large and highly significant accident reduction
Renaud and Suissa (1989)	Behaviour on the road generally (Canada)	Simulation games	Improved attitudes and behaviour
Bowler and Torpey (1988)	Safety-related behaviour (Aust)	Community program, media support	Period too short for evaluation
Castor and Rush (1988)	General road behaviour, ages 5-11 (Australia)	Material resources for classroom and parents	Positive reception from children and teachers
Rush and Castor (1988)	General road behaviour, pre-school ages (Australia)	Material resources for teachers and parents	Positive responses from children and teachers
Drink-Driving Countermeasures			
Freedman and Rothman (1979)	Drinking drivers (NSW)	Advertising in mass media	Knowledge improved, small attitude change
Elliott and South (1983)	Drinkers (Aust)	Mass media campaign	Small changes in drinking behaviour
Homel (1988)	Drinking drivers (NSW)	Mass media publicity	With RBT laws, 36% red'n OH-related deaths
Job (1983)	Drinking drivers and RBT laws (NSW)	Advertising and media coverage	Increased knowledge, especially on legal limit
Cashmore (1985) (review)	Drinking drivers and RBT laws	Advertising and media coverage	Heavy publicity resulted in high level awareness
Elliott and Shanahan (1983) (review)	Drinking drivers and RBT laws (Aust)	Advertising and media coverage	High level awareness RBT, strong recall of advertisements
Harrison (1988)	Males aged 18-30 (Victoria)	Television advertisements	Raised perceived risk detection
Batchler and Grundy (1986)	Schoolchildren (NSW)	Classroom lessons and materials	Popular but practical difficulties
National Campaign Against Drug Abuse (1990)	15 year old school students (Queensland)	School curriculum with public education	Small but significant changes in attitudes and knowledge
Ross (1987)	Drinking drivers in Britain, general	Large planned and unplanned media campaign	Large but very short-lived drop in fatalities
The Reduction of Speeding			
Manders (1983)	Drivers' perception of radar detection (Vic)	Mass media campaign	No significant effect on speed
Croft (1990)	Speeding generally (NSW)	Mass media	Increased awareness of speed as hazard; but no reduction in reported speeds

Authors	Target Group	Measure	Findings
Novice Driver Training			
Stock et al (1983)	High school drivers (US)	Evaluation of improved course and curriculum	Fewer accidents and violations, but short-lived; greater exposure
Ohlson and Stoke (1986)	Novice drivers (Virginia, US)	Commercial versus school-based training	School-trained drivers had fewer crashes than commercial-trained
Potvin (1988)	All novice drivers (Quebec, Canada)	New mandatory standard training course	No change in new-driver crash rate; more new drivers on road
Simmonet (1982)	All novice drivers (France)	Traditional versus improved intensive training course	No difference between courses
Dreyer and Janke (1979)	Young drivers (US)	On-road versus off-road training	Equivocal results; ? benefit for off-road training
Strang (1982)	Young male learner drivers (Victoria)	On-road versus off-road training	No difference in later crash or violation rates
Post-Licence Driver Training			
Payne et al (1984)	Drivers generally (Queensland)	Defensive Driving Course	No reduction in crash rates except males aged 20-39
Manders and Rennie (1984)	Transport company employees (Victoria)	Vehicle handling and defensive driving	Crash rates declined with package of safety measures
Cavallo (1987)	Transport company employees (Queensland)	Defensive driving as part of package	Crash rates and severity declined
Lund and Williams (1985) (review)	Various; many court-ordered (US)	Defensive Driving Course in US	From studies with strong design, no effect on crashes, some on violations
Barmack and Payne (1963)	Heavy-vehicle drivers (US)	Smith, Cummins, Sherman method	Reductions in crashes depending on instructor
Sandow (1979)	Company heavy-vehicle drivers (South Australia)	Defensive driving course	Decrease in crashes with employee selection criteria
Motorcycle Training			
Raymond and Tatum (1977)	Motorcyclists generally (UK)	RAC training scheme	Trained riders higher crash rate than untrained
Satten (1980)	Learner motorcyclists (US)	US Motorcyclist Rider Course	Self-reported crash and violation rates lower in trained
Anderson (1980)	Motorcyclists failing test (US)	Skills training	Crashes 22% fewer in trained

Authors	Target Group	Measure	Findings
Lakner (1984)	MRC graduates versus others (US)	Motorcyclist Rider Course (MRC)	Lower self-reported crash rate in MRC graduates
Mortimer (1984, 1988)	MRC graduates versus others (US)	Motorcyclist Rider Course (MRC)	Crash rates same in two groups, less severe
Jonah et al (1981)	Formal training versus others (Canada)	Canadian Motorcycle Training Program	No effect on crash rates, but exposure lower in trained
Adams et al (1985)	Australia Post riders (NSW)	Closed-track training and defensive riding	No effect detected, but numbers small
Wood and Bowen (1987)	Novice motorcyclists (Victoria)	Training and testing combined	Major reduction in casualties
Batchler (1988)	Motorcyclists generally (NSW)	Classroom and closed-track training	Popular with teachers and pupils
Pedal Cyclist Training			
Trotter and Kearns (1983)	Child cyclists (Aust)	'Bike-Ed' course	Safer behaviour
Wells (1979)	Child cyclists (UK)	On-road and off-road training	Both methods reduced errors
Preston (1980)	Child cyclists (UK)	ROSPA cycling proficiency scheme	Fewer crashes in those passing test
The Use of Cycle Safety Helmets			
Torpey (1984)	Child pedal cyclists (pre-compulsion) (Victoria)	Mass media	Usage raised from 5% to 15%
Wood and Milne (1988)	School-aged and adult cyclists (Victoria)	Mass media and general promotion	Significant rise in use all groups; drop in head injury rate

1 INTRODUCTION AND OBJECTIVES

THE RESURGENCE OF BEHAVIOURAL INTERVENTIONS

Traffic safety policy has seen over the years a continuing and vigorous debate between those who advocate technological change based on environmental and vehicular countermeasures, and those who favour countermeasures oriented to the driver and other human road users. Clearly, in the end both sets of countermeasures will be necessary, but disagreement continues about priorities and productivity in the long term, especially because resources will always be limited.

Until the 1960s the traffic safety establishment was essentially composed of educators, law enforcers and administrators. The emphasis was on improving driver performance, and resulted in an explosion of education and training programs, the definition of new licensing standards, the writing of regulations and increasingly intense law enforcement.

The safety revolution of the sixties, spearheaded by those in the United States such as Dr William Haddon Jr and Ralph Nader, placed emphasis on technological countermeasures oriented towards vehicles and the environment.

Advocates of this fresh approach downplayed behavioural countermeasures. They saw these as useless, or at best of low priority.

In recent years, however, there has been something of a resurgence of interest in behavioural countermeasures (Graham, 1988). They have gained strength through their *combination* with other advances, including those based on technology. For example, the use of better and more effective child restraint systems can be encouraged by education and enforced by law. Another set of behavioural changes that have had a manifestly beneficial effect on traffic accident losses in Australia are those aimed at drinking and driving. In this case, vigorous and tightly targeted mass media campaigns have been combined with a research-based set of drink driving laws, resulting in a hastened fall in drink related traffic accidents.

It is therefore an appropriate time to review some aspects of behavioural change, and in particular the influence of education and publicity in bringing it about.

There is an increasing concern with effectiveness and obtaining the best returns on resources, and for that reason there has been a building emphasis in recent years on the need for measurement and evaluation. There has been understandable disappointment among some groups that such evaluations have sometimes led to negative assessments of well established and highly regarded programs. But the benefits of evaluation and research will be finally manifest in increased effectiveness through the development and implementation of programs and countermeasures that work, rather than continuing with those that do not.

METHODOLOGY FOR REVIEW

The primary objective of the present study was to review the research literature on education and publicity in road safety, and to analyse findings especially relevant to the situation in Australia. The aim was to reach conclusions that would be applicable within the Australian context.

Coverage of this review encompassed road user education in a very broad sense, including skills training for better performance, education of specific road user groups, and persuasion through mass communications transmitted via the press, television and radio.

The sources of data included scientific journals with an emphasis on traffic safety. In addition, the literature that was reviewed included journals peripheral to the field but which have published papers relevant to the objectives of the review. Much of the literature relating to this subject was published in monograph form by university departments and government bodies, and as far as possible these reports were obtained and reviewed.

Emphasis was placed on literature based on scientifically acceptable studies, and those oriented towards evaluation rather than description. However, when promising (and some negative) effects were found they were identified and are discussed in this review. The scientific validity of the conclusions of the papers was identified as far as possible.

The emphasis of the literature search was on the last ten years, because there are literally thousands of relevant citations on road user education in the databases searched. However, reference to earlier literature was made when it appeared to be of especial importance because of relevance, scientific quality, or because the paper was itself a comprehensive review of some aspect of the subject. In general, when the older literature has been well reviewed by other authors, these reviews have been used as source material in order to avoid duplicating already satisfactory work. The emphasis of the review was on the world-wide literature, but literature originating from Australian sources was included where appropriate for its local importance, even if in some cases its scientific rigour was less than the studies favoured for the review as a whole.

The databases that were searched included the following:

- Highway Safety Research Information Service (HRIS); Highway Safety Literature (HSL); International Road Research Documentation (IRRD); Transportation Libraries (all in the Transportation Research Information Service);
- British Education Index (BEI); Educational Resources Information Center (ERIC);
- the (Australian) Literature Analysis System on Road Safety (LASORS).

In addition, the library at the Australian Road Research Board was visited for a cross-check on literature cited by IRRD and other database sources. Most documentation was accessed through the library at the Road Safety Bureau of the Roads and Traffic Authority in New South Wales, the Australian Road Research Board, Worksafe Australia, and the NSW Department of Education. Documentation published by the various Australian Government administrations was obtained directly or through private sources.

ARRANGEMENT OF REPORT

Following this introduction, Section 2 reviews some current issues relevant to the examination of human factors in road safety. Attention is drawn in particular to the difference between performance and behaviour and the implications of this difference for education and training.

Section 3 is addressed to reviewing the literature on behavioural change in road safety, concentrating on studies of education and media publicity. Children, and drinking drivers, are selected for particular attention.

Section 4 emphasises performance, especially that of drivers and motorcyclists, and the extent to which attempts have been made over the years to improve their performance through various programs of training.

In Section 5 the threads of the review are drawn together in summary form, and conclusions drawn from the literature reviewed.

2 ROAD USER SAFETY: SOME CURRENT ISSUES

Measures centred on changing human behaviour through education and publicity must, if they are to be successful, be based on a proper appreciation of how and why people act as they do on the roads. Without such appreciation, the whole behavioural approach to road safety is simply a matter of "common sense", and in the past this has been found wanting.

Accordingly, some approaches to the examination of human behaviour and the driving task will now be discussed, with reference to the best of the literature.

THE INTERACTING ROLES OF PERFORMANCE AND BEHAVIOUR

There is obviously no single category of "road user". In today's motorised society virtually every one among us at some time has to use the road, whether as a child or adult, pedestrian, driver, motor cyclist and so on.

The traffic system places high demands on all road users. If such demands are not mastered, or dealt with wrongly, then the system is "failing" and a collision becomes possible. The way we cope with all the demands imposed upon us by the traffic system depends not only on the way we *perform*, but also on the way we *behave*. (For a stimulating discussion on this distinction, see Evans, 1991.)

Naturally, road user performance and road user behaviour are inextricably intertwined. The very words are defined in ways that blur the distinction, where it exists, one from the other. Nevertheless, the terms encompass attributes which are usefully differentiated when considering road user education and training, so that it may be made perfectly clear where measures are directed and what they are intended to do.,

As used in this discussion, "performance" relates to our abilities to perceive and react to circumstances in an appropriate and- timely manner. It is the manifestation of what we commonly refer to as "skill".

"Behaviour" refers to what we actually do, not what we are *able* to do. It embraces not only performance as in fact performed, but also attitudes to the task, cultural differences and pressures, and the way we perceive and respond to risk. Because driver performance focuses on abilities and skills it can be investigated by laboratory tests" simulator experiments, instrumented vehicles and studies of vehicles in traffic. In principle, at least, it can be taught. Behaviour, however, is much harder to study under all but the most advanced laboratory conditions and information is therefore much harder to come by. It cannot be taught by rote or simply enforced by decree.

This kind of distinction between performance and behaviour helps greatly in an examination of road user education, because at least in our adult lives we tend to choose a level of performance that depends on how we wish to cope with the task demanded of us.

A skilled driver, for instance, may choose to negotiate a complicated driving task faster than another who is less skilled. In essence, the way the identical task is performed by these two drivers results in the same level of risk to themselves and to others. The skilled driver has chosen increased speed as a trade against increased safety. Nearly a decade ago a Parliamentary committee of inquiry (House of Representatives, 1982) recommended research on the extent to which driver behaviour was influenced by the extent to which drivers are prepared to accept risk.

However, in a regulated, structured, environment such as that of the professional driver behind the wheel of a bus or truck, an increase in skill may well increase safety, because it can *not* be traded for an increase in task difficulty, such as driving faster, taking more overtaking opportunities or reducing acceptable gaps in traffic. The same applies to pilots, for whom an increase in skill imparted by training can not (in commercial flying, at least, as opposed to recreational or stunt flying) be traded for a reduction in safety margins, because that is simply not allowed.

Another form of enforced limitation of choice of risk arises through the imposition of speed limits that are rigidly controlled, which Summala (1985) suggests increase safety by imposing limitations on drivers who would otherwise choose increased speed as an option, rather than safer driving.

This concept has important implications for the outcome of training, and could account for some of the disappointing outcome studies of driver training that will be reviewed in this paper. It could also account for some of the differences in the reported success rates for the training of professional as opposed to "amateur" drivers. In day-to-day driving, which is characterised by a relatively unconstrained environment, some drivers may trade an increase in skill for an acceptance of a higher level of task difficulty, rather than in a wider margin for safety.

Since motor vehicles became popular and the number of accidents started to rise, approaches to making road use safer have been based on a perception that accidents are failures of skill, and that the safety of a road user is mainly determined by the level of skill applied in response to the demands that are faced.

Accordingly, the general strategy has long been to increase road-use skills and decrease the demands placed on road users by the environment. There are many aspects to the general concept of skill, but some apply to all road users, from child pedestrians ("look right and left", for instance) to truck drivers (off-road skid training is an example).

THE TASK OF DRIVING

Attempts to evaluate and improve the effectiveness of driver training programs are made difficult by the lack of agreement as to what constitutes safe and proficient driving. At its most basic level, driving a motor vehicle is a very simple activity. Most people can learn to do it quickly and children encounter no special difficulties. On the face of it this is rather surprising.

At the turn of the century, when the passenger car emerged upon the scene, Carl Benz is supposed to have considered that the market for his automobile was limited because "there were going to be no more than one million people capable of being trained as chauffeurs". Yet now we see adolescents in their teens driving racing cars in top-level national competition: arcade games incarnate. For the huge majority of people, learning to drive a car is much easier than learning to play the piano.

It is strange, therefore, if driving is such a "simple" task, that a high proportion of people facing the initial driving test fail it, and there is such a high crash rate among young drivers. It must follow that there are features of safe driving which have little to do with the ability to steer, brake, accelerate, reverse and park a motor vehicle. It is those features which analysts capsule as "models" of the task. The suggestion is that if we can

construct valid and comprehensible models, then we can approach education and training in a more precise and structured way.

Over the years there have been hundreds of different studies of the driving task and hundreds of different models outlined in an attempt to describe it, and in a review addressed at novice driver performance issues, Drummond (1989) summarises what is known of the driving task and models of driving behaviour.

In terms of information processing, the driving task requires the extraction of information from the environment, processing that information, making decisions and monitoring the resulting performance.

In the early stages, a person learning the task comes to understand those basic components of it that include the location of vehicle controls and the responses of the vehicle. When first starting to drive, novices tend to concentrate their vision and attention comparatively close to the car. Brown (1982), for example, found that young drivers are relatively poor at identifying distant hazards, although they compare well with older drivers in identifying nearby hazards. Hazard perception is now being built into driver licence testing procedures (Hull, 1990), a direct example of how human factors research can feed back into training and administration.

This early phase then extends into the exploration of different strategies, the learner being acutely sensitive to feedback. The trainee driver must devote full attention to the task, and increases skill by responding to this feedback either from seeing what happens when the controls are operated or as a result of directions from an instructor. During this phase, it will be necessary for the trainee to tolerate a relatively high level of perceived risk. As skill develops, the task can be performed effectively with less effort, using a small part of the driver's attention. Perceived risk becomes much less important (Colbourne, 1978), except to the extent that younger drivers - an effect specifically of age, rather than inexperience - are content to operate at a higher level of perceived risk than older drivers (Näätänen and Summala, 1976).

Brown (1982) pulled together such observations in a proposal for a model which attempted to describe the effects of age and inexperience on accident risk. He suggested, like others, that the inexperienced drivers (especially young males) failed to understand the importance of the cognitive skills of understanding rather than of car control, did not appreciate that they lacked the skills that were in fact important, and were accordingly overconfident of their ability.

With developing experience, the capacity to anticipate situations expands, and as information processing becomes more efficient the most basic driving skills develop a degree of automaticity. This frees capacity for strategic planning and other aspects of the total driving task.

As the importance of perception and understanding of hazards became apparent as determinants of safe driving, Quimby and Watts (1981) investigated the effect of several human-factors variables, with measures including accident histories and observed driving behaviour. They found that it was risk taking which correlated most highly with safe driving. However, drivers whose speeds resulted in the greatest risk-taking as assessed by observers considered that the risks were low.

Benda and Hoyos (1983) studied the extent to which drivers could comprehend the extent of a hazard which was presented to them; how well, in other words, they could perceive "real" risk. They found that inexperienced drivers based their estimates on simplistic observations based on single, identifiable factors such as the weather, the presence of an intersection and so on. Experienced drivers, on the other hand, were more able to appreciate the situation in a holistic manner.

If people understand risk poorly, they may consequently rate their abilities wrongly. Job (1990) surveyed 2,963 Australian drivers as part of an evaluation of the effect of random breath testing for alcohol. Drivers were asked to rate their driving ability, and their ability to drive after drinking. Overconfidence was the main finding for these Australians, the same overconfidence that has been observed in similar studies in Canada, Sweden, New Zealand and the United States.

Since clarification of the idea that the simple ability of the driver to control a vehicle was only one - and perhaps not a very important one - of the many factors in safe driving, there have been moves by human factors scientists towards advancement in our understanding of what drivers actually do, through the identification and definition of more sophisticated models of safe driving.

Michon (1985), among other behavioural scientists, believes that a more sophisticated approach to driver instruction will eventually allow us to capture the essence of what constitutes good driving. It is a more general strategy which takes into account (among other things) the mental set of the driver and the complex way the driver makes individual judgements and solves problems according to the risk that is perceived and what is understood about the traffic environment. The more we understand about the task as a whole, whether it is the one faced by the driver, the rider or the walker, the better we will be able to educate and train people to cope with it safely.

In his discussion of some conceptual issues surrounding novice driver training, Drummond (1989) notes the longstanding imbalance between what is to be taught and how it is to be taught. Little information based on empirical evidence is incorporated into the training curriculum. Driver education is based on vague foundations, concepts of the driving task that are only intuitive, and has objectives that are insufficiently objective to contribute to effective program development and evaluation. It is hardly surprising, therefore, as will be reviewed later in this report, that outcome studies have generally given disappointing results.

THE INTERACTION OF RISK-TAKING AND SKILL

Driving is a task for which drivers may to some extent choose their own desired degree of difficulty (Näätänen and Summala, 1974, 1976). Increased skill may lead a driver to accept more difficult tasks, which may in turn lead to driving faster, overtaking under more dangerous conditions or accepting secondary tasks such as talking to passengers or selecting cassettes for the vehicle stereo. On the other hand, when the level of task difficulty is held constant, increases in skill are likely to lead to increases in safety.

Wilde and Murdoch (1982) go further. Arguing towards a theory of "risk homeostasis", they have claimed that all variables, other than motivational ones, have only a marginal effect on crash causation. The major determinant of crash rate is the level of risk chosen by the driver, and it is easy to find examples of drivers who have intentionally sought risk. Evans (1991), however, argues that while this may be true for certain individuals, it is not

reasonable to argue the same case for the population as a whole. It seems more plausible that most of the time drivers seek the lowest possible risk. The thrills to be found in speed and acceleration are pleasurable and exciting, but increasing the risk of crashing is not one of the "benefits" to be sought in fast driving, whether on the road or the race track.

This is consistent with the "motivational model" of Näätänen and Summala (1974) which states, in essence, that as a result of their being able to choose a level of task: difficulty, drivers do not generally perceive any significant risk. The driving task is customarily "paced" by the individual road user, who (assuming a normal level of alertness) makes moment-to-moment choices in adjusting performance so as to cope with the perceived difficulty of the task faced at any given time.

Hampson (1984) suggests that drivers who customarily select wide margins of safety, thus accepting a low level of risk, are consequently able to commit many more errors without disaster than those adopting low margins of safety.

Those drivers who choose a wide margin of safety are also able to cope more easily with the errors of others, including the young, the old, the drunk and the incompetent. Much of the literature promoting "advanced" driver training demonstrates a remarkable degree of intolerance for such groups, with the implication that they should be "trained" better or kept off the road altogether.

Observation suggests that many drivers with a highly favourable perception of their own driving skill drive as if all others shared their capacity for car control, a recipe for trouble in a heterogeneous road-using population. Support for this concept in the literature comes from Howarth (1985), who showed that motorists in Britain behave as if they consider it the responsibility of the child, not the driver, to avoid child-pedestrian collisions.

If it is correct that skilled drivers reduce their margin of safety rather than increase it, then their net crash rates should not be any lower than the unskilled. In order to discover if unusually skilled drivers really did have better driving records than average drivers, Williams and O'Neill (1974) obtained the names and addresses of national competition licence holders from the Sports Car Club of America. They compared the driving records of these competition-licensed holders to comparison groups of drivers matched by age and sex. What they found was that the rates for several measures for the racing drivers exceeded those for comparison drivers, and in most cases by considerable amounts. For yearly periods, the racing drivers had substantially more crashes and more violations, especially speeding violations. Although the racing drivers travelled more than others, this did not explain all of the difference that was observed.

The unambiguous conclusion was that the possession of a national competition licence in the United States was associated with higher crash and violation rates.

It was not possible to determine whether the effect flowed from the use of the additional skills acquired by the drivers to drive more aggressively or simply because it is high-risk drivers that are attracted to motor sport. Whatever the reason, this study showed that higher skills are not necessarily associated with lower crash rates.

This widely-quoted study does not, of course, address the question as to whether the skills of race driving have anything whatsoever to do with the skills required in driving on the road. That they do, is taken for granted by most commentators and advocates of

"advanced" driving schools. If they do not, then it is not surprising that higher race-driving skills are not related to lower crash rates.

Driving *safely* in traffic encompasses far more than skill in vehicle control. It requires the absorption of a body of accumulated knowledge and experience, which in turn is important to correct judgement. The road user must be a problem solver. Rare events - such as a child running out on a roadway in front of a car cannot be taught by trial and error. It requires an appreciation of risk that normally takes years to refine, and it requires an approach to driving that is not typically associated with the "skilled". Safe driving means for most people changes in the way they *behave*, not in their level of skill.

3 CHANGING ROAD-USER BEHAVIOUR

THE EVALUATION OF ROAD USER EDUCATION

In 1984, the Organisation for Economic Cooperation and Development brought together a scientific expert group with the aim of reviewing and assessing the design, implementation and effectiveness of road safety education programs in OECD member countries on the basis of experience obtained with such programs at regional and community level. Their valuable report was published in 1986 (OECD, 1986).

A major part of the OECD report deals with the various types of evaluation that can be used for traffic safety education measures, including those aimed at increasing knowledge and improving attitudes. They make the reasonable claim that it is important that some consensus is reached about the terms to be used in describing the particular types of evaluation, and about the role of these different types of evaluation in the development of the road safety programs they describe.

"Formative" evaluation is defined as the collection and analysis of data before and during the development of a program, with a view to making it as good as possible. Two types of formative evaluation are distinguished: process evaluation, which aims to assess the acceptance and use of the program material and methods; and product evaluation, which aims to assess the outcome of the educational process (for example, changes in understanding of traffic regulations).

"Summative" evaluation is defined as the collection and analysis of data on an operational program in order to determine its effects, costs and unintended side effects.

The difference between these groups of evaluations lies in their different purposes. Formative evaluation serves to provide information for further development of a program, whereas summative evaluation provides data on which to base decisions regarding continuation of- the existing program or implementation of a new one.

The OECD group were also careful about defining goals. The goal of road safety education, they suggested, could be defined as achieving an optimal use of the transportation system with optimal safety for all participants. Specification of goals for road safety education is crucial to its impact, and should be based on a careful and detailed analysis of the problem to be addressed, using accident and exposure data.

The OECD report goes into considerable detail on different methods of evaluation and these will not be reviewed again here. They form a useful check list for those engaged in research in this field, especially with respect to the education of children in traffic safety.

They set out the several outcomes that are open to measurement apart from numbers and rates of accidents, which for individuals occur so infrequently that large samples have to be used to allow the detection of an effect of an education program on accident reduction. The use of accidents in evaluation studies can only be undertaken if the program is operational on a sufficiently large scale, and therefore accident measures can only be relevant in summative evaluation studies. If a program is under development, the use of accident data as a criterion is not feasible.

The collection of accident data over a period of several years in order to obtain sufficient numbers for analysis may be feasible for the evaluation of engineering measures, but

cannot be applied in most cases: for the evaluation of educational measures. The first reason is that it is unrealistic to assume that the effects of a particular short term program will continue over several years if not backed up by other activities. Secondly, the longer the time lag between treatment and measurement, the more likely it is that compounding factors will start to play a role. All such factors make it unlikely that the effect of an educational program can be tracked in terms of accident involvement over a long period of time.

In addition, accident statistics need very careful handling if they are to be used for evaluation. Those accidents that are less severe, although numerous, are relatively unlikely to be reported and appear in official records. Fatal accidents are reliably reported, but limiting measurement to fatal accidents alone reduces the numbers that can be used in an analysis. This may therefore require methodology including case controls as well as a longer time period for the collection of data than for studies which include all accident numbers.

At the time of the OECD report, as the research group comments, elaborate evaluation studies that have convincingly used accident involvement as an evaluation criterion for road safety education programs are not surprisingly sparse. However, given the obvious importance of accident involvement as an evaluation criterion the group recommended that studies should be undertaken to develop a feasible research and evaluation strategy in this respect.

Indeed, there are several ways to consider the issue of effectiveness as it is applied to road safety education programs. Shaoul (1976) proposed that because accidents are the results of the activities of road users, rather than the activities themselves, the focus of evaluation should be shifted to the accident-producing behaviours. It is thereby possible to learn more about the effect of training on safety and about the nature of the training process. The evaluation, it followed, should require assessment in terms of the following:

- traditional educational criteria, namely formal tests of knowledge;
- training criteria, the acquisition of skills;
- the relationship between the two types of criteria;
- ultimately, accident and violation rates.

Shaoul noted that the selection of a criterion is rarely singled out as a problem in evaluation, but it may well affect the conclusions to be drawn from the research. Certainly, much of the criticism that researchers have drawn from educators has been on the basis that the evaluations have been on the wrong or inappropriate criteria.

A suitable model is that of Limbourg and Gerber (1981), who pioneered the establishment of operational programs based on sound research in the context of learning and instructional psychology. In general terms a program is effective if it does what it sets out to do. The aim of the program therefore determines the criteria for its effectiveness. In road safety education programs the formulation of educational objectives is a first and most important step. The educational objectives should describe what the program has to achieve in terms of the changes in traffic behaviour underlying knowledge, skills and attitudes in the target group.

There is some debate on whether accident analysis studies and traffic behaviour and exposure studies can be used to determine safe use of traffic. Formal analysis of the tasks involved describes the behaviour required for coping with various situations, and this information can be used to determine educational objectives.

Grayson (1981) argues that stringent approaches such as this are not feasible. There is simply not enough empirical evidence available. The validity of educational objectives that are formulated in non-accident terms such as knowledge, skills and attitudes is even more controversial. It has proved hard to demonstrate that improvements in traffic knowledge, or changes in attitudes, do in fact lead to changes in accident involvement. Of course, to a certain extent knowledge is required to perform certain behaviours at all. For example, a cyclist must know that it is wrong to ride through a busy signalised intersection against a red light. However, as argued elsewhere in this review, the link between attitudes, behaviour and performance are complex ones.

In summary, summative evaluation is perhaps the most difficult step in developing and evaluating road safety education programs. There are two distinguishable issues. The first is whether the program does indeed reduce the accident involvement of the target group. Many educators and program developers do not consider it necessary to undertake summative evaluations, and in fact there are few programs that have been decisively evaluated in terms of their effect on accident involvement. The second consideration is the manner in which the educational program fits into the overall educational curriculum. It may simply be impossible to incorporate large segments of traffic safety education into the school curriculum.

Nevertheless, summative evaluation is of importance in any major program especially where resources are limited, because this is the only way in which the role of the importance of educational measures in a general program of accident countermeasures can be established. Failure to include summative evaluation can have two undesirable effects. It may increase the priority given to other measures simply because their positive effect on accident reduction is more easily established. Or, on the other hand, unproven measures with wide public support may be continued irrespective of their lack of benefit, and thus more effective programs may be deprived of their share of a limited budget.

THE ROLE OF PUBLIC EDUCATION AND PUBLICITY IN ROAD SAFETY

The first substantial review in Australia of the role of mass communications and public education in traffic safety was that of Avery (1973). Even then, nearly twenty years ago, Avery was able to draw attention to the very large sums of money that were being spent on road safety campaigns in Australia. However, as she commented, there had been little or no evaluation of the effectiveness of these campaigns in reducing the number and the severity of traffic accidents. Typically, measures of effectiveness to that point had (when undertaken at all) been confined to recall of the message or assessment of how people had received it. She suggested from her review of the existing literature that neither reception nor recall were related to whether or not safety-related behaviour had been modified by the message.

Avery proposed that communications in road safety had two distinguishable purposes: to inform, and to persuade. However, it was rare for a campaign to be either purely informative or purely persuasive. Most traffic safety education involved some degree of persuasion in an attempt to modify attitudes and behaviour.

Following her review, Avery stated that people were more likely to change their behaviour following mass education that has the following characteristics:

- includes specific detailed recommendations of the behaviour in question and how to modify it;
- perceived as coming from a highly credible source;
- balances the pros and cons of an argument rather than being purely one sided;
- draws the conclusions clearly for the audience.

At the time of her review threats and fear appeals were commonly employed in public education, but Avery suggested that the behavioural literature indicated that they would be unsuccessful. Fear appeals did not appear to provide lasting attitudinal and behavioural changes in the desired direction. The emotional tension aroused by fear appeals could interfere with subsequent learning, and fear might in fact have a negative effect, actually decreasing thereby the number of people taking the desired action. Under high fear appeals the seriousness of the threat is often minimised when the recommended solution is seen as being ineffective. Avery did, however, suggest that fear appeals could be effective under the following circumstances:

- when some relatively immediate overt action can be taken to reduce the anxiety aroused by communication;
- when the recommended action is given clearly and in sufficient detail to facilitate its adoption;
- when the behaviour affected by the communication is not so well established that it involves very high personal costs to change;
- when the solution offered is seen as being effective in removing threat.

As a corollary, Avery suggested that the continuing reference made to the mounting "road toll" by the media, which was designed to shock people, may be self defeating and have a negative effect on attitudes to safe driving. This permitted people to "inoculate" themselves by frequently exercising and reinforcing their defences against anxiety. Consequently, she concluded, if there were fewer references to road deaths by the news media there would be fewer inoculation opportunities.

In a recent Australian study Job (1990) supported many of the kind of reservations expressed by Avery in this respect. He attempted to explain the failure of numerous fear-arousing campaigns to change the manner in which people drive. Being an occupant in a car and learning to drive may be seen as a desensitisation process, he suggests, in which fear is extinguished or a response inconsistent with fear is learned. Subsequently, the fear response is unlikely to be reinstated by messages pointing out dangers on the road. Further, exposure to news about dramatic crashes and the "road toll" only serve to confirm the individual drivers' perceptions that they are safer than average, and that the risk to them is negligible.

Effective communication is a two-way process, with continual reference being made to the psychological and social contexts in which the message is to be received. However, before a message is sent its aims, content and to whom it is to be sent must be specified in detail. Once the message has been defined the beliefs and needs of the people intended to receive the message should be addressed, and when it comes to transmission, research is needed on

the best channels for transmitting the message to the chosen audience. Feedback from that audience is also needed to ensure that the message has been interpreted accurately and understood.

Information is needed about any changes in behaviour that might have occurred during and after the campaign. Following an effective message the recipient should modify behaviour, whereas following unsuccessful communication there is at best no response or at worst the behaviour change may be contrary or irrelevant to the message.

Traffic safety information is only one factor operating in a total social context, and it needs to be supported by other elements in the social and road use systems, including the legal and regulatory framework. There are some members of the community whose behaviour may be almost impossible to modify solely by mass communications through the normal channels. These include the very young, the very old and the heavy drinkers. In order to affect the target group's behaviour, it might be necessary to transmit the message via parents, relatives, members of peer groups, community leaders and other members of society. The reference groups to which an individual belongs, such as work colleagues and friends, provide a powerful force for countering, supporting and transmitting mass communications.

Another extensive review undertaken at the same time as that of Avery was by J. Walter Thompson (1973). This was done by professional communicators as part of a national review of road safety. Its conclusions were essentially the same as those of Avery (1973). Like her, they quoted studies such as that of Haskins (1970), who had concluded that there had been relatively little research up to that time on the mass campaigns that had been conducted. It was probably safe to say that the majority of safety communications campaigns had little or no research support, with the major decisions on campaign contents and evaluation of campaign effects being carried out purely subjectively. The research design in most of the studies had been inadequate.

However, even these critics conceded that despite the lack of adequately designed research, there was evidence that mass communication campaigns could have a positive effect on safety behaviour. This did not mean that any campaign would have beneficial effects on any sort of safety practice. The greatest likelihood of success would follow those campaigns where systematic use was made of known communications principles, based on scientific study and accompanied by appropriate pre-testing research at various stages of the development process.

Since publication of those early papers, public education and road safety campaigns have generally moved towards embracing the principles laid down in them.

For example, a well controlled Australian study on the effectiveness of television publicity on the correct wearing of seat belts, was that of Johnston and Cameron (1979). This was an example of a campaign where the target behaviour was very clearly specified. Improvements in behaviour demonstrated by this investigation were both statistically significant and substantial in absolute numbers. The authors concluded that the aspects of the program that were most responsible for its success were as follows:

- the target behaviours were directly related to the possibility of injury;
- they were specific and capable of unambiguous demonstration;
- the form of publicity used a message source of high credibility and high status;

- a mild fear setting was employed as a motivating factor;
- and the publicity was comprised of specific concrete demonstrations of the behaviours it was wished to change.

A major publicity campaign aimed at increasing seat belt use by rear-seat passengers was undertaken in Victoria in 1981/82. The campaign emphasised the dangers of riding unrestrained in the rear seat and reminded people that the use of belts in the rear was required by law. An additional campaign was aimed specifically at promoting restraint for children from birth to seven years of age.

Television, radio, the print media, press conferences and displays were all employed. There was also a police blitz on enforcement of the law.

A careful evaluation (Lane et al, 1984) showed a significant increase in rear seat belt use (from 39.5% to 67.8%), a 9.5% increase in the use of child restraints, and a significant reduction in rear-seat casualties among those aged 17 and over.

The authors of the evaluation credited the following factors for the success of the campaign:

- the publicity was aimed at a behaviour perceived as being relevant to the risk of injury or death;
- the target behaviour was illegal, easily observed and thus enforceable;
- the publicity was carefully researched for potential effectiveness before use;
- formative evaluation during the campaign allowed adjustments;
- the use of a range of media ensured exposure to a wide cross section of the community.

Of course, this study did not show that the use of the publicity *on its own* had the desired effect. It did show, however, that heavy publicity in association with enforceable laws could be very effective.

A recent Australian review and description of how best to use the media is that of Elliott (1989). This report is a summary companion volume of a much larger and more detailed set of guidelines that were produced for the South Australian Department of Transport, the Federal Office of Road Safety, the Roads and Traffic Authority of New South Wales and the Road Traffic Authority of Victoria.

Elliott warns that road safety campaigns differ in many ways from the conventional advertising of consumer products. Much of the research in the past has shown that when employed without support, straightforward advertising campaigns for road safety can fail, even when heavy expenditure is invested in them. However, when combined with other activities (such as the introduction of new laws, vigorous enforcement of them, parental enthusiasm, informal media attention and so on) a total program can be very effective, and there are several examples from Australian studies in this present review.

Until the 1980s, the belief was that advertising injected a message into an audience that brings about changes in attitude which leads to change in behaviour. This belief meant that the focus for road safety communications was the message. This viewpoint is now being replaced by one which starts from the premise that what matters is what people do with the

messages transmitted to them. The focus is thus turning towards the audience and away from the message, and the question to be answered is not what the messages do to people but what people will do with the messages.

But road safety campaigns can succeed if advertising is only one of the elements in a total campaign (and usually not the key element), with specific tasks to accomplish. Usually, behaviour changes will not be among the outcomes that can be accomplished by the campaign itself. He summarises the evidence as suggesting that road safety mass media campaigns can achieve, and have achieved, the following:

- an increased awareness of a problem or a behaviour;
- a raise in the level of information about a topic or issue;
- help in the formation of beliefs, especially where beliefs are not held formally;
- the establishment of a topic as more salient;
- sensitisation of the audience to other forms of communication;
- stimulation of interpersonal influences by conversations with others (police, teachers, and parents);
- generation of self-initiated information seeking;
- reinforcement of existing beliefs and behaviour.

Sometimes campaigns that are aimed at the general public can be justified on the grounds that a road safety issue must be brought to attention as a matter of public importance. A mass media campaign can play a useful role in helping create a desirable supportive climate of opinion in the community. Public opinion does matter, and can act as a potent influence on the beliefs and behaviour of individuals. People's opinion depends on what others think, and by providing information via mass media campaigns it is possible to influence the climate of opinion.

Further, road safety mass media campaigns can play a role in suggesting to the public what to think about ("agenda setting"). Attempts to change immediate attitudes, however, are unlikely to succeed. The best way, summarises Elliott, to achieve attitudinal or behavioural change is to influence experience. New experiences provide the excuse to change individual opinions and behaviours.

Advertising can signpost the changed situation which in turn can lead to change in attitude or behaviour.

For example, the regular wearing of bicycle safety helmets or seat belts changes people's attitudes to them. The introduction of random breath testing is another case of changed circumstances that have led to changed attitudes, and the use of the mass media to support the introduction of random-testing regulations will be discussed in the later section on "drink-driving". Advertising can provide strong support for these changes.

Elliott makes the point that the evaluation of campaigns is required not only as a matter of public accountability but also as a critical input to future progress.

However, summative (outcome) evaluation is costly, difficult and sometimes inconclusive. Scientific experimentation is rarely practical or affordable either in road safety or product advertising.

In general, therefore, it is better to minimise the likelihood of failure as early as possible through formative evaluation than wait until the campaign has run its course and then attempt to find out how successful it was. Evaluation has to be specified at the beginning of the campaign, and the focus for outcome evaluation should be relevant to the objectives of the campaign.

It follows, as reviewers such as the OECD (1986) have pointed out, that criteria for success need not only be accident reduction or campaign awareness. They may include awareness of hazards, traffic knowledge, risk perception, skills of performance or understanding, attitudes towards safety, or behaviour in real or simulated traffic.

Criteria should flow as directly as possible from the educational objectives of the program, and will also depend on the stage of its development. All these outcomes may be regarded as responses of a lower order than those directly, and measurably, related to accident reduction. There are some indications, however, that they may nevertheless be essential steps towards (or even a precondition of) behaviour change. Although empirical evidence of this is lacking, long-term evaluations of some of the larger-scale public education campaigns could provide data to support or reject such a hypothesis.

The purpose of formative evaluation is to gather information that can be used to design or improve road safety education programs. It is a diagnostic device.

Typical questions that may be asked include the usefulness, attractiveness and ease of use of resource materials. The comparative effectiveness of different approaches can be established; the effect of a modified program can be compared with an existing one, for example. Some parts of the program may improve behaviour but not the perception of risk.

The primary goal of formative evaluation is; not necessarily to establish the outcome of a program, but to establish what factors in the educational process determine its possible effects. The information it provides helps to move towards maximum effectiveness, and in this respect it is essential.

CHILDREN IN TRAFFIC

Children may be injured in traffic as pedestrians, vehicle passengers, or as pedal cyclists. They run disproportionate risks because their skills of performance and understanding are limited and poorly developed. Yet they can perform reasonably well in certain types of traffic tasks, and they can be taught in ways that will improve both their perception and choice of safe situations and their behaviour in such situations.

As part of the process of teaching, children have been exposed to a wide variety of countermeasures based on education, training and publicity.

The educational objectives and evaluation methods of pedestrian safety education for young children have been well reviewed in the Australian context by Bowen (1985), for the Victorian Road Traffic Authority. Bowen contrasts several European programs with the Victorian primary school unit's "Roadwork" program, pointing to the greater emphasis placed in Europe on behavioural approaches and behavioural change, rather than the cognitive objectives - seen as prerequisites to behavioural change - more common in this country. This author suggests, however, that in the end it is behavioural change which should be the outcome measure rather than changes in attitude or knowledge.

Some analysts have been pessimistic that any public education can affect the behaviour of child pedestrians. Howarth and Gunn (1982) have argued that children learn about "safe" pedestrian behaviour in ways that are too conflicting to result in a consistent response as they grow: they are taught formally about road-crossing drills and so on, but go on to draw lessons from the behaviour of parents and other adults, sometimes very different indeed. Elliott (1984) stated that by the mid-eighties there had been no documented educational program which had ever produced a reduction in accidents of more than 10%, but went on to argue (contrary to Bowen, 1985) that the criteria for assessment should be based on the adoption of "safe" behaviours rather than accident reduction.

However, a well controlled investigation of the effect of educational material on the behaviour of child pedestrians by Blomberg (1983), based on a tightly-defined campaign, gives rise to more optimism. The accident types selected for attention were "dart out" accidents in which the child pedestrian was struck during a crossing between intersections. Previous analyses had indicated that these dart outs represented about 39% of all child pedestrian accidents. The program included a six to seven minute classroom film, three 30 second and three 60 second television advertisements, and a poster. All media employed an animated character as a spokesperson. The six television advertisements covered each of the behavioural messages used in the film employed in the classroom.

The promotional materials were distributed to television stations and schools in three major cities in the United States during 1976 and 1977. Pedestrian accidents were examined in detail for at least three years before introducing the material and for two years after the introduction. Several associated measures were taken, including the exposure of the children to the television and class materials, recall of the knowledge, and actual street crossing behaviour. The vast majority of the television broadcasts were during periods when children typically watched television, and surveys in each city showed that over 70% of the school children knew who the promotional character was after the material had been available for about one year.

The results of all the measures were highly encouraging. The children's expressed knowledge of safe street crossing behaviour increased dramatically. Their actual street crossing behaviour was observed and measured in all the three cities, and the data showed a statistically significant improvement in visual search patterns in each of the sites. Totally correct stopping behaviour also showed an improvement.

The ultimate measure of the effectiveness of this campaign was its impact on dart out accidents. Importantly, in each city a significant reduction of dart out accidents was observed. Across the three cities, dart outs involving pedestrians 14 years and under declined by an average of over 20%, which was much higher than the 12% reduction in all pedestrian crashes involving this age group. In addition, there was a statistically significant drop in each of the three cities.

The accident reduction results were not uniformly distributed by age. The great majority of the reduction took place among the four to six year olds. Overall, dart outs by four, five and six year old children declined over 30% from the baseline to the program period. This large impact in the pre-school years strongly suggests that television exposure to this audience was effective, as they were not exposed to the classroom materials.

It was calculated that this campaign saved society almost three million dollars while it was being tested. Thus, the program was concluded to be both an effective and a cost effective pedestrian accident countermeasure.

An Australian study rather similar to that of Blomberg (1983) was reported by Schreiber and Lukin (1978). This was an analysis of educational material utilising a fantasy animal character, "Hector the Cat", aimed at communicating to children aged five to eight years. The study was aimed at investigating the character's appeal as a communicator, the clarity of content of some of the materials, and the effect of a 60 second film using the character on children's performance of the kerb drill.

It was found that the child subjects in general perceived Hector as having positive attributes. The children became more interested and involved in the Hector stories than they were with the educational content of the material. Further, the Hector road safety film was found to be unsuccessful in changing safe road crossing behaviour among the subjects as measured by behaviour on a simulated road.

It may be the case that parents' behaviour is not always as bad as that suggested by Howarth and Gunn (1982), and that parent training can have a good effect on children's behaviour.

Limbourg and Gerber (1981) argue that in order to modify the behaviour of children in traffic, it is necessary to use behavioural rather than cognitive training methods, that children learn through observing models such as the behaviour of their parents, and that it is important that parents both themselves use and explain to their children correct road behaviour. In a complex training experiment, these authors used films and educational materials in a package (the Tübingen road safety program), and found a highly significant effect on the observed behaviour of both the parents and the children. The program was subsequently extended throughout West Germany.

Van der Molen et al (1983) reported the results of a study of video observations of the road crossing behaviour of 63 pre-school children and their parents, before and after the application of a pedestrian training program for children in which the parents were actively involved. The parents' behaviour was better than the children's both before and after the program, but after the program the parents gave a better example to their children and more verbal instruction, something that rarely happened before. The children displayed the trained behaviours more frequently after the program. The conclusion was that it is not only desirable that parents set a better example for the children they accompany, but that it is also possible to achieve this end by specific training programs.

An educational program aimed at six to seven year old child pedestrians was based on demographic accident data and implemented in four cities in Alabama (Fortenberry and Brown, 1982). The learning activities included demonstrating crossing behaviour on real streets and associated classroom discussions. A highly significant reduction from 122 expected to 82 observed accidents was recorded for the four cities. This was a carefully conducted evaluation that controlled for a number of potentially confounding variables such as changes in enforcement activity and traffic flow.

Aiming at children before they would normally be exposed to the real road situation on their own, Renaud and Suissa (1989) in Canada used simulation games as an educational tool for the teaching of five-year-old children. The objective of the well designed evaluation study was to determine the effect of certain elements within the simulation - role playing and behaviour training - on the attitudes and behaviours of this group of children. They found that groups thus trained did better than control groups in attitude, behaviour, and transfer of learning. The authors concluded that simulation games could be

an effective educational strategy in modifying attitudes and behaviour, at least for young children.

A more general community road safety program in Australia was reported by Bowler and Torpey (1988). This was a program that was coordinated by a local committee of community representatives. Five campaigns were conducted under the theme of "Child and Youth Road Safety". Considerable community and local media support was generated in the first 18 months of operation.

In operational terms the program was seen to be an efficient way of generating road safety campaigns for minimal expenditure. However, the ability of the program to generate behavioural changes to meet specific objectives was not so clear. The most significant result was a 6% increase in overall restraint wearing rates for the 0 - 8 years age group that was a particular target of the campaign. The authors commented that past experience with ongoing publicity in road safety issues had shown that publicity and educational approaches had a gradual and cumulative effect. Insufficient time had been allowed in this case for adequate evaluation. Any new initiative endeavouring to elicit community support, in the opinion of these authors, needs at least a year to establish the organisation and the program, and would need an operational period of about three years before any conclusive evaluation would be possible.

In 1985 the Federal Office of Road Safety developed an education package to support a campaign aimed at children aged five to eleven years, "Out and About".

The aims of the campaign were defined as follows:

- make children more aware of dangerous situations which they will face as road users ;
- encourage them to adopt safe behaviours to help them cope with these situations;
- provide parents, teachers and children themselves, with basic and simply expressed information, to assist in achieving the first two aims.

Teacher packs were distributed to primary schools early in 1986. Formative evaluation (Castor and Rush, 1988) found that the material helped children to sustain previous awareness of unsafe behaviour and focus on a small number of specific situations, such as crossing at pedestrian crossings and wearing seat belts. Safe behaviours were encouraged. Teachers were positive about the material.

As a follow-up, the Federal Office of Road Safety produced a pre-primary schools version of the same resource material, again with very positive responses from the teachers and children using it (Rush and Castor, 1988).

In the long term, it will be important to clarify exactly what it is we are trying to do when we go about "educating" children for road use.

Rothengatter (1981) reviewed several approaches to the formulation of objectives through analysis of existing curricula and programs, and through the investigation of the opinions of experts, parents and teachers. He argued that both approaches circumvent the problem of validity; there is no guarantee that the objectives of existing curricula, or those considered important by parents or experts, are in fact objectives that enhance the safe behaviour of children. The reason is that the objectives are not formulated on the basis of empirical research on traffic accidents, behaviour, exposure and psychological capabilities.

Important in the context of evaluation, and directly related to the twin aspects of "performance" and "behaviour" that are so important to driver training, is the distinction between the outcomes of tests and of unobtrusive observations after the training is completed. While the obvious test will give an insight into the ability of the child to perform correctly, the unobtrusive observation is much more likely to provide a true representation of actual behaviour.

Extending this sceptical approach, Van der Molen (1984) agreed that a., commonsense" approach to the management of child pedestrian safety is insufficient. Educational objectives should be carried through systematically and in detail. This can be done through various forms of task analysis, making use of the findings of empirical research. He presents a conceptual framework for examination of the problem which is a useful guide and checklist for any authorities and groups intending educational countermeasures for this group.

An example of how such principles may be put into practice is found in the development by the US National Safety Council (Race, 1988) of resource materials to be used in a national program on pedestrian safety. Accident research data were used to build a structure for evaluation and review, existing materials were collected and reviewed, and new material designed. Race comments on what she perceives to be a dramatic decline in research in this area over recent years, and urges that more effort should be made to redress this deficit.

PUBLIC EDUCATION AND THE PREVENTION OF DRINKING AND DRIVING

What successes there have been in the use of public education to reduce the incidence of drink-driving and alcohol-related crashes lie primarily in the unique way which, in Australia particularly, they have been combined with often quite draconian legislation.

Education employed in this manner helps to build support for the laws, it helps to explain what the laws mean, and it helps to maintain a high visibility for the laws after their introduction and raise the perception of drivers that may be apprehended for violation of them.

It is difficult, nevertheless, to single out aspects of education for hard evaluation of the effects of each component on crash reduction. This can be frustrating for researchers, who would prefer to operate in a less cluttered research environment.

And it does genuinely make it hard for researchers, educators and administrators to discern from the mass of conflicting documentation a clear path towards better educational measures.

For all these kinds of reasons, tightly-controlled research on the effect of public education on drink-driving is sparse. The best studies have been concentrated on specific, well-defined campaigns with stated goals. ("Best", in this context, refers to scientific validity rather than to the extent of effect on the community as a whole; community campaigns, in the most desirable way of things, come after the "best" path has been defined by smaller efforts).

One of the first such media campaigns focussing on drink-driving in Australia to be exhaustively evaluated was the "Slob" publicity campaign conducted through all the mass media in New South Wales (Henderson and Freedman, 1976;

Freedman and Rothman, 1979). This campaign was designed to increase knowledge about alcohol and traffic crashes and to change attitudes towards drinking and driving in the target group, young people (especially young men) aged between 17 and 30 years. The campaign resulted in significant improvements in knowledge, but the changes in attitude (although statistically significant) were small. The authors rather pessimistically concluded that a disproportionately large allocation of resources would be required to bring about useful results from this type of campaign, and that education programs more tightly aimed at (say) secondary school children might be a more cost effective way of changing attitudes in the long term. Advertising would then serve to reinforce desirable attitudes that it was hoped would flow from the school based program.¹

Elliott and South (1983), as part of a major effort in 1980-81 to improve approaches to drink-driving publicity, reported a well-controlled evaluation of a pilot stage of the campaign, using before and after reported drinking behaviour in an experimental and a control city. They found some positive results, but effects of not a great magnitude. The award-winning campaign itself was highly regarded and commended by the community. Such acclaim, as the authors point out, is not necessarily related to effectiveness in changing target behaviour.

The pilot was then extended to a national campaign in 1982 and 1983. Improvements in drink-related behaviour were detected (Boughton and South, 1983), especially in Sydney, but the campaign coincided with the introduction of random breath testing in that State. This made attribution of any positive results to the campaign extremely difficult, if not impossible.

The publicity associated with the new random-testing laws in New South Wales would, indeed, have swamped any other similar countermeasure. More than one million dollars were spent on mass media advertising over Christmas 1982, and millions more over the following months. There was a vast amount of media interest, leading to heavy associated publicity through editorials, articles, news reports and cartoons.

In the early part of the campaign the message was centred on the high risk of apprehension and arrest. Knowledge about the drink-driving laws and the legal limit was found to have increased (Job, 1983), with strong recall about the original advertisements. Cashmore (1985) suggests that public interest peaked in December 1982, but that it declined during 1984, following (perhaps, she suggests, as a result of) some negative publicity about the effects of the law and the extent to which it was policed (which never slackened, in objective terms).

The road toll showed some tendency to reverse the spectacularly good trend which started at the time random testing was introduced in 1982-83, raising questions about the possible influence of economic factors (there was a deep recession at the time) which are discussed by Cashmore.

In their evaluation and review of the effects of random breath testing in New South Wales on traffic accidents, Homel et al (1988) point to the unprecedented extent to which enforcement and publicity worked together at the start, and were maintained over several years. This was in marked contrast to the conditions prevailing in most other jurisdictions

¹ An interesting overseas perception of the "Slob" campaign is found in Hochheimer (1981), where it is stated that "Mr Slob" became an endearing character with whom the public identified. This was in fact never researched or documented. Could there have been confusion with "Norm", or "Life: Be In It"?

which have introduced new drink-driving laws. The evidence reviewed by these authors suggested that the law resulted in a 36% decline in alcohol-related fatalities, that the perceived chance of detection was raised, and that new moral sanctions against drinking and driving may have been stimulated in the State.

In Victoria, where random testing was first introduced, the initial legislation was also accompanied by publicity, but in a less aggressive (and expensive) manner. By 1987 Hutchinson (1987) reported that the perceived risk of detection for drink-driving was falling, and new procedures for enforcement were introduced. The Road Traffic Authority, with financial assistance from the Transport Accident Commission, prepared a publicity campaign aimed at increasing awareness and the perceived likelihood of detection. It was based on television advertisements. The questionnaire-based evaluation of this campaign (Harrison, 1988) showed that it reached the target group of 18-30 year old males, and that the campaign raised the perceived risk of apprehension. There was some evidence of a reduction in self-reported drink-driving behaviour, but (if that happened) the relative influence of enforcement and publicity could not be identified.

The Transport Accident Commission then embarked on a road safety campaign with perhaps the largest per capita budget ever seen in Australia (and perhaps the world).

The campaign ran from late 1989 to late 1990. It was intended to support a package of road safety initiatives, with two key elements being a large increase in resources available for random breath testing and a major emphasis on speed enforcement through the use of automatic speed cameras. The aims of the campaign therefore extended beyond drinking and driving to the "road toll" generally, but a specific objective was to position two key issues - drink-driving and excessive speed - as predominant in the minds of drivers. "If you drink, then drive, you're a bloody idiot" was the theme for the first of these issues, and "Don't fool yourself, speed kills" was the theme for the second.

The television commercials and other promotional efforts employed to support these themes were highly intense and emotional in their approach, with realistic portrayals of bereaved, anguished families and guilt-tormented drivers. They were classified as being unsuitable for showing to children. In this fearful appeal to the emotions, the content of the advertising ran counter to concepts accepted by most behavioural scientists. The results of any such campaign would therefore be of great importance to future efforts in road safety public education.

As advertising, the campaign was exceedingly effective, and was the winner of awards in this respect. There was an unprecedented 92% unaided recall of the campaign, and a very high proportion of respondents correctly nominated the subject of the commercials they remembered.

A detailed study of the effects of particular parts of the campaign on specific road user groups has not yet been published, but some general indications can be gleaned from an analysis of the fatality figures for Victoria for 1990 (Drummond et al, 1991). During that year, there was a dramatic reduction in the overall figures for road deaths in Victoria, with a sharp deviation downwards from a trend in total deaths which had been gradually upward from 1984 to 1989. The total figure for 1990, 548, was 29 per cent below the figure for 1989, 28 per cent below the figure projected by a trend line, and 22 per cent below the five-year average number.

In the rest of Australia the equivalent figures also showed a reduction, but less striking: 12 per cent below 1989, 13 per cent below the expected value, and 17 per cent below the five-year average. As Drummond et al point out, the nationwide fall in deaths was probably related to the concurrent drop in economic activity, whereas the additional drop in Victoria could be related to uniquely Victorian factors.

The reduction in deaths (and severe injuries) was shared among drivers, passengers and pedestrians, with middle-aged and older drivers showing the greatest drops, and the improvement being more apparent in the Melbourne metropolitan district than other areas. Serious casualties started decreasing well before the number of deaths.

More directly related to alcohol countermeasures are casualties in "high alcohol times" (broadly, nights and weekends). Deaths during high alcohol times were reduced throughout 1990, to a greater extent than during other times of the day.

In 1990, the proportion of drivers and riders killed with blood alcohol concentrations of over 0.05 per cent was 30 per cent, down from 32 per cent in 1989 and 38 per cent in 1988 and 1987. Drummond et al found it reasonable to conclude that the random breath-testing initiative - including the associated publicity campaign - made a significant contribution to the good result for 1990.

Drink-driving education is now a subject of importance in many schools. One program that has been evaluated has operated in New South Wales since 1981, in Armidale (Batchler and Grundy, 1986). It is based on six classroom lessons over a ten-week period, and includes slides, videos and associated materials.

Questionnaires and interviews showed that the course was popular with teachers and students, but it had many practical difficulties and a more integrated approach is now being used throughout the State, putting drink-driving issues to students during their normal exposure to other subjects.

A particularly interesting education-based program aimed at the prevention of drinking and driving, and directed towards 15 year old high school students, has recently been reported from Queensland (National Campaign Against Drug Abuse, 1990). In 1984, when the project began, there were few drink driving education programs aimed at high school students that had been systematically evaluated for their impact on later driving. At that time it was not possible to ascertain whether such programs had changed behaviour or whether any changes were in the desired direction.

The drink driving project's research, therefore, involved a social experiment that aimed to provide information on these issues for future workers in the field. It was suggested that the effectiveness of the school based programs would be enhanced if they were taught in association with public education programs and with highly visible law-enforcement initiatives.

The design of the project included a longitudinal outcome study to measure whether it achieved the goal of reducing crashes, deaths and injuries among the students who had undergone it. Throughout development, however, it was regarded as important to determine whether the program was meeting the design " objectives. Briefly, these were to reduce the likelihood that students would drink and drive or be the passenger of a drinking driver, and to increase the likelihood that they would use alternative strategies and plans to avoid drink driving and being the passenger of a drinking driver.

In order to determine whether these objectives were met, a short term evaluation using self reported behaviour measures was undertaken. The early evaluations found that a significant change was achieved in intentions to drink and drive after licensing and to be a passenger of a drinking driver. Significant effects were also obtained for attitudes and knowledge. Rejection of myths about safety and drink driving, and an increased likelihood of using alternatives, were both found.

Reported undesirable behaviour did not change, but the numbers of drink driving or riding students were small.

Considering the students as a whole, the magnitude of change achieved by the intervention was considered by the authors to be modest. However, the results for all groups were consistently in the desired direction.

Two rather similar overseas studies (Albert and Simpson, 1985; Duryea and Okwumabua, 1988) had both found that there was an unexpected increase in drinking reported by students after the intervention. The Queensland program, however, was found to have no such effect.

This program is now being extended progressively to all year 10 students in about one-third of Queensland state high schools each year, beginning in 1988. The evaluation will continue. The program is a good demonstration of a research based approach to the design of drug education directly relevant to road safety.

The examples given above are of generally tightly-knit campaigns, planned with evaluation in mind. It is very hard to conduct valid evaluations on immense, disparate campaigns with no inbuilt plans for evaluation and with non-specific, general (albeit desirable) goals such as community awareness, concern and benefit. In one of the few attempts at valid evaluation of such a campaign, Ross (1987) assessed the effects of intense media coverage of drink-driving issues which occurred in Britain over the Christmas of 1983. Although the media attention was only partly planned - much of it involved reporting of news events related to drinking and driving - the combined focus of several major stories about the certainty of apprehension and punishment for drink-related offences was dramatic. Crash fatalities fell by 23% during December, while the media campaign was at its most intense. Unfortunately, however, crash fatalities returned to their previous levels within a matter of weeks.

PUBLIC EDUCATION AND THE REDUCTION OF SPEEDING

There are other road-use behaviours, apart from drink-driving, which are known to be associated with a raised risk of crashing and a high risk of crash injury. Among these is inappropriate speed, and speeding is a common target for mass education campaigns. They are rarely evaluated in any adequate way.

Some are, however, and an example of such evaluation was that reported by Manders (1983). In December 1981 legislation was passed in the Victorian Parliament enabling police to use radar equipment to measure vehicle speed, and to detect speeding offences in certain circumstances. It was decided that to highlight the introduction of radar a publicity campaign would be run to increase drivers' awareness of radar and the increased chance of detection for speeding.

Accordingly, a publicity campaign was run in the second half of 1982. The central theme was the increased detection of speeding offences through the police use of radar equipment.

Since this equipment was mostly used on open highways, the publicity focussed on the 100 km/h speed limit applying on these roads. Television, radio and outdoor (billboard) advertising were all used. Television and radio commercials highlighted the increased detection of speeding offences and the associated penalties. The campaign was run in all parts of the State and reached 90% of the population aged 18 years and more. Each person in this target group was estimated to have seen the commercial an average of 15 times.

The primary outcome measure was vehicle speeds measured at selected sites before, during and after the campaign. Observations focussed on rural areas with a speed limit of 100 km/h but were also carried out in the Melbourne metropolitan area. A questionnaire survey was also undertaken before and during the campaign. The speed data were analysed to show changes in speed, changes in 85th percentile speed, and changes in the proportion of drivers exceeding the posted limit.

Although some of the changes approached significance the general conclusion was that there was no significant effect on speed, either during the campaign or after it. Two studies attempted to detect a change in the perceived risk of apprehension for speeding but no significant change was detected.

Overall, it was concluded that the campaign did not have any short term effect on drivers' speeding, although there were some encouraging observations in two sites.

The author comments that this was the first speed-related publicity campaign to be run in Victoria. Other similar campaigns such as those concentrating on the use of restraints and on random breath testing for alcohol have tended to have a cumulative effect, with early campaigns not showing the significant effects that later campaigns were able to demonstrate.

In New South Wales a major program for tackling the speeding problem was begun in 1986. The strategy included a substantial publicity component, seeking to raise community awareness of speeding as a safety problem and of the need to lower speed limits to appropriate levels, remind road users of the increased penalties for speeding offences, and to build a platform for a strong deterrent effect.

First evaluations of the campaign indicated that although it increased awareness of speed as a factor in accidents, a majority of motorists in 1988 - the same proportion as in 1985 - reported that they exceeded the speed limit (Croft, 1990).

The intensity of the advertising was therefore increased towards the end of 1990, and a new evaluation program is being developed.

The massive 1990 campaign in Victoria, aimed at both drink-driving and speeding (to which reference has been already made in the former context) was reviewed for its effect on speeding by Drummond et al (1991), but it was concluded that more detailed investigation would be necessary in order to evaluate the effects of the speed camera initiative. Total numbers of deaths and injuries are, of course, very blunt instruments for evaluation, and large effects are necessary for them to be detectable in mass data such as these.

4 IMPROVING ROAD USER PERFORMANCE

THE EFFECTIVENESS OF NOVICE DRIVER TRAINING

Serious attempts at evaluating the effectiveness of driver education started in the 1960s, mainly as a result of concern about the large sums of money being expended on high school driver education in the United States of America. Whole bibliographies have now been published consisting of nothing else but citations to thousands of articles, reports, studies, monographs and papers dealing with driver education.

The results of those first evaluations were very encouraging.

For example, nearly 30 years ago Macfarland (1964) showed that the accident rates of drivers trained at school were about half as high as those of untrained drivers, at least during the first years of driving.

However, there were many deficiencies in those early studies, deficiencies that continue to plague evaluations of driver education and training even now. When studies are large in scale, it is difficult to control all the factors that may influence the results. On the other hand, in small studies it is difficult to obtain statistically significant data. Many investigations were subject to a considerable degree of bias from the authors, especially it must be said among those studies that illustrated significant improvements in driver performance as a result of education.

Another important deficiency was that which flows from self selection of the participants in the studies. Students volunteering to take driver training or who volunteer for research studies about driver education are different from those who do not. Those who choose to participate may be more mature and conscious of safety than those who choose not to participate. Distortions in the resulting data give rise to distortions in the conclusions.

More recently, concern has surfaced about measures of outcome, particularly as to whether statistics on accidents and violations of the law are accurate and adequate means of measuring driver proficiency. Accidents are rare events, and particularly at the lower end of the severity scale are reported unreliably and inconsistently. The same can be stated with even greater strength in the case of reported violations.

As analysts came to recognise these deficiencies and allow for them, evaluations of driver training began to emerge with results which were much more pessimistic than previously.

Where driver education and training stood at the beginning of the last decade was reviewed by Saffron (1981) from an Australian perspective. With respect to earlier studies of high school driver education (performed mostly in the United States), Saffron commented on their various deficiencies and on the possibility that education in high school might increase the public health problem of road crashes by encouraging young people to get their licences earlier and to drive at younger ages. In 1981 this author concluded that the evidence of the time was that no system of driver education and training was soundly based, or if there was, it had not been used. This deficiency referred both to the contents of the courses and also to their effect in changing driving behaviour. He commented that because experienced drivers tended to be less likely than inexperienced drivers to crash, research was required to discover the basis of this difference. He stressed that there is evidence that motivation is more important than skill to safe driving, yet driving instruction programs had concentrated on skill.

Notwithstanding some rather negative research findings, driver education programs have steadily become a standard fixture in high school class rooms across the United States. They are the primary source of novice driver training in that country today. However, these programs have come under increasing attack in recent years with critics charging that they are both deficient and ineffective. Critics point to the lack of any solid research evidence that high school driver education actually improves a young person's driving skills beyond the level that would have been obtained if that person had been engaged in an alternative system of instruction.

Proponents of public high school driver education, on the other hand, maintain that public instruction is crucial since it reaches young people at a time they attain legal licensing age and are thus highly motivated to learn. Proponents argue that it is only common sense that driver education is helpful in reducing the rate of accidents and injuries, because such courses teach proper driving manoeuvres and the rules of the road. Because of the consequences that could flow from poor training, they consider that it is imperative that society retain control over the driver education process so as to ensure that quality instruction is provided.

The whole subject of high school driver education was reviewed by the National Highway Traffic Safety Administration (1975) following its Driver Education Evaluation Program (DEEP) study. In this report, the NHTSA commented that the basic idea of training people to operate motor vehicles stems from the assumption that trained or experienced drivers will perform better in traffic than the untrained or inexperienced. Driver and safety education is based on this assumption, and implemented because of face validity for accident prevention. It was only very late that attempts had been made to determine scientifically which attitudes and skills were determining factors in crashes, and whether such variables can be manipulated by training. The essential outcome, crash prevention, was coming under critical review.

Following this detailed review, the NHTSA embarked on a 12-year ongoing research program, embracing task analysis, instructional objectives, curriculum specifications, skills acquisition, and safe performance measures. This program culminated in what was intended to be the definitive evaluation of driver training in the United States. This study was completed in 1983, at a cost of well over four million US dollars. It was conducted in DeKalb County in Decatur, Georgia (Stock et al, 1983).

The primary objective of the DeKalb County study was to determine the crash reduction potential of a high quality driver training program based on competency and known as the Safe Performance Curriculum (SPC). The experimental design called for the random assignment of 18,000 volunteer high school students in DeKalb County schools, Georgia to one of the following:

- the Safe Performance Curriculum (SPC), a 70-hour course including classroom, simulation, range and on-street training;
- the pre-driver licensing course, a modified curriculum incorporating only the minimum training required to obtain a driving licence;
- the control group, for whom no formal driver education was given in the secondary school.

This study was unique in its random assignment of students to different groups, and its use of a control group (no formal training). This is often an ethical problem in research, when

if a measure is assumed to be effective then it is unethical to restrict - on a random basis - groups of individuals from its presumed benefits. It was emerging doubts in the United States about the effectiveness of formal in-school driver education that made this research design possible.

The sample of students was monitored for a period of two to four years after group assignment to assess measures of intermediate and ultimate performance. The primary measures of ultimate performance were the numbers and types of crashes and violations these students experienced over this period of time.

The results of this study showed that students who had completed the Safe Performance Curriculum (SPC) or the pre-driver licensing courses had 13% fewer accidents and 16% fewer violations during the first six months of driving than did those students who had been placed in the control group. However, the study also showed that during the next year the statistically significant differences between the groups were marginal, and that these differences disappeared completely after a year and a half.

These findings led to the conclusion that neither the SPC nor the basic pre-licensing training program was preferable to no formal driver education program at all. In addition, this study showed no significant statistical difference in the subsequent performance of those students who had received the lengthy SPC driver education instruction and those who had received the greatly streamlined pre-licence training that contained only the minimum instruction required to obtain a licence.

The short-term beneficial effects of the training were additionally offset or neutralised by the fact that the trained drivers were licensed earlier, and consequently suffered an increased exposure to accident risk.

The authors of the study concluded overall, therefore, that the improved driver education program, the Safe Performance Curriculum, was not an effective accident reduction countermeasure. The net outcome was there were no statistically significant differences in accident rates among the three groups, and no statistically significant differences in violation rates among the three groups. It was concluded that driver education should be restructured somehow to exploit and emphasise the short-term benefits achieved, but further suggestions could only be speculative. The fact that the basic and the "best" training led to much the same outcomes was not of great assistance in defining future advances.

Although this was the best controlled study of a major driver training program yet to have been undertaken, and one that it would be difficult to duplicate (and impossible in Australia), there are still deficiencies in it. For example, although the students who participated in the project were randomly assigned, the initial group consisted of individuals who had volunteered to be part of the experiment. Second, a number of people dropped out of the program or did not go on to obtain a driver licence. And third, performance was only monitored for quite a short time after the training programs.

Australian critics of US school-based driver education programs and evaluations of them often claim that the education and training are themselves flawed, and that their demonstrated effectiveness - or lack of it - is therefore not relevant in Australia, or to "better" programs of instruction. The designers of the DeKalb study tried to counter such potential criticism by ensuring that the SPC was as "state of the art" as possible. Instructional sites, simulators, classrooms and off-road driving ranges were all especially built or modified from existing facilities. A national search was undertaken to ensure

selection of the best instructors with demonstrated management and educational skills, plus relevant experience. They were all given additional training. The curriculum was developed by university groups in conjunction with the NHTSA. It would accordingly be difficult to criticise the SPC course on any grounds of "quality". Most parents would be pleased to offer their children the same opportunity.

One effect of the approach to driver training in the United States is that it is difficult to compare the performance of students trained in different ways with the performance of students who have not been trained at all, or trained informally. This is a deficiency of an otherwise well controlled study undertaken on behalf of the Virginia State Department of Education (Ohlson and Stoke, 1986). This investigation was able to distinguish between the types of schools attended (public, private or commercial) as well as the types of programs taught. In addition, it was possible to categorise crash and conviction data according to various levels of experience up to three years.

The findings of this Virginia study were that students graduating from commercial driving schools in Virginia had significantly more crashes and convictions than their counterparts from public and private schools. Further, it was found that students taught only in classrooms and behind the wheel were likely to have driving records similar to or better than those receiving training in simulators and driver training ranges. This study also found that the annual number of convictions for every hundred students actually increased during each of the first three years of driving despite the associated increase in driving experience.

During the 1980s evaluation of education and training programs has continued, and extended to countries other than the United States. Studies have generally been of a higher standard of research design than hitherto, and more sharply focussed. The results of the evaluations, however, have not been in general different from the earlier ones. Potvin et al (1988) studied the impact of introducing mandatory driver training for all new drivers in Quebec, Canada.

This followed the introduction in 1983 of a change to the Road Safety Act, ensuring that every driver in Quebec was given a standard preparation in driver training. Evaluation was seen as important because the law placed an extra cost on obtaining an initial driver's licence and because the effect of driver training programs could be assessed without having to deal with volunteer subjects, as had been the case in previous studies. Before 1983, approximately 30-40% of newly licensed drivers aged 18 and over did not take the driver training course.

These authors used four indicators - the risk of accident (with injuries and without injuries) during the first year of driving experience; the mortality/morbidity rate per accident involving at least one driver in his or her first year of driving experience; the number of newly licensed drivers; and the mean age of receiving a driving licence. The analysis was restricted to drivers in their first year of experience, because the impact of driver education would disappear in subsequent years. This approach is open to criticism, however, on the basis that analyses were made only on the study participants who had obtained a driver's licence rather than on all randomised subjects.

The method used was an interrupted time series study. The results of these analyses showed that the 1983 legislation had no appreciable effect on the risk of crashing or on the rate of injury per accident for newly licensed drivers aged 18 and over. However, the authors commented that since 1983 the number of women under 18 years of age getting their first driver's licence had increased by 20% and their mean age had decreased from

over 18 to under 18. The authors suggested that the mandatory driver training may have increased the numbers and consequently the risks of accidents for young, primarily female, drivers. The increase in the number of newly licensed drivers at younger ages may have been due to the fact that after January 1983 there was no further economic advantage in waiting for 18 years of age before obtaining a first driver's licence.

These results were in general agreement with most of the studies previously undertaken to evaluate driver training programs. With evaluations showing little or no benefit, there were - and are - real concerns about programs that expose young people to the risks of road use before the case might have been without training, a point made well in the Stock (1983) study in DeKalb County and emphasised by Lund et al (1986) in their re-analysis of the DeKalb data. Within the United States context, Robertson (1984) had already claimed that among all possible measures to improve road safety, driver training programs were among the least efficient in terms of accident reduction. The Quebec study showed that this statement was valid for at least one administration outside the United States, and for a known population of volunteers.

In France, Simmonet et al (1982) compared two methods of driving instruction in terms of the problems encountered by learners after passing their driving test. The subjects had either been taught by the traditional, intermittent series of lessons which were normally used in France (and most other countries, including Australia) or by a new system developed by the French road safety organisation ONSER. This incorporated an intensive series of lessons, and had already been implemented by the French armed forces. There were no substantial differences in outcome. Overtaking, parking and joining main roads were the difficulties shared by both groups during the early stages of their driving. These authors found a great increase in confidence after about eight months of driving.

The House of Representatives Standing Committee on Road Safety (House of Representatives, 1982) concluded after reviewing such evidence that it could not support the extension of school programs which emphasise the training of manipulative skills. It conceded, however, that despite the evidence of all such studies, driver training programs for young people remain very popular.

A public opinion survey conducted a year after the Quebec enactment of mandatory driver training estimated that about 80% of the Quebec population thought that professional teaching was the best way to learn how to drive, that it helps to prevent accidents, and that private driving schools produced better drivers. The students interviewed by Simmonet were just as enthusiastic about the need for better training.

In Australia, where driver training has been until recently an essentially unsupervised voluntary activity, there is similar enthusiasm for its potential benefits. The New South Wales Parliamentary Staysafe committee (Staysafe, 1990) refers to a long list of driver training courses and resource materials commended to the committee. In an enquiry into novice drivers, Staysafe received submissions from many fervent advocates of full driver training within high schools. Some community groups and high school teachers, it was noted, had taken the matter into their own hands by using cars loaned by local dealers to run classroom and behind the wheel training. However, as Staysafe noted, none of the driver training schemes in New South Wales - or indeed Australia had been subjected to evaluation even approaching the rigour of the DeKalb County study in the United States.

It is important, in the long run, that this enthusiasm is so directed that education and training are directed into channels which will have the most beneficial effects on road

safety. The House of Representatives (1982) suggested that objectives should encompass understanding of the use of the motor vehicle in society as well as the development of skills of awareness and understanding, a theme with a common thread in the reviews of most analysts; Macdonald (1985) also came to the conclusion, with many others, that driver training programs most likely to be effective are those which emphasise perception and understanding.

Several studies on driver education have focussed on one particular facet of the subject. For example, numerous papers have been written examining a single aspect, such as training on simulators, at driver training ranges or in commercial schools.

Studies of simulator training were recently reviewed by Henderson (1991), with the overall conclusion being that "simple" driver training in a simulator has so far been shown to make little difference one way or the other to most measures of outcome. However, simulators are developing rapidly in sophistication, even those used for training. In addition, simulators can be highly valuable for many aspects of human factors research, and may find a vital role in the development of improved training methods. Most such studies cannot be undertaken in the real road environment.

Similarly, early studies of driver training using off-road ranges indicated that there were no significant differences between the performance levels of students trained on the ranges and students who had received other types of driving instruction (Council et al, 1975). Dreyer and Janke (1979), in a rather confused study, found that drivers trained on off-road ranges had lower self-reported accidents, but the same number of police-reported accidents. Intermediate criteria (skill and knowledge) showed better results among those not trained on an off-road range.

An Australian study (Strang et al, 1982) also investigated the effects of different training courses on young, male learner drivers, with the primary objective being to determine whether there are any specific advantages in using an off-road training area. In this well-designed and conducted study, almost 800 subjects were randomly allocated to four experimental groups, three of which underwent various forms of training at an off-road training centre and the fourth was a control. It was found that off-road training did not appear to facilitate the acquisition of driving skill, and there was no later difference in accident or violation rates between the four groups. There were greater improvements in attitude and knowledge in the groups trained at the centre, but these differences did not seem to be closely related to accident or violation records.

Research conducted to determine whether commercial driving school programs were superior to public high school programs also gave rise to contradictory results, with the best studies (for example, Jones, 1973) indicating that there was no difference in accident rates observed between publicly and commercially trained students.

But in general, the discussion on driver behaviour in the previous section leads to a possible conclusion that what is often taught is ineffective, or even harmful. What, then, is wrong with driver training? Brown et al (1987) and Michon (1988), in recent reviews, confirm that the evidence on the present state of affairs in driver training (and testing) is still negative, or at best inconclusive. If there is any positive effect at all, it is not large, it is not lasting, and there is no demonstrable effect on the primary criterion, that is, on accident statistics.

Michon (1988) believes that the key findings of the available research are as follows:

- Training received from relatives or friends has a more beneficial effect on accident involvement than a professional training course. This indicates that relatives and friends are better informed about a student's mental representation of the driving task, and about the student's personality generally-
- What is learned during training under supervision of a professional does not help the experienced driver. This indicates that the knowledge thus imparted, based on procedures regarded as "expert", does not lead to safer procedures.
- Training under professional supervision hardly ever passes beyond the stage of feedback. There is little or no evidence that novice drivers learn how to monitor and correct their own behaviour. This indicates that student drivers are apparently not learning to think, and are not employing skills that make use of anticipation.

Milech et al (1990) take a conceptually very similar view. Accepting that current programs can be effective in teaching aspects of expert knowledge, they do not teach novices to use knowledge like an expert. They do not teach novices to perceive the environment holistically, interpret what they see effectively, respond automatically, integrate their responses or assign priorities.

Much more work is required to determine more precisely just what safe driving entails, but the literature strongly suggests that car control and manipulative skills are far from being the most important features of the driving task in terms of safety.

From his review of the literature Drummond (1989) also found, as is discussed throughout this present review, that there are two major areas for countermeasure development: improvements in skilled performance on the one hand, and motivational improvements - notably in the area of novice drivers' risk taking on the other.

However, while the thrust of the argument in the present review is that risk-taking and motivational factors need emphasised attention now, the evidence being that skills training has failed virtually every test of effectiveness, Drummond takes a more pragmatic position. This is that preference should be given to improvement in skilled performance because it is potentially more productive in the short to medium term. He concedes that single skills cannot be taken in isolation, but analysed in association with driving experience and other factors which make up the complex overall task of driving. Such an analysis, he suggests, would facilitate approaches intended to hasten the acquisition of skills by young drivers. Whether this is truly a short to medium term strategy remains to be seen. But it is certainly true to say that just because an approach has not worked in the past does not mean that it would not work in the future if was to be undertaken differently.

POST LICENCE DRIVER TRAINING

The preceding discussion has centred on the training of novice drivers, training which is intended to bring them at least up to the standard of the official driving test while attempting to impart desirable attitudes to safe driving performance. Throughout Australia, follow-up training schemes have been introduced from time to time, aimed at drivers who already have their licences.

Most of these have been based on the "Defensive Driving Course" (DOC) that was originally developed in 1965 by the United States National Safety Council. The courses

were first introduced in Australia in 1969, and since that time the Queensland Road Safety Council in particular has placed considerable emphasis on the program.

The Defensive Driving Course is an eight-hour curriculum spread over four sessions. It emphasises specific actions drivers can take to reduce the chance of a crash occurring. The course also contains information about the number and seriousness of motor vehicle crashes. Although DDC was developed for professional drivers it is widely recommended for use by the general population of drivers and for programs intended for the rehabilitation of problem drivers. The popularity of such training is largely based on the assumption that driver error is responsible for crashes and that drivers commit fewer errors when they know what behaviour leads to fewer crashes and violations. As pointed out earlier in this review, however, the real effects of driver training are in fact rather unclear.

In 1979 the (Commonwealth) Office of Road Safety commissioned a study of the Queensland Defensive Driving Course (Payne et al, 1984). In planning this study these authors reviewed early research on defensive driving courses in the United States, concluding that the evaluations were at that time inconclusive. The evaluation of the Queensland DDC course involved the comparison of the accident rates between the experimental (taking the DDC) and population control groups. The variable of interest was the difference between the groups in the percentage who had accidents in the 12 month period following the experimental group's exposure to DDC.

It was found that for the age group 17-19 years the results showed a significantly higher accident rate in the after-DDC period for those attending the course, compared with the population group. This result held for both males and females, and persisted when the results were analysed in terms of driving exposure. For accidents defined as "severe" the results for this age group did not show a statistically significant difference in accident rates, but the direction of the differences was again not in favour of those attending the course.

These authors concluded that there was no support for the proposition that DDC was effective in reducing accident rates within this age group. They commented, however, that because the course was designed by the National Safety Council as a driver improvement program, it was not surprising that the course was found to be ineffective for these young people.

For females aged in their twenties and thirties, and for both sexes over 40 years of age, there was no evidence one way or the other on the effectiveness of the DDC. For males in the 20-39 year age group the results showed consistently lower accident rates after the DDC course for those who attended it, compared with the population groups. Analysing the data by driving exposure showed that the DDC appeared to be more effective in reducing accidents for those attendees who drove as part of their work. For this group, but for none of the others, the course was found to be cost-beneficial. However, given the small numbers in the group, the authors concluded that this finding was of restricted value for recommending policy.

Another Australian study was that of Manders and Rennie (1984). This investigation examined the effectiveness of an advanced driving course given to employees of a Victorian transport company. All drivers had attended a (theoretical) defensive driving course shortly after joining the company, aimed at improving knowledge and attitudes rather than skill. The training course under evaluation was of one day, and all drivers were trained in cars regardless of the type of vehicle driven at the company. Car control

techniques covered normal driving as well as emergency situations such as skidding and skid control, emergency braking and the use of the handbrake in emergencies.

Over the period of study, covering 11 years of accident data, accident rates were reduced significantly. However, accident rates were most strongly related to a driver's previous accident history, and the number of years the driver was employed by the company; the company also undertook other accident reducing measures during the period, which was a confounding variable. Controlling for the effects of such variables resulted in loss of statistical significance for the accident reductions as a whole, although the reduction in accidents for which the driver was held (by the company) to be responsible was statistically significant.

If it had been possible to include larger numbers in the sample, the apparently beneficial effects might have achieved statistical significance overall. The authors of the study came to pessimistic conclusions, but even so, the course was part of a generally successful package from the point of view of the company.

The same company also provided training as part of a total safety package in Queensland. Cavallo (1987) reports that within twelve months of the introduction of the safety package at the company, the mileage-related fleet accident rate was reduced by 4%, the severity of accidents was greatly reduced, and vehicle days lost were halved in comparison with the period before training. Eleven and a half years after the package was instituted the mileage-related fleet accident rate was 82% lower than beforehand. Much credit was claimed for the driver training course as a cause of this reduction, but it was not compared with Queensland road accident rates generally over the period of training and it was concluded that the influence of training was not possible to identify.

The Defensive Driving Course had previously been evaluated in several studies in the United States. These studies were jointly reviewed in detail by researchers from the Insurance Institute for Highway Safety (Lund and Williams, 1985).

Lund and Williams pointed out that it was so widely assumed that driver training courses such as the Defensive Driving Course were effective in reducing motor vehicle crashes and violations that some States allowed drivers to remove points or citations from their records by participating in such courses. Some States even required drivers with multiple citations or crashes to attend them. In most of the cases they reviewed, those who had taken the course had been ordered to do so by traffic courts or their employers.

Lund and Williams evaluated the methods and findings of 14 studies of DDC. This particular course was emphasised because the National Safety Council provided uniform, detailed, lesson plans and teaching materials. The 14 studies all evaluated the effects of DDC on subsequent crash and violation experience. Any study that evaluated DDC solely in terms of knowledge or attitude change was excluded. They categorised their review in terms of the degree of confidence that could be held in the results of the data as "inadequate, weak and strong". Only five of the data tests were judged to warrant strong confidence.

The five experimental designs that provided strong tests of DDC effects were all true experiments with successful random assignment, or analyses that compensated for unsuccessful randomisation.

There was a clear pattern to be discerned in the results reviewed by Lund and Williams. Those studies that found the most positive effects from DDC were those that were methodologically weaker, whereas the studies with stronger analytical designs usually found no significant effects on crashes resulting from the Defensive Driving Course. However, there was evidence of a small reduction in violations of traffic law.

Among the studies with inadequate methods, reductions in crashes of over 50% were reported, with reductions in violation rates as great as 30%. However, in the five methodologically strong studies the effects of DDC were either weak or absent. All but one study observed fewer traffic violations among DDC drivers than among comparison drivers, but the observed crash rates for DDC drivers ranged from 11% lower to 37% higher than the crash rates for comparison drivers. None of the crash differences were statistically significant, but two of the studies reported significant reductions in violations.

It should be noted that many of the studies were of DDC courses aimed at "problem" drivers with a strong motivation to reduce their future violation rate in order to retain their driver's licence. Lund and Williams also reviewed studies of other (non-DDC) courses aimed at problem drivers, but again failed to find improvements reported by any studies of methodologically strong design.

Only well designed and executed studies can provide valid estimates of the effectiveness of driver training courses. The weight of the evidence reviewed by Lund and Williams does not support the contention that the Defensive Driving Course reduces crashes, although it does indicate that it reduces violations. The much greater positive effects cited for DDC in many anecdotal reports have probably been due to regression to the mean, self selection of candidates, or other aspects of larger crash-reduction measures of which DDC was only one part. All these factors require consideration when claims are made for the effectiveness of driver training courses of any kind.

It could be argued that studies of samples with insufficient numbers are unable to detect significant differences even when they are true and are favourable. Only one study with good experimental design incorporated a sufficient number of observations to have a reasonable expectation of detecting an effect of DDC as small as 10% (Salzberg and Klingberg, 1978). In this case the estimate of the effect of the Defensive Driving Course on crashes was zero.

The findings of the other studies do not rule out the possibility that the Defensive Driving Course has an effect that is too limited for the analyses to have detected. But it must necessarily be the case that if there has been a reduction in crashes, it has been a very small one.

Evaluations such as these are also open to criticism that crashes and violations may be inappropriate criteria for the success of the courses. Some of the studies did examine changes in knowledge, and most of them did indeed indicate that knowledge of driving skills increased after the course.

The extent to which knowledge and skill are related to safe driving behaviour is discussed in more detail elsewhere in this review.

HEAVY VEHICLE DRIVER TRAINING

Throughout the developed world the training of the drivers of heavy vehicles is seen as self-evidently valuable because of the potentially horrendous consequences of heavy vehicle crashes. Such consequences have of course been the subject of considerable media attention in Australia over recent years.

Opinions on the value of heavy vehicle driver training are held very firmly, and are exemplified by an introduction to the topic in a recent discussion paper published by Austroads (1991):

The step up from a normal car driver's licence to that of a professional heavy vehicle driver is too easy. It requires minimal or no training ... Clearly both practical and theory training ... are vital in achieving safety. Governments and the road transport industry consider that a competent well trained driver has a better chance of being a safer and more productive driver.

The recently introduced Federal Government Training Guarantee Legislation will mean that tens of millions of dollars will each year be committed by the heavy vehicle industry to training. The number of groups providing training will greatly increase. The National Road Transport Industry Training Committee has identified national core competency standards for all classifications of rigid and articulated trucks, and is seeking validation by comment from State road transport training committees, training organisations and major companies with in-house training courses. The TAFE National Centre for Research and Development has prepared a truck driver manual for the Federal Office of Road Safety. Clearly, this is a matter that is being taken very seriously indeed.

Unfortunately, despite this high level of activity (with its parallels throughout the developed world) there is remarkably little published work dealing with the training of the drivers of heavy vehicles, let alone scientific evaluation of the effects of such training. Accordingly, the developments in heavy vehicle driver training now in motion in Australia are necessarily based on the well-considered opinion of those most closely concerned with training operations, such as those bodies listed above.

There is considerable general evidence to the effect that greater experience leads to fewer accidents (MacDonald, 1985), although Linklater (1978) found no significant relationship between experience of truck drivers and crash frequency when exposure was taken into account. The relationship between experience and accident risk is not well documented in the Australian literature. Large transport companies are nevertheless well disposed to signing on more experienced drivers than inexperienced. In an excellent review of training for the heavy vehicle driver undertaken for the Road Traffic Authority in Victoria, Cavallo (1987) comments that a particular level of driving experience is already characteristic of truck drivers, and the finding that general driving experience reduces the likelihood of a crash for the general driving population does not mean that further truck driving experience will reduce the risk of a truck driver being involved in a road crash.

Cavallo (1987) suggests that the scope for the use of heavy vehicle driver training would depend on the following considerations:

- There is widespread agreement that the demands and skills necessary for driving heavy vehicles are different and more complex than those required for the driving of passenger cars.

- If critical safe driving skills were identified, and these skills were amenable to the application of teaching principles, a safety oriented training program would need to have the potential
 - (a) to reduce the time and increase the probability of acquiring skills associated with lower accident risks; and
 - (b) improve on the optimum level of accident free driving now attainable, either by developing safety skills already attainable or through developing extra safety skills.

The fulfilment of the above prerequisites depends on the quality of training courses, and there is a need to investigate the process and development of particular driver qualities in order to determine whether they may be instilled through training. However, present courses of instruction are based only on the judgement and experience of experts in the field rather than on scientific research.

Some early studies of heavy vehicle driver training concentrated on a defined method in the United States: the Smith, Cummins, Sherman (SCS) method. The SCS method focuses on the development of systematic perceptual search habits to detect driving hazards, and uses driving strategies to dispose of these hazards before they become critical. Cameron and MacDonald (1973) concluded that there appears to be no evidence that the SCS method is valuable for ordinary drivers. It is, however, intended for truck drivers, and Payne and Barmack (1963) studied 120 professional drivers in a truck company. They were divided into two matched groups, one of which was given SCS training and the other acted as a control. A subgroup of drivers taught by a particular instructor had a subsequent accident history that was significantly lower than the accident rates of drivers taught by other instructors and those who were in the control group.

While Cameron and MacDonald (1973) considered this to be a favourable indicator for the SCS system, both Saffron (1981) and an expert OECD working group (OECD, 1970) concluded that the results of this study were more related to the personality of the trainer than to the method employed. It was considered by these reviewers that the instructor was the important factor rather than the instruction method.

Sandow (1979) examined the effectiveness of training by a defensive driving course of commercial heavy vehicle drivers employed by a company in South Australia. It was found that the rate of accident reduction over the four year period studied was consistent with rigorous employee selection criteria instituted by the management. This resulted in a developing pool of an older and more experienced group of drivers, and this fact was primarily responsible for the observed decrease in accident rate. Early studies in America had observed a similar effect (see for example Coppin, 1977). Overall, the South Australian study was not able to come to any firm conclusions as to the effect of training on accident reduction.

The lack of hard evidence on the effectiveness of truck driver training during the last decade, compared to the almost universal support for its application and extension, is a striking feature of a literature review in this field.

MOTORCYCLE TRAINING

To the observer who had never seen them performed before, some tasks in traffic would seem to be so inherently difficult that it is a marvel that they can be accomplished at all, let

alone safely. Motorcycling is one such task. The late Dr William Haddon Jr once observed to this author that riding a motorcycle was more akin to a circus trick than to an activity suited to sensible adults in a civilised society. Motorcycling is certainly a tribute to the ability of the human being quickly to learn and undertake complex perceptual and motor skills, to the extent that quite young children can operate motorcycles and indeed do so quite commonly in Australia under (usually) off-road conditions.

Not only are the perceptual and motor skills required for riding motorcycles on the face of it of a high order, when the system fails and the motorcyclist comes into collision with other road users or the environment the chance of injury is much higher than for road users protected within the shell of a motor vehicle.

Inexperience has an effect on motorcycle accidents that was identified by many researchers as important in studies during the sixties and seventies (see, for example, Henderson, 1970; Waller, 1972; and Messiter, 1972).

For all the above reasons the performance and behaviour of motorcyclists has long been a matter of especial concern to licensing authorities, educationalists and researchers alike. Most States in Australia have put their weight behind special motorcycle training schemes, generally complying with a recently formulated national core syllabus for motorcycle rider training. Victoria has for some time used licence tests developed by the Motorcycle Safety Foundation in the United States, and New South Wales is introducing a similar program.

It is at least arguable that because motor cycling on the public roads is both difficult and dangerous, then training in motorcycle skills might be expected to have a more direct and easily measurable effect on motorcycle accidents. An international expert group reviewing two-wheeler safety (OECD, 1978) suggested the following measures to counter the effect of inexperience on motor cycle accidents :

- the availability of training programs for those who elect to enrol, and as a mandatory requirement for those who fail any part of the recommended licensing system;
- improved testing, based on hard accident data and comprehensive task analysis; and
- the issuing of provisional licences with certain restrictions.

The OECD review also pointed to the several training courses then (as is the case now) being offered in the United Kingdom, Japan, Sweden, the United Kingdom and Canada, various aspects of which have been picked up and used for implementation in Australia. However, rather few attempts have been made to evaluate the effectiveness of training courses in reducing motorcycle accidents and traffic: violations among their graduates.

In the United Kingdom, Raymond and Tatum (1977) evaluated the motorcycle training scheme run by the Royal Automobile Club. They compared the accident rates of trained and untrained riders. Controlling for exposure - taken as being the distance travelled by motorcycles - it was found that the trained riders had a significantly higher accident rate compared to the untrained control group.

In 1972 the motorcycle industry in the United States, concerned about high crash rates among motorcyclists, contracted for the five-year development of a safety plan. The Motorcycle Safety Foundation (MSF) emerged as the body responsible for its administration and promotion. In 1974 the MSF released the Beginner Rider Course

(BRC), used until the emergence of the Motorcycle Rider Course (MRC) (Robinson, 1980).

This course was based on a series of task analysis and curriculum development projects, and combines classroom and on-cycle activities. Several early reviews of the MRC were reported at an International Motorcycle Safety Conference organised by the Motorcycle Safety Foundation in 1980, and the enthusiasm with which it was received by those who were using it was striking.

For example, Thackray and Prescott (1980), working under contract to the NHTSA, concluded as follows:

- MRC graduates acquired basic skill(s) and knowledge required for safe riding;
- the MRC is administratively feasible: in terms of its schedule and costs;
- the course was found to be a valuable and enjoyable experience by students and instructors alike;
- school administrators and parents approved of the course and would like to see it continued in the school system.

Satten (1980) interviewed 200 motorcyclists, and compared the reported records of those who had completed the MRC with those who had not. The MRC-trained riders were found to report lower rates of law violation and crash involvement, and were more likely to wear protective and bright clothing.

Anderson (1980) reviewed the effectiveness of a skills training program that was part of a project designed to improve the motorcycle licence program in California. Applicants who failed the motorcycle riding test were offered a three-hour training course focussing on the skills measured by the test. It was found that applicants failing the test on their first attempt and receiving remedial training had 22% fewer accidents during the 12 months following the training than those applicants who failed the test on the first attempt but who did not receive remedial training. However, exposure was not controlled for in this study.

Lakner (1984) conducted a telephone survey of a sample of MRC graduates and a sample of other motor cycle drivers, and also found a lower reported accident rate for those who had taken the course.

It is hardly surprising, therefore, that the MRC has become something of a role model for many motorcycle instructional programs throughout North America and other countries, including Australia.

Some doubts, however, were arising from follow-up studies. Among the most thorough of the evaluations of the MRC was that of Mortimer (1984). The study was done with a sample of 51(0) riders, some of whom who had taken the course within the three years before the study and others who had not taken the course.

The data were collected by means of a questionnaire. All the major findings of this study were disappointing for those promoting the course. Riders who had taken the course did not afterwards have a lower accident rate than controls. They did not commit fewer violations of the law. The costs of motorcycle crash damage and personal medical treatment were no lower.

In order to further evaluate the Motorcycle Rider Course and to substantiate the findings of this earlier study, a subsequent investigation was conducted using a much larger sample (Mortimer, 1988). The same questionnaire that was used in the earlier study was mailed to a sample of riders who had taken the course in 1980-1983. A total of 2307 questionnaires were mailed. Some of the questionnaires were not returned, and about 30% of people who had taken the course did not ride a motorcycle thereafter. The final sample consisted of 1,413 riders who had ridden at least some miles on a motorcycle during the preceding 12 months, 914 (64.6%) of whom had taken the MRC and 500 (35.4%) who had not.

One of the important findings of this later study, also reported in the earlier investigation, was that drivers who had taken the course used protective clothing significantly more frequently than did drivers in the control group. This is an important potential contribution of motorcycle training courses. This study also corroborated a finding in the earlier one that loss of control, including sliding on wet, icy and gravel surfaces, accounted for more than half of the accidents. About 16% of the accidents overall involved another vehicle. The group of trainees from the MRC tended to have more accidents due to sliding on gravel and low friction pavements than the control group. On the other hand, the control group was involved in almost twice as many collisions with other vehicles.

Mortimer suggests that the course trainees adopted a more defensive posture with respect to other vehicles, but lacked the skills necessary to identify low friction surfaces and to control the motorcycle on them.

The study found that both groups committed about the same number and rate of moving violations. Also, there was no difference overall between the two groups in the number of accidents, with 19% of the MRC trainees and 15% of the control group riders reporting at least one accident as defined in this study. These percentages were quite similar to those reported in Mortimer's earlier study.

Further, the trainee group did not have a lower mileage-related accident rate than the control group. Mortimer and other authors have stressed that older drivers and those who have been licensed longer had lower accident rates. Also, those who drive more miles have a lower accident rate.

In order to evaluate the severity of the accidents the damage to the motorcycles and the severity of injury were assessed. It was found that the mean cost of damage to motorcycles in accidents was significantly less for the trained group than for the control group, indicating that the MRC riders accidents were less severe. However, the rate of damage cost per million miles covered was not very different, so that when exposure was taken into account there was no difference between the two groups in the cost of damage to the motorcycles.

Although the mean cost of medical treatment per accident was lower for the trained group than the control group, the difference was not significant at the .05 level. The treatment cost per million miles was not lower for the trained group.

Overall, the results of this larger evaluation of the Motorcycle Rider Course were similar to that of Mortimer's earlier study, although slightly less positive. The greater use of safety clothing by the MRC graduates was probably a factor in their lower, but not quite significantly different, severity of injury. Likewise, the accidents were probably less severe as indicated by the lower costs of damage to the motorcycles. About 98% of the accidents of the MRC group involved only a loss of control of the motorcycle. This suggested to

Mortimer that the course should put more emphasis on vehicle handling skill. However, it might also be speculated that the trainees had been given a falsely high perception of their ability to cope with such conditions by the course, or that after the course they were prepared to take higher risks.

In Canada, Jonah et al (1981), as part of an evaluation of the Motorcycle Operator Skill Test (MOST) noted that motorcyclists reporting some formal training before the test also reported fewer traffic law violations than those who were not formally trained. (The rates for accidents were the same.) The Canada Safety Council offers in most Provinces the Motorcycle Training Program (similar to the MSF Motorcycle Rider Course), and as a follow-up to the above study Jonah et al (1982) retrospectively examined the riding histories of graduates of this program, and compared them with riders who had been trained informally.

The Canadian Motorcycle Training Program is about 20 hours in duration, and is usually taught during two consecutive weekends. About four hours are devoted to theoretical aspects of motorcycling, and sixteen hours involve riding, of which six hours are spent on public roads. Jonah et al controlled as far as possible for sex, age, time licensed, exposure, education and riding after drinking.

With these controls applied, no significant effect of the motorcycle training program on the likelihood of accidents was observed. However, graduates were less likely than informally trained riders to have committed a traffic violation. An interesting finding was that 16% of the graduates of the course did not have a valid motor cycle operators license at the time of being contacted for an interview, compared to 5% for the informally trained sample. The authors suggest that the program had a beneficial effect on accidents by discouraging some people from riding a motorcycle and thereby reducing their exposure to risk. A similar effect was noted in California by Anderson (1980).

Another finding of this study that is important to evaluation of the outcomes of education and licensing programs is that the incidence of accidents recorded on motorcyclists' driving records was considerably lower than the incidence of self-reported accidents that were of such severity that they should have been reported to the police. Driver records in this case provided an underestimate of the frequency of accident involvement of motorcyclists, a finding that has been noted by other researchers in the past (Zylman, 1972; Smith, 1976).

In New South Wales, Adams et al (1985) reviewed a training program started in 1952 by Australia Post in order to attempt to reduce the number of injuries being suffered by motorcycle riders among the organisation's telegram delivery staff. The study employed an unusually good experimental design. The Sydney Metropolitan area was divided in such a way that half of the Australia Post operational divisions were selected to receive training, while the other half was selected not to do so. Unfortunately, the planned design could not be properly maintained because of personnel movement from one division to another and an uneven allocation of the course to various riders. Personal injury data were taken from Australia Post records, which minimised under-reporting of accidents.

The training course was conducted for Australia Post by external consultants at a motor racing track in Sydney's outer suburbs. It was of 12 hours duration, conducted over two consecutive days. The content included maintenance of the motorcycle, attitude, road craft, hazard identification and defensive riding. The course instructors had many years of experience as police motor cyclists and instructors. Because some riders did not attend the

course although being selected to do so, for the purpose of analysis riders were divided into three groups; trained, not attending and control.

This study found that there was no significant difference between the drop (before and after) in accidents among the trainees, and the drop that also occurred in the control group. However, the sample sizes were too small to give statistical significance to the observed drop even if it was a real one. Further, those who actually attended the training courses had had better crash records in the past than those who were in the control group, so the experimental groups were different to some extent even before the course.

In Victoria, a revised system for preparing novice motorcyclists was introduced in 1983. All applicants for a motorcycle learner's permit had to pass two written tests, and where facilities were available, also a pass an off-road skills test. Some riders might also take a voluntary rider training course which also included the skills test.

The introduction of the scheme resulted in a sharp reduction in the number of permits issued. It was also followed by a decrease in accident frequencies and rates throughout the State, with the involvement of learner riders in casualty crashes going down by 29 per cent in 1983/84, and 45 percent and 47 per cent in 1984 and 1985 respectively (Wood and Bowen, 1987). Time series analysis confirmed that this reduction was a deviation from previous trends, and it appeared to be a result of a combination of fewer learner permits and greater safety.

However, more detailed analysis showed a complex pattern of results, and it was not possible to separate the effects of the written test, the skills test, and the rider training.

The strong intuitive support for the benefits of training for motorcyclists has led to the introduction of many other government-supported courses throughout the country. At the New South Wales Traffic Education Centre in Armidale trials were undertaken of several different syllabuses, leading to a "Motorcycle Riders' Basic Skills Programme". This was evaluated by Batchler (1988), who found that participants and instructors perceived the course to be successful. The course was, according to this author, appropriate as a basic course for riders who have some experience but are not yet licensed, as well as for those without previous riding experience.

THE TRAINING OF PEDAL CYCLISTS

The training of pedal cyclists has received less formal attention than the training of drivers and motorcyclists because it is more customarily associated with general efforts to education children about the safe use of the road. Adults, presumably, are assumed to know enough already.

The Australian "Bike-Ed" course, which originated in Geelong, has been evaluated by Trotter and Kearns (1983) and Kearns and Rothman (1983). The aim of the course is to teach road law and encourage care and alertness, and to instil in riders a feeling that they are part of a total road system. The evaluations show that "Bike- Ed" does assist in the adoption of safer road behaviour, and Shanks (1983) demonstrated that it was: a cost-effective measure.

Wells et al (1979) compared the: effect of on-road and off-road training for child cyclists in three age groups in England. They found that either method of training reduced errors,

with on-road training rather more effectively. They also found that eight-year-olds did not benefit as much as those aged nine or ten.

Child cyclists were also the subject of a study by Preston (1980). In the United Kingdom the Royal Society of Prevention of Accidents introduced cycling proficiency schemes for the training of child cyclists in 1959. This study investigated the effect of taking the training and cycling proficiency test as provided in one region of the United Kingdom. The study used questionnaires, with some support by interviews.

The results showed that 20% of the girls and 44% of the boys reported that they had been injured in a cycling accident at some time. For both boys and girls there was no doubt that those who failed the cycling proficiency test had higher accident rates than the other children, and that therefore the test did seem to be assessing skills that were relevant to safe cycling. For boys (but not for girls) aged 10 and 11 years those who passed the test had fewer accidents than those who had not taken it.

An important aspect of the education of vulnerable road users such as cyclists is the use of safety equipment. Years before the wearing of helmets by pedal cyclists became compulsory there were efforts to raise the proportion using helmets voluntarily.

An intensive and well-researched campaign was employed in Victoria in 1984, following market research to help understand the attitudes of cyclists to helmet wearing campaigns. It was aimed particularly at parents and younger children, older boys being given up as a lost cause as a target group. Television and radio commercials and substantial promotional support activities were used in the campaign. Helmets were sold at a discount.

An early evaluation indicated that the campaign appeared to be primarily responsible for a trebling in this proportion, from 5% to 15%, in some parts of Melbourne (Torpey, 1984). A later, more detailed evaluation (Wood and Milne, 1988) showed that the wearing rate by school-aged children rose from 4.6% in 1983 to 13.3% in 1984 and 38.6% in 1985, with lesser increases and rates among secondary school children. Among adults, the wearing rate rose from 26.1% in 1983 to 42.0% in 1985. The incidence of head injury among cyclists colliding with motor vehicles in Victoria dropped about 20% between 1982/3 and 1984.

In subsequent years the wearing rate continued to increase in most groups, setting the scene for mandating the use of bicycle helmets, laws now becoming well accepted throughout Australia.

Education of other road users about cyclists' rights and requirements is necessary to improve cyclists' safety. Martin (1987) found that a NSW campaign effectively communicated to motorists many (but not all) messages important to the safety of cyclists, but that the concept that cyclists safety was a problem for motorists was rejected. Cyclists were seen as "irresponsible", especially children.

5 GENERAL DISCUSSION AND CONCLUSIONS

In a world where most people - whether adults or children - are forced to negotiate the hazards of the roadways because they need to drive to work or play, or ride, or walk, we have the obligation to protect road users from hazards as far as we can. It may be that in the end, these road users may not choose to act in a safe manner. But that does not relieve us of the obligation to teach both experienced road users and newcomers to road use what safe behaviour means, and how to act safely.

This means that reductions in the number of traffic accidents, deaths and injuries are not the only - or perhaps even the most important - goals of traffic safety education. They are, of course, fundamental aims of public health, and as such with our renewed enthusiasm for public health objectives in traffic safety - have received the lion's share of critical attention in recent years. But in assessing the success of traffic education and publicity programs, it may be just as appropriate to formulate the goals in terms of educational objectives. Road user education is not simply a transport issue.

Thus, the basic task is to help people recognise and select a safe environment and situations, and assist them to behave as safely as possible in those situations.

Negative evaluations of the effect of educational programs (and they well outnumber the positive, as is clear in this review) should be used not to tear education down, but to build it up, by making it more effective.

THE RELATIONSHIP OF EDUCATION TO ENFORCEMENT

Throughout this review there have emerged several examples of the success of education and publicity in bringing about behaviour change when intimately linked with new and existing rules and regulations.

The dramatic effect of the massive media campaign and editorial writing that supported introduction of random breath testing in New South Wales, and the marked drop in Victorian road fatalities following a media campaign on speeding, drinking and RBT of unprecedented scale and expense, are perhaps the most dramatic. These campaigns have almost certainly raised the perceived chance of detection and apprehension for breaking traffic laws to an unprecedented high, and resulted in a sharp drop in related crashes.

It is clear that to maintain the success of such efforts, not only must the regulations stay in effect and be vigorously enforced, but also public education must be maintained as well. Education and enforcement go together, is the conclusion from the evidence. If enforcement activity eases, education cannot by itself maintain the desired behaviour change. And if educational efforts are neglected, the previously successful effects of a new and potentially life-saving piece of legislation may gradually lose its effect as the perceived chance of detection falls away.

THE IMPORTANCE OF SPECIAL GROUPS

Some groups are commonly singled out for special attention through education and publicity. Among them are drinking drivers. But there are others, perhaps because of the high risk inherent in their use of the road, such as motorcyclists, and perhaps because of their especial vulnerability, such as children and elderly pedestrians. While the priority for

attention may appear to be low in numerical terms, it may be high in terms of community desires.

In addition, the priority to be given to behavioural measures will depend on the extent to which studies have shown that change is achievable. For example, child pedestrians are at high risk, and research has demonstrated several examples of how their behaviour can be changed quite markedly for the better. Although they may comprise a small part of the road toll numerically, the fact that they are open to behavioural change makes them an appropriate target for behavioural countermeasures, including education. On the other hand, while elderly pedestrians may contribute more heavily to total traffic injuries, a high proportion have their abilities adversely affected by age-related deficiencies in perception and motor capabilities, with alcohol another potent factor. Educational efforts directed at this group cannot be expected to have a marked effect, and environmental change will be required in order to make faulty behaviour as safe as possible.

That said, for the immense and complex road system as a whole, it may be as desirable to achieve a small change in a large group of road users as it is to bring about a big change in a small number. Only careful evaluation at all stages can indicate what is being achieved, to whom, and why.

BEHAVIOUR VERSUS PERFORMANCE

An important aspect of the present review has been the examination of differences between changes in behaviour and changes in performance. Performance relates to the things that people are able to do: see and appreciate hazards, react quickly and appropriately, control skids, walk smartly across at pedestrian crossings. All these things can be trained, and are an important aspect of the acquisition of skills that can make for the safe use of the road. Research should lead to more effective ways of imparting such skills.

But people may choose not to use these skills, or use them in an inappropriate and unsafe manner. With his sharp perception and quick reflexes a young driver may choose to weave aggressively through heavy traffic. A skilled rally driver may feel confident in car control at speeds far above the norm on a highway and choose to drive very fast as a result. If as a result the real risk is higher than the perceived risk, safety will be compromised.

This is the problem faced by educators and those who aim to improve safety through publicity. Training for safety through improved performance can be beneficial when freedom of choice is relatively constrained, as when laws are strictly enforced by police, company regulations or the rules of the airways, for example. But if a road user chooses to trade away improved performance for reduced margins of safety, increased speed and so on, then the result is not improved safety. To put it at its simplest, a racing driver doing his best on the track will be using up all his skills in order to drive as fast as possible; his risk of crashing will be at least as high as it is on the road, great skill notwithstanding.

While debate is likely on the most useful approaches in the short term, the road user training of the future is likely therefore to be associated much more with skills of perception, judgement and understanding than with performance and the finer points of car control.

Driver and rider training programs have suffered over recent years from the fact that many skilled and careful evaluations have shown little effect, none, or even a negative effect on accident rates when it has been employed. Yet systematic examples of such programs have

been with us for over 50 years, remain popular, and are commonly viewed as fundamental to our overall approach to preventing traffic accidents. A more sophisticated approach to instruction will eventually allow us to capture the essence of what constitutes good driving and safe riding, and transfer this knowledge to the learner.

It is: certainly true to say that just because an approach has not worked in the past does not mean that it would not work in the future if was to be undertaken differently. It may have been that the importance of improving skills as part of training has been over-estimated, or that more research is required into what skills are most germane to safe road use and to training. Further, an approach worth investigating (and evaluating) is that skills training should be more closely integrated with other educational and promotional approaches to road safety, so that: it might better be placed in a social and environmental context by those being trained.

EDUCATION AND PUBLICITY IN CONTEXT

This review has shown how large-scale educational programs are very expensive, whether distributed through a school system or via advertising in the mass media. They compete for resources, therefore, with all other traffic safety programs.

In some specific aspects of safe road use - the use of headlights by motorcyclists, for example - there are a number of ways of bringing about the same outcome. In this example, it may be achievable through several alternatives: mass advertising, promotion through motorcycle magazines, legislation, or by wiring the light switch into the ignition circuit, for example. In such cases, educational and other behaviourally-oriented countermeasures must demonstrate not only that they are effective, but also that they are cost-effective in comparison with other measures, in bringing about their desired objective.

However, educational aims are rarely so circumscribed. They often encompass more general community goals, perhaps defined in ways that are frustratingly vague to the analytical mind. Analogies can be found in the environmental movement, where human aspirations for a cleaner and better lifestyle are hard to enumerate in terms that could be evaluated by changes in death rates. Yet environmental concerns are developing a public health emphasis, just as are concerns about traffic safety, and these are simply different sides of the same coin.

In this case, resources for traffic safety education and publicity may be justified not only on the basis that they reduce crash rates, but also because we all need help to cope with changing lifestyles in a complex and hazardous world.

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