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Selection of heavy vehicle drivers: A literature survey

H. Bangert

Nasionale Instituut vir Personeelnavorsing — NIPN
National Institute for Personnel Research — NIPR

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H. Bangert, B.Sc. (Hons), Researcher

National Institute for Personnel Research
Executive Director: Dr G.K. Nelson

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ABSTRACT

Current selection procedures for heavy vehicle drivers are not particularly effective. These procedures are not relevant or are too simple to assess driving aptitude. Psychological and other factors that have an influence on the driving task are identified in a review of the literature. Theoretical models of driver behaviour are also discussed. The complexity of driving suggests that the selection of drivers be based on a variety of tests. Recommendations for tests to be included in a selection battery for professional drivers are made.

EKSERP

Keuringsprosedures vir swaarvoertuigbestuurders wat tans gebruik word, is nie besonder effektief nie. Hierdie prosedures is òf nie relevant tot die bestuurstaak nie, òf is te eenvoudig om bestuursaanleg te meet. Sielkundige en ander faktore wat die bestuurstaak beïnvloed, word aan die hand van 'n literatuuroorsig geïdentifiseer. Teoretiese modelle van bestuursgedrag word ook bespreek. Die kompleksiteit van die bestuurstaak dui daarop dat die keuring van bestuurders op 'n verskeidenheid toetse behoort te berus. Aanbevelings word gedoen ten opsigte van toetse wat by 'n keuringsbattery vir professionele bestuurders ingesluit behoort te word.

1. INTRODUCTION

In the road transport industry there is a need for research on the selection of heavy vehicle drivers. This need has arisen from the rising number of accidents in which professional drivers are involved. This accident rate can be attributed partially to the high density of heavy vehicles as well as to increasing urbanization with its concomitant increase in traffic. The exposure of professional heavy vehicle drivers to hazard increases the probability of accidents. The cost of accidents to South Africa, not only in economic terms but also in terms of injury and loss of life, is generally regarded as unacceptably high. The road transport industry is aware of the accident problem and is concerned with improving standards of selection and training of drivers. Several transport operators have demonstrated their concern by offering to supply subjects for this research project.

The background for the development of a selection procedure for professional heavy vehicle drivers is presented in this report. The project, Selection of Heavy Vehicle Drivers, aims to provide a test battery that will be more effective than selection procedures currently being used. Whereas training was considered to be the answer to the accident problem in the past, it is no longer believed that this alone can solve the problem. Training is important in bringing drivers up to a standard level of proficiency in handling vehicles, but it is only effective to the extent that drivers maintain an acceptable level of safety in their day-to-day driving.

Combining selection with training would help to achieve the goal of safe driving.

Driving is a complex interaction of perceptual motor skills and decision making, requiring a number of different abilities and skills that may be influenced in various ways. Consequently a selection package will have to be used to assess the various factors. This will necessarily involve researching those factors which have been associated with road accidents, and determining which ones are most applicable to heavy vehicle drivers.

This report will also look at background research on accidents and road safety. Earlier research tended to deal with driver behaviour in isolation: that is, individual differences were correlated, usually with traffic accident records but also with traffic violations. More recently though, several theoretical models of driving behaviour have been proposed that regard the driver as part of a broader environment. Generally speaking there has been a swing away from the purely personality characteristic approach to a more holistic conceptualization of accident causation. Risk taking has become a popular subject in accident research. One of the more popular risk theories is the Risk Homeostasis Theory proposed by Wilde (1982a). There are some criticisms of this theory (McKenna, 1985a, 1985b) and some reformulations (Graham, 1982). Naatanen and Summala (1976), also investigating the role of risk in driving behaviour and accident causation, have developed the Zero-Risk Model.

In this literature review the current selection procedures used by South African transport organizations will first be discussed. Secondly those tests which have been produced by the National Institute for Personnel Research, and research projects it has undertaken that are relevant to this project will be considered. The next section of the literature review will concern several individual differences in behaviour or abilities which may have an influence on accident causation and more general considerations of selection. Several psychological mechanisms which have been suggested as having an influence on driving will also be discussed, and various theoretical models of driver behaviour will be described. In the conclusion of the report a selection test battery for heavy vehicle drivers based on the information presented in this literature review will be presented.

2. CURRENT DRIVER SELECTION PRACTICES IN SOUTH AFRICA

2.1 DRIVER SELECTION

In a survey carried out in the bus transport industry, Bangert (1983) discussed the most prevalent types of selection and training practices which were then being used. The main results of this survey indicate that, although a wide variety of selection tests and procedures are used in the transport industry, these are mostly inadequate and have a historical rather than a research rationale. This is evidenced by the use of certain outmoded techniques including tests such as simple reaction timers (in various forms), two-hand co-ordination tasks, eye-hand co-ordination tasks and some cognitive tests. The abilities measured by the above tests appear to tap only certain aspects of driving ability, and possibly not the most crucial ones required for safe driving. Although transport operators are concerned with improving the quality of their drivers by improving selection procedures, very few organizations have the infrastructure to perform scientifically controlled validations on the tests they use. The effectiveness of these tests therefore becomes difficult to determine and can only be judged from anecdotal evidence. The current interest in new selection procedures seems to indicate, however, that there are inadequacies in the current selection process.

The selection strategy in the road transport industry tends to be more or less standard (Bangert, 1983). Most transport companies have some form of prescreening for drivers, usually involving a reference and licence check. A licence check is necessary because there are estimated to be approximately one million false driver's licences in South Africa, many of them Code 9, 10, and 11 (heavy vehicle licences). Drivers who present false licences are obviously not suitable for employment. Licence endorsements also often decide whether applicants are rejected outright. Once drivers licences have been approved applicants sometimes have to undergo medical and eye tests. The selection process may end here in some organizations. A test or test battery may however follow and, depending on the results of these tests, the driver applicant is employed or rejected. A short period of training usually follows, but this is dependent on the facilities available to the organization.

There are no readily available packages for selecting heavy vehicle drivers in South Africa. Because of this many organizations have developed their own selection procedures from whatever tests and instruments are available. Some tests presently used for selection originate abroad. These tests are not suitable for the South African situation because of cultural differences between overseas and local drivers. Most heavy vehicle drivers are Black. The norms and cut-off points of these tests are inappropriate because they have been determined by and standardized for American or European populations, thus making them inappropriate for assessing Black applicants. Other problems in using these tests involve issues such as cultural bias. Many tests are culture-bound and it is unfair to expect Black applicants to perform as well as White applicants.

There are not many facilities available to transport operators for the selection of drivers other than in-house "selection centers". Although some consultancies offer test scoring services, these are not frequently used in the industry. Practical problems arise when consultancies are used, the primary one being the time-lag between testing drivers and receiving recommendations. This can be a number of weeks. Because drivers are usually employed relatively soon (within a day or two) after applying for a position, the use of consultants may be an impractical way in which to carry out selection.

The selection procedures used can obviously be improved upon, despite Abbotts' (1984) assertion that only a background check and a practical road test are required. Several attempts at improving the selection and consequently the accident record (the most obvious indicator of a poor selection) have been made. Operators have implemented selection tests and started to train their drivers. At one stage it was thought that good drivers could be produced by training alone. If a driver could be brought to a certain level of proficiency, it was thought that driver would theoretically be able to drive so well that he would not be involved in accidents. Statistics indicate, however, that well-trained professional drivers are also involved in accidents and traffic violations. Training is nevertheless important in improving and maintaining drivers' driving skills.

Many organizations do not train or do not have the facilities to train their drivers. Although there are advanced driver training facilities available to those organizations with no in-house training facilities, there are too few of these and, unfortunately, some lack good quality training. Transport operators do not utilize these training facilities as intensively as could be expected. A pattern noticed in the road transport industry that perhaps tends to discourage expensive selection and training is the movement of trained drivers from large organizations to smaller ones. Smaller organizations tend to believe that selection and training are undertaken in the large companies and that they are thereby "relieved" from conducting their own selection and training.

2.2 RESEARCH ON SELECTION

There has not been much research on constructing selection batteries for professional drivers in South Africa. Engelbrecht, (1983) attempted to validate a selection battery for professional drivers in the mining industry (driving very large ore carrying vehicles). Predictors of work success were the TAT-Z, the Classification Test Battery, a night vision test, and a simple reaction timer. Somewhat earlier, Spangenberg (1967) attempted to validate a selection test battery for Coloured bus drivers. Physiological indicators seemed to be important as well as several non-psychological variables.

Early theories of accident causation were based on the principle that some drivers were more likely to have accidents than others. This is the "accident proneness" conceptualization. The theory claims that in a population (for example professional bus drivers) there exists a group of people whose personality characteristics are responsible for accidents. For professional drivers the theory implies that if the accident-prone drivers (those with a higher probability of having accidents), are removed from their driving duties, the accident rate will drop. This prediction has never been conclusively proved, and the personality profile of these people never properly established. Early research into accident proneness (Greenwood, 1950) suggested that there was a statistically identifiable group of people who had a greater tendency to be involved in accidents. A statistical probability distribution was fitted to the data collected from the accident records of accident-prone people in various job categories, including bus drivers (Greenwood, 1950). For the bus drivers, there were no significant differences between high and low accident groups from year to year. Tillman and Hobbs (1969) later hypothesized that accident-prone drivers could be identified by particular personality and demographic characteristics.

Shaw and Sichel (1971) used the concept of accident proneness in an attempt to explain accident causation in a South African bus company. They investigated the accident records of drivers of a large organization and the records indicated that some drivers were indeed having many more accidents than others. These were labelled the accident-prone group and their removal from driving, coupled with the implementation of selection tests, brought about a decrease in the accident rate. This added substance to the accident proneness theory but later, however, the theory was discredited when detailed accident research showed that the composition of the group of accident-prone people changed from year to year (Froggatt & Smiley, 1964), as did the time period in which they had accidents (Vilardo, 1967). The application of the accident-prone theory, although it may identify people who are likely to have accidents over a short period of time, does not provide insight into the psychological antecedents of accidents nor the psychological mechanisms involved in accident behaviour since it is purely a statistical concept.

L. Shaw (personal communication, August, 1983) later constructed a practical selection test, the Mechanical Test Battery (MTB), which has been in used by several transport companies in South Africa for a number of years. This test was originally devised for use in selecting certain categories of miners working underground. Although the MTB has face validity for the jobs mineworkers are doing, it is doubtful whether it transfers or generalizes to the driving situation. The test involves manuevering a "loader" (a mechanical device with wheels, powered by a 12-volt car battery) by means of two levers, between two lines around a specified course. (The second part of the test is a simple reaction timer.) The manipulations of the levers on the loader are completely different to the manipulations performed by a driver using a steering wheel. Anecdotal evidence from several transport organizations using the MTB suggests that its usefulness varies. Some organizations claim the MTB can discriminate between trainable and untrainable drivers while others find that the MTB does not discriminate adequately between applicants. The standard of applicant may have an effect here. If the applicants are very unsophisticated the cut-off points will be too high. If the cut-off points are arbitrarily lowered to accommodate the group, the test may lose its ability to discriminate.

Anecdotal evidence also suggests that other reaction time tests used in organizations do not discriminate properly between good and poor drivers. One organization believes that the reaction timer indicates which applicants will train quicker (the faster the reaction time the easier to train), although the effects do seem to wear off after drivers have been in training for a number of weeks. Researchers have shown an interest in reaction time measures because drivers have to respond appropriately to many stimuli in the road and traffic environment. Measures of information processing speed rather than simple reaction timers seem to be required however.

The cognitive tests used in some South African companies are various sorts of arithmetic-type tests (or simple change-giving tests) and variations of the OTIS. The OTIS is an omnibus intelligence test which has been standardized for a White population. This makes its applicability to Black drivers suspect. The use of a cognitive test presupposes a basic underlying cognitive ability that applies to driving, and this has not been established. Cognitive abilities may have only tenuous connections with driving ability. In addition, cognitive tests of a verbal-numerical type are not suitable for selecting applicants from a poorly educated group. Many organizations prescribe no minimum level of education for their drivers (many professional drivers have a only a Standard 2 education) and some employ illiterate drivers. Transport operators do however prefer drivers of a higher educational standard because it is claimed that these drivers seem to be more aware of abstract concepts and can better understand how vehicles work. Cognitive functioning could be assessed better by a lower level test than the OTIS, on account of the applicants generally low level of education. The Industrial Test Battery (Taylor, 1986) may perhaps be a more appropriate instrument to assess lower levels of cognitive functioning.

Some transport organizations use a number of cognitive and performance tests not mentioned above, which include the Classification Test Battery (CTB), the Form Series Test (FST), and several others described by their users as a practical driving test, a trainability test, a manual dexterity test, a comprehension test and a learning ability test. Information on their efficacy in selecting drivers is not available, but, with the possible exception of the trainability test, their relevance to driving appears to be limited.

The CTB measures some aspects of cognitive functioning (primary mental abilities) and was developed to classify Black mining recruits for the Chamber of Mines. The test is appropriate for illiterates. The FST is a test of reasoning ability and may prove useful to those organizations using it who want some measure of intellectual ability. It may not however be the best measure available.

One test which has demonstrated its usefulness for selection is the practical driving test, which is also one of the most frequently used tests in selection. Because of the inadequacies of many licences held by drivers, a driving test is essential to determine if the driver applicant can actually handle a vehicle. A problem with the practical driving test is that driver applicants are driving at their best, rather than in the manner they usually do. Risk taking and other undesirable driving behaviour will probably not be detected in this test because of the extra care the driver is taking. The duration of the practical test is also usually too short to assess accurately how well a driver will perform once employed. Although an experienced trainer can usually determine the quality of a driver, there are too few good trainers available to test and train all the drivers in the transport industry.

Transport operators have expressed interest in a driver trainability test. A trainability test is an assessment of an individual's ability to learn a skill (Trainability Tests: A Practitioner's Guide, 1978). The Industrial Training Research Unit (ITRU) has developed several trainability tests for various industries including the transport industry. A trainability test has had some success in the forestry commission in England (Goodwin, Armstrong & Carruthers, 1982). The ITRU test for drivers, Selecting Trainee Drivers For Public Service and Heavy Goods Vehicles (Warren, 1977), attempts to assess the ability to be trained for the job of a professional heavy vehicle driver. This test involves a short interview followed by a brief period of driver training: after this, a driving test is administered. A drawback is the fact that previous training influences the results.

The fact that most heavy vehicle drivers have received some form of training and that many have been trained in several different places, reduces the usefulness of the trainability test as a tool for the evaluation of drivers. Trainability tests are most suitable in situations in which all testees are unfamiliar with the behaviour in question. Because trainability tests are more useful in selecting employees in the lower (unskilled) levels of the employment hierarchy (T.R. Taylor, 1982), and because driving is a highly skilled job, the drivers' tasks do not easily lend themselves to development into a trainability test.

Various forms of projective personality tests are being used to select drivers. One transport company has been using an "African" version of the Thematic Apperception Test (TAT) (E. Kretchmar, personal communication, March, 1982) for many years with success. In this organization the test is used as a measure of literacy as well as a personality assessment. It also seems to have an effect on morale, that is the drivers feel that they have been carefully and specially chosen.

According to Shaw (1965) good drivers are characterized as being mature, easy-going, socially conforming, cheerful, assertive and unambitious. The Social Relations Test (De Ridder, 1961), a more structured projective test, was used in conjunction with the TAT mentioned above, in the same organization. Shaw (1965) believes that a certain amount of aggression is needed for a heavy vehicle driver to perform the job effectively, but that this aggression should not be excessive. A degree of aggression or assertiveness is required to manoeuvre a large vehicle into a stream of traffic. Excessive aggression, however, might result in altercations with other road users. As high aggression has been found in individuals who tend to have accidents (Parry, 1968), selecting drivers on the basis of (moderate) levels of aggression has its dangers.

The 16 Personality Factor Test (16-PF) is also used to assess personalities of drivers in some transport companies. The 16-PF is a questionnaire-type personality test that measures sixteen different personality dimensions. There are several problems in using the 16-PF to select Black drivers. The most important criticism of this instrument is that it is obviously culturally biased, making it unsuitable for selecting Blacks. Another criticism is that the 16-PF is not designed to be used on populations with levels of education as low as those found among heavy vehicle drivers in South Africa.

An administrative problem in using personality type measures is that they are C-level tests (tests only a registered psychologist or psychometrist is allowed to use). This could create practical problems for transport organizations, since they generally do not employ registered psychologists.

Because of the generally low educational level of drivers, questionnaires and inventories are not easy to administer, even when translated and applied verbally. When inventories are applied in the vernacular there are problems involving accurate translation and the correct interpretation of responses. The responses gathered in this way may not be very descriptive of the individual nor spontaneous. Because of the presence of the test administrator the questions may elicit socially desirable responses rather than true responses. The questionnaires and inventories can nevertheless be used to gather important information, especially when applicants are more literate.

Transport operators have tried using various psychological and non-psychological tests in an attempt to select better drivers. These operators tend to ascribe the indifferent results of their selection procedures to the generally poor quality of applicants, but the selection procedures themselves may be at fault. The procedures or tests used may be inappropriate for the applicants, or the dimensions measured by the tests may not correlate with driver performance. It may also be difficult to determine which criteria are important in driving.

Wilde (1982a) explains that there seems to be a stable accident rate determined by the driving risk levels that road users set for themselves and the risks they are therefore prepared to take. The implication of Wilde's theory is that the present accident rate will remain unchanged as long as drivers do not change their risk levels. Accident researchers are convinced that unless road safety programmes are aimed at reducing the level of risk people are prepared to take (Wilde, 1982a), or road user's motivations for road safety are increased (Naatanen & Summala, 1976), the accident rate will remain at its present high level.

Training can help to reduce accident risk. If professional drivers who are safety conscious are selected and well trained, a drop in the accident rate in an organization can be expected.

3. THE CONTRIBUTION OF THE NATIONAL INSTITUTE FOR PERSONNEL RESEARCH

3.1 INFORMATION PROCESSING

The National Institute for Personnel Research (NIPR) has done some research on factors relevant to driving and selection. Information processing, an important aspect of driving, has for instance been looked at by several researchers of the NIPR.

In an experiment to measure information processing rate, T.R. Taylor (1976) found that the rate of information processing apparently improved after the consumption of alcohol, with a further improvement the following morning. A series of traffic situations involving traffic signs, a policeman, a pedestrian, and a bicyclist were presented on slides. The experiment required the testee firstly to learn a set of five "safe" and "dangerous" rules relating to particular traffic situations, and then to make a majority decision on the degree of "safeness" or "dangerousness" of those traffic situations. The design of the experiment may have contributed to the surprising results. The explanation for the result was that some learning had taken place during the performance of the task. The memory load (learning a number of artificial rules) of the task was very high and this made it possible for testees to improve their performance with practice.

This experiment points out the need to eliminate, or reduce to a very low level, the amount of learning in any information processing task unless time for the experiments is unlimited, and subjects can be trained before testing to the point where learning is no longer a factor. However an extended testing period is usually impractical in a selection test.

Although T.R. Taylor (1976) distinguishes between conceptual and perceptual information processing there is no clear distinction between the two. In purely perceptual information processing the answer is apparent in, or is suggested by the stimulus. For example, if the stimulus is an arrow pointing left, the response would be some response in the left direction. Conceptual information processing requires more processing as it involves rules and non-trivial classifications of information. The stimulus material must be transformed cognitively in some way in order to arrive at a response. "Hybrid" tasks may involve both perceptual and conceptual elements.

Another information processing experiment, carried out by the NIPR at about the same time, was described by J.M. Schepers (personal communication, December, 1985). The test he developed was called the Rate of Information Processing Test. This was designed to measure both perceptual information processing and conceptual information processing. It involved the presentation of a number of aircraft silhouettes, varying in a number of ways, to which subjects had to respond in an appropriate manner. The nose, wing, and tail fin of the aircraft could vary in three dimensions. (Both the wing and the tail fin could have a delta, swept back, or a straight shape, whereas the nose could be either pointed, round, or square.) This resulted in 27 different aircraft silhouettes.

Subjects had to respond verbally to the stimulus material and the responses were recorded by a tape recorder. The responses were recorded in this manner to eliminate the motor reaction time which would have been required if the subject had had to press a button to record the response. Thus it was hoped that a purer information processing time could be measured. The silhouettes were presented for a constant period of a tenth of a second, whereas the rate of presentation was gradually increased to one per second. Subjects practised the items thoroughly beforehand to ensure that they could accurately categorize them.

The first part of the test was designed to measure perceptual information processing. This perceptual reasoning (information processing) section required subjects to respond to a presentation of two aircraft in the affirmative if the wing and tail fin had the same shape, and in the negative if the wing and tail fin were different.

The second part of the test was designed to measure conceptual information processing. The stimulus material was very similar. Although the same silhouettes of aircraft were presented, and a complex decision rule had to be used to classify the aircraft into one of two conceptual categories, designated "foot" and "fin".

The results of the studies described above are helpful in that they point out some pitfalls in information processing research. The Rate of Information Processing Test had a high cognitive load and subjects required a relatively long period of training. A certain amount of overlearning occurred because of this. The Rate of Information Processing Test is not a pure measure of information processing. A test to measure purely information processing requires a relatively long period of training to ensure that the task is overlearned. To obtain a purer measure of information processing it is therefore desirable that the information processing task require the minimum learning of rules and allow all subjects to reach the same level of proficiency after a few practice items.

Information processing does seem to be an important ability in driving as will be seen later. It is related to various abilities necessary for driving. It therefore seems logical to include some form of information processing test in a selection battery for drivers.

3.2 OTHER NIPR TESTS

The Form Series Test (FST) mentioned above was developed by the NIPR, and is still being used by several organizations to select drivers. This test measures general cognitive reasoning.

A new battery recently developed by the NIPR, the Industrial Test Battery (ITB), measures in a similar domain. Tests of this kind may have their application in predicting how quickly trainees learn the more cognitive aspects of driving (e.g. the rules of the road). FST and ITB type tests are not likely to correlate strongly with on-the-road driving performance.

3.3 FATIGUE

The Ergonomics Division of the NIPR has carried out research on fatigue as a factor in driving heavy vehicles. Experiments were carried out in the vehicle simulator built for this purpose. Fatigue is a consideration when one looks at a heavy vehicle driver's duties, which may impose arduous time schedules. Van der Nest's reports highlighted the seriousness of fatigue in this group (Van der Nest, 1971a, 1971b, 1978; 1984).

Because there are great distances between towns in South Africa and inadequate rest facilities, the working hours of truck drivers tend to be long. Bus drivers also have long working hours in the sense that, as passengers commute from very early in the morning to late at night, drivers are on the road at these times with a long break during the day. Working hours for drivers are not adequately controlled by law, and many drivers may drive for very long periods without sufficient rest. The main conclusion arrived at by Van der Nest (1984) is that drivers can overcome the effects of fatigue by stopping and taking 20 minute rests every two hours together with a small intake of food. Many long distance drivers think they can overcome fatigue by taking certain drugs, usually stimulants (Willumeit, Kramer, & Neubert, 1981), but the effects of fatigue are actually exacerbated by alcohol (Nelson, 1981).

A number of studies carried out elsewhere (Brown 1967), and (Brown, Tickner, & Simmonds, 1970), indicate that there is a definite decrement in skill observed in drivers after prolonged periods of driving. With fatigue inadequacies of judgement occur, and visual search and anticipation are affected (McDonald, 1984). Because of this fatigue maneuvers such as overtaking are impaired (Fuller, 1980). Other researchers in the same field point out that prolonged driving can cause reduced driving performance. Lawrell and Lisper (1978) noted that the detection of roadside obstacles decreased with increased hours of driving. Because the accident rate declined slightly after regulations governing drivers' driving hours had been introduced in the United Kingdom, McDonald (1981; 1984), recommended regulations restricting the hours of driving and regulations providing for rest periods for heavy goods vehicle drivers. Verburgh (1985) also considers the most important accident preventative measure an operator can undertake is to control driving hours.

Reduction of fatigue-related accidents can be controlled quite easily by implementing recommended driving hours and control can be effected by checking tachographs and logbooks. Rest stops can be arranged on a long trip allowing the driver to eat, drink and even sleep. For example the new overnight truck stop near Durban provides parking facilities for vehicles as well as ablution and recreation facilities for drivers, and will shortly be able to provide food (Now Durban is safer by night, 1985). Control of driving hours has to be enforced by management and can be assisted by discontinuing practices such as paying bonuses for shortening trip times.

There appears to be no literature on assessing individual differences in "fatigue-proneness" and it does not at present seem practical to include it in a selection battery for drivers.

4. SELECTION BASED ON NON-PSYCHOLOGICAL CHARACTERISTICS

4.1 PRESCREENING

A selection procedure must initially discriminate between totally unsuitable and possibly suitable drivers. Therefore some form of prescreening has to take place. In transport companies the prescreening usually involves a reference check, a licence check, a visual examination and a medical examination.

The reference check is performed in order to determine why drivers have left or were dismissed from their previous posts. Such dismissals may be the result of offences such as an excessive number of accidents, stealing, or other undesirable behaviour. The driver may have adequate skills but be unemployable for other reasons. Licence endorsements must also be looked at carefully, especially those for drunken driving. Any other traffic violations may indicate a tendency to disregard traffic rules.

Age and other biographical characteristics are a consideration in selection. The age after which drivers are usually employed is 25. At this age it is presumed that drivers will have had some years of driving experience, which is an advantage when starting to drive heavy vehicles. Research points out that young, especially male, drivers are more likely to have accidents than older drivers (Konecni, Ebbesen & Konecni, 1976; McGuire, 1972; Naatanen & Summala, 1976, and Planek, 1981). This makes it undesirable to put young drivers in a position of responsibility for other peoples' lives. Although older drivers with much experience should be able to overcome the handicaps of age to a certain extent, their reactions are slower than those of younger drivers. Older drivers' health also tends to suffer from the mostly sedentary job of driving, which may also cause stress.

The medical check will eliminate applicants with health problems that would disqualify them from driving. Applicants who have a history of alcohol or other drug abuse should be eliminated at this stage.

4.2 VISION

Visual acuity testing should be part of the standard screening procedure for professional drivers. It is estimated that approximately 90 % of all information on the road and vehicle environment received by drivers is through the eyes (Golding, 1984). It seems reasonable then to assume that poor vision leads to poor driving. The fact that most transport organizations require some form of eye test tends to support this assumption, although the actual test used differs. The "Orthorator" is the most commonly used vision tester in larger companies, but the standard "Snellen" chart is most commonly used by all organizations. Some companies have vision testers which are not suitable nor acceptable, for example home-made eye ("Snellen") charts, or other tests which require applicants to read some words or the numbers on the licence plates of cars parked a certain distance away.

Vision research, as related to driving, has investigated what eye movements occur while driving (McDowell & Rockwell, 1978; and Hills, 1980), how perceived speed is influenced by visual pattern (Denton, 1980), how attention to traffic is related to eye movements (Ceder, 1977), and the influence on reaction time of visual distraction whilst driving (Holahan, Culler, & Wilcox, 1978). Connections have been established between vision defects, poor driving performance (Booher, 1978) and accident risk (Golding, 1984). This research indicates the importance of vision in driving and the need to control the driving population's standard of vision.

The Driver Training Scheme of the Industrial Council for the Motor Transport Undertakings (Goods) considers adequate vision to be important in the driver's job and does extensive vision testing at its training grounds. Certain defects in eyesight can be overcome if the defect is identified and the driver is aware of the defect. For example if a driver has poor vision in one eye or has tunnel vision that driver must be taught how to overcome the problem. This can be done, for instance, by instructing the driver with poor vision in one eye to turn his head more in the direction of the bad eye, in order to check the area that should be covered by the bad eye.

Myopia and other minor visual defects can be corrected by wearing corrective lenses. Although there is not a strong relation between visual acuity and accident risk (Golding, 1984), deterioration of vision with age is marked, and therefore regular eyetesting is recommended, especially for professional drivers.

Some part of most heavy vehicle driver's duties involves driving at night and at dusk. This is particularly true for goods vehicle drivers, but also for bus drivers. Driving at these times is more dangerous than daytime driving. A test for night vision could be carried out for those drivers who would be driving at night. The visual guidance system in South Africa is not well developed nor well controlled; this makes night-time driving doubly dangerous (Yates, 1985). Steps are apparently being taken to improve the situation.

4.3 BIOGRAPHICAL DATA

Biographical data has in some instances proved a good predictor of various aspects of work performance. Fick (1975) has used a weighted application form in an attempt to counteract various personnel problems in the clothing industry. Fick states that problems such as labour turnover and absenteeism are not necessarily indicative of problems within the organization, suggesting that there are individual differences which can be associated with undesirable work behaviour. The latter could be important in selecting drivers, as training is a long and expensive process. Operators would therefore prefer to employ a driver likely to remain with the organization for a number of years.

Fergenson and Johnson (1968) attempted to find demographic characteristics that could indicate and predict which drivers would have a high violation and accident rate. Age, marital status and socio-economic status were distinguishing characteristics between good and poor drivers: slightly older, married and higher socio-economic status drivers were the safest. Harano, McBride, and Peck (1973) also found that marital status and age discriminated between safe and unsafe drivers, married and older people driving more safely.

When developing an application form or a biographical questionnaire to be used for selection purposes, it is important to include items that are job related (Fick, 1982a-e). For professional drivers these may include private or leisure driving behaviour, previous accidents whether on the job or during leisure time, and number of years' driving experience.

The weighting of questions in the application form also has to be worked out carefully. This is to ensure that the most important factors will have the most influence in the inventory.

4.4 KNOWLEDGE

It seems reasonable to assume that a good working knowledge of road signs and traffic situations will improve a driver's chances of preventing an accident and incurring violations. Provided drivers are able to understand the meaning of road markings and traffic signs, they can guide themselves on a relatively safe course. Apparently not all drivers are able to understand road signs. Most road signs are non-verbal, but some have a verbal content. Illiterate drivers experience problems with these traffic signs. Many organizations require their drivers to be familiar with traffic signs and road markings.

A high score in a road signs test does not necessarily indicate a through understanding of the meanings of the signs. A road signs test may prove useful for easy-to-understand signs, in which the meaning is obvious (for example "no overtaking"), but this may not be the case for other signs with more complex meanings (for example "single vehicle width structure"). These signs do not indicate something a driver has to do or not to do when faced with the sign.

Even if one can be sure that drivers know and understand the traffic signs, there is no guarantee that these drivers will perceive them on the road, (Summala & Hietamaki, 1984) or obey them.

4.5 PSYCHOPHYSIOLOGICAL FACTORS

Psychophysiological variables have been correlated with driver behaviour (D.H. Taylor, 1964; Zeier, 1979). Roberts (1971) notes that obvious pathological physiological states may lead to traffic accidents. The physiological effects of fatigue on driving have also been well documented. Galvanic Skin Response is a physiological variable which seems to correlate with aspects of driving (D.H. Taylor, 1964). Strong emotions may lead to altered physiology, such as an increase in heart rate which may in turn have an effect on driving behaviour. Practical problems with administration, scoring and interpretation may prevent psychophysiological measures from being used efficiently for selection.

5. SELECTION BASED ON PSYCHOLOGICAL CHARACTERISTICS

5.1 GENERAL

Psychological (human) factors have conservatively been estimated to be responsible for about 70 % to 75 % of all traffic accidents (Willumeit, Kramer, & Neubert, 1981). Deppe (1985) suggests that nearly all accidents are caused by "...negligence, carelessness, misdirected aggression, poor judgement, inadequate training or some other deficiency of the human being" (p. 2). This is probably an overstatement, as engineering and mechanical failures do account for a proportion of accidents. Dean (1981) contends that in any accident there are many causative factors, possibly also a combination of human and mechanical failures. There can be no doubt though that the human factor is responsible for many traffic accidents.

Although several psychological characteristics have been associated with accident causation, there has not been much effort to develop a selection procedure that measures a reasonably broad spectrum of relevant characteristics. Because there are so many Black professional drivers in South Africa, it is important to concentrate research on these persons. The selection criteria may also differ for various race groups.

Golding (1983) suggests that research should look at the relationships between individual differences and specific driver faults. The study of differential accident involvement will be useful as this type of research is based on psychological testing rather than statistical modeling (McKenna, 1982). When individual differences that are related to specific driver faults or psychological abilities are found, this may lead to a better theoretical understanding of accident antecedents. These differences in specific abilities could then be formulated in a theoretical model that includes driving as well as other behaviour.

The various psychological factors researched may have some influence on driving, but it has not yet been determined how much of an effect they have. Some human factors that researchers have looked at are personality traits, mood, selective attention, information processing, field dependence, decision making, risk taking, stress, and social factors.

Recently the concepts of risk and risk taking has become more prominent in the literature as a factor in accident causation. Quimby and Watts (1981) in a review of human factors that are important in driving discovered that risk-taking was the most highly correlated with poor driving performance.

Some human factors accident research has unfortunately suffered from bad methodology and generally weak design of experiments. One of the reasons for this may be because accidents are not high frequency occurrences for individuals, and consequently it is difficult to investigate specific factors related to specific accidents. There are many possible contributory factors in road accidents; not all are psychological. Hence it becomes a difficult task to identify and isolate these causes. A distinction may also have to be made between traffic accidents and offences; the causative factors may not necessarily be the same.

5.2. PERSONALITY

Psychologically oriented researchers have attempted to find a personality pattern for drivers who become involved in accidents (Craske, 1968, Fergenson, 1968; McGuire, 1976). It has been hypothesized that certain personality traits manifest themselves in people's driving behaviour. Signori and Bowman (1974) noted a relation between various psychopathological states and reckless driving. Schepers (1976) looked at the personality traits of introversion versus extraversion, emotional stability and instability and field dependence/independence. Extraverts had more violations and accidents, which Schepers attributed to lack of socialization, thus leading to a disregard for traffic rules. Extraverts scored high on a measure of impulsivity which might have predisposed these drivers to hazardous road behaviour.

Despite all the research into relations between accidents and personality factors, there has been very little research on attempting to understand and clarify the underlying causal relationships. Much of the personality research is unfortunately not applicable to South African drivers. The situation in South Africa is complicated by the fact that the population is heterogeneous. The structure of personality may differ from group to group, as may the relations between personality characteristics and driving. "White" personality measures are generally not applicable to other groups, particularly Blacks.

Some attempts have been made to develop personality measures suitable for Blacks. Baran (1971), for example, constructed a Thematic Apperception Test (TAT-type) projective test for Blacks. Another variation of the TAT personality test quite recently developed is the TAT-Z (Thematic Apperception Test for Zulus). This variation of the TAT has, as its name implies, been standardized for a group of Zulus (only males), (Bosman, 1982; 1984). The TAT-Z measures ten different personality constructs including aggression, emotional stability, leadership potential and interpersonal relationships. It is claimed that the test is quite accurate in measuring several personality constructs, for instance attitude to both Black and White authority, leadership potential, and the degree of acculturation. The application of the TAT-Z has been most successful in selecting clerical staff, although it has been used experimentally for selecting heavy vehicle drivers (Steenkamp, 1985) with some success.

For use in a transport organization the TAT-Z can be impractical because only a registered psychologist or psychometrist is permitted to use it. Psychologists are not employed widely in the transport industry. Although use of a psychological consultant to interpret the protocols could be considered, there is obviously some delay in the transportation of protocols between the consultant and company. Time delays are likely to render this approach impractical.

5.3 RISK TAKING

A risk can simply be defined as an action which does not have a safe or sure outcome. Kogan and Wallace (1964) suggest that in risk taking a decision is made on some action, but the outcome of this decision is not certain. Although there is a large volume of literature on risk taking, much of this examines it in the context of gambling or other economic situations (Johnson & Tversky, 1984).

If risk takers enjoy engaging in behavior which involves a degree of physical danger (Looking for a life of thrills, 1985), then it would be desirable to limit their entry into those occupations where there is an opportunity for taking risks that would endanger their lives and the lives of others. Driving is such an occupation. Risk takers, or type T (thrill seeking) personalities can be identified by psychological tests. They tend to vary their solutions to maze-type tasks, and prefer more complex patterns to simple ones. Measurement of risk taking would have to rely on an objective method rather than self-report as most drivers consider their rating lower than average risk takers (Svenson, 1981). A task which encourages subjects to take risks may identify those more likely to do so; such a task might be a useful predictor of risk taking on the road.

It is not clear whether risk taking can be measured accurately by personality assessments. It has been thought that risk taking is similar or is related to impulsivity, but this relation has been questioned (O'Keefe, 1979). Risk taking in driving has been identified as driving through an amber light (Konecni, Ebbesen, & Konecni, 1976), following too closely on highways (Evans & Wasielewski, 1983), and failure to use seat-belts (Evans, Wasielewski, & Von Buseck, 1982) amongst others. Unfortunately these research projects have not examined the relation between risk taking and other characteristics of drivers.

It is clear that risk taking is not only the responsibility of the driver; vehicle characteristics (Evans & Herman, 1976, Rumar, Berggrund, Jernberg, & Ytterbom, 1976; Wilson & Anderson, 1980), and road layout (Watts & Quimby, 1980) also have an influence on risk taking.

Poortinga (1969) attempted to measure risk taking by using an auditory and visual signal detection task. A monetary reward was used to encourage subjects to take risks. Subjects had to respond to stimuli and indicate their confidence (more sure or less sure) in their decision. The experiments differentiated reliably between subjects in terms of the relative frequencies of more confident responses.

The definition of risky behaviour of drivers driving in a real-life situation presents problems. An arbitrary value therefore has to be placed on objective risks in the road and traffic environment and subjective risk felt by the driver. Subjective risk is considered by Colbourne (1978) to be the decision maker's working estimate of objective risk. A problem with assessing risk in the testing situation is the unrealistic situation presented to the subject. A problem in assessing risk taking in the laboratory situation is to determine whether the tendency to take risks in an the experimental situation will generalize to the real environment, say, of driving a vehicle. A further problem is that driver applicants are aware that they are being tested and will present a "safer" image. A risk taking test will therefore have to encourage subjects' tendencies to take risks without their being aware of doing so.

Zwahlen (1973) carried out some experiments to measure risk taking. Subjects were instructed to drive through a gap of varying distances, at various speeds and under two different reward conditions - reward or non-reward. Zwahlen defines risk acceptance as "...a behavioral characteristic of a driver, exhibited when willing to drive, or actually driving towards and through a gap made up by obstacles where there is some probability of failure..." (p. 2). Zwahlen calculated a "mean risk score" to define drivers risk taking behaviour. This "mean risk score" was calculated using a driving skill score and the percentage of drive through runs the subject made. The results of the sets of experiments are mostly inconclusive. What seemed to be important though was the relation between "looking" (at the possible hazard) behaviour and presumed risk taking. The reward situation did not alter subjects' behaviour to any significant extent. The results of the experiment should not be overinterpreted due to the small number of subjects (N = 4).

Konecni, Ebbesen and Konecni (1976) measured risk taking of drivers by their tendency to drive through the amber phase of a traffic light, and the way in which this decision was made. The experiment was carried out <u>in situ.</u> Drivers were observed while approaching a light-controlled intersection, on the green light which changed to amber before they reached the intersection. The decision to stop or cross was recorded. Younger and male drivers were more likely to take a risk by driving through the amber light. The presence of passengers also reduced risk taking.

In an important experiment carried out by Ebbesen, Parker, and Konecni (1977), on risk decisions while driving, it was found that there are differences in laboratory and real-life decisions. The authors stress that external validity testing of models should be performed.

5.4 REACTION TIME

As the reaction timer seems to be a popular instrument in selection, some research on reaction time and other perceptual-motor skills should be mentioned. Babarik (1968), looking at the reaction time aspect of perceptual-motor behaviour, related response time to initiation time and movement time in the following formula:

$$\text{response time} = \frac{\text{initiation time}}{\text{initiation time} + \text{movement time}}.$$

<u>Initiation time</u> is the time taken to begin a movement in response to the stimulus and <u>movement time</u> is the time taken to complete the perception reaction as represented in the jump reaction time.

Babarik calculated the ratios of simple reaction time to jump reaction time (initiation plus movement time) of a group of professional taxi drivers and found those with a slow initation time and a compensatingly fast movement time had more "struck from behind" ("bumper bashing") accidents than drivers with a normal reaction pattern. These drivers with what Babarik called the desynchronizing reaction pattern, however, did not have as many accidents in making headway and had fewer accidents overall. This could have implications for selection as professional drivers are more likely to be involved in an accident on the highway, where the incidence of bumper bashings is high.

It is not reaction time per se that is important, but rather the rate of information processing. Information processing is the cognitive activity that occurs between the presentation of a stimulus and the response that the stimulus elicits.

5.5 INFORMATION PROCESSING

Driving is not an instinctive behaviour and all driving behaviour has been learnt, including appropriate (and inappropriate) reactions to traffic and road situations. Information processing plays an important part in this. Information processing is the ability to take in information from the environment and process it in order to be able to interact efficiently with the environment. In road and traffic situations there are many different informational cues that have to be processed and reacted to appropriately, frequently in a short time span. In much urban driving split-second reactions requiring very fast information processing is needed to avoid accidents. The implication of this is that those drivers who are fast and accurate information processors will be those who have fewer accidents.

Two broad styles of information processing have been described: conceptual information processing and perceptual information processing (T.R. Taylor, 1976). Although when a person is just learning to drive most of the information processing is conceptual, once the driving skills are learnt, the information processing becomes mostly perceptual. Most information processing research has concerned itself with perceptual information processing.

There is a vast amount of information impinging on the driver. Baker (1971) estimates that under normal driving conditions the number of road and traffic events a driver has to process is about ten a second, and the number of driver decisions to be made is about one to three a second. Baker further claims that drivers make an error approximately every two minutes. During the course of driving the driver has to perceive stimuli, understand what they mean, make decisions on the basis of this understanding, and carry out the decisions made. Fell (1976) classifies four types of information processing failures: perception, comprehension, decision, and action failures. Speed can affect the rate of incoming information drivers have to process: the faster the vehicle travels the faster the driver must process information (T.R. Taylor, 1972).

It is impossible for a driver to process all the information in the road and traffic environment (Cumming, 1966/1967), and it seems to be a breakdown in information processing which may be involved in accident causation. When there is too much incoming information for a driver to process there is an information overload and some information has to be ignored. This capacity varies among drivers; this implies that an overload may occur earlier for some drivers. Drivers have to reduce the incoming information to prevent such an overload. Driving experience enables drivers to attend more selectively to road and traffic situations (Cumming, 1966/1967). Drivers also recode information input into larger meaningful units (Connell, 1983). This allows drivers to attend to more information in the road environment.

The relation of information processing to driving accidents has been studied. Connell (1983) measured information processing by means of a test involving visual search and perceptual matching. A positive correlation was found between testees' speed in the test and accidents (accidents involving moving vehicles only). Fergenson (1971) looked at information processing and its relevance to driving and found a relation between information processing speed and accident involvement and traffic violations. One assumption Fergenson made in his study is that reaction time to a complex reaction timer could be transformed into an information processing metric, that is information processing can be measured in bits/second (p. 174). Information processing times of four groups of drivers (zero-accident, zero-violation, zero-accident, high-violation, high-accident, zero-violation, and high-accident, high-violation) showed that there was a significant interaction between accidents and violations. The fastest information processors were the drivers in the high-violation, low-accident group. Siegel (1985) found that performance in complex reaction timers did not correlate well with complex tasks such as driving.

Fergenson's conclusion, similar to Cumming's, is that each individual has an information processing capacity (channel capacity), and when the amount of information to process exceeds this capacity, it leads to an overload and possibly an accident. Those drivers who have a large channel capacity may be involved in more emergency situations because of their driving behaviour, but manage to avoid accidents with their superior information processing ability. Conversely, slow information processors might not even be aware of dangerous situations because they have not had enough time to process the information.

Cumming further states that the information load on the driver can be too low, for instance when he is on roads that give rise to boredom or perhaps unlit roads at night. When this happens drivers may use up their spare information processing capacities by engaging in other non-driving activites, for instance adjusting a radio or tape player, smoking or even drinking.

It is possible that there is some connection between information processing speed and risk taking. That is, very fast information processors may feel they can afford to take risks because they can think (process information) and act fast enough to escape risky or dangerous situations. In a heavy vehicle, maneuvers are more difficult because of the size and momentum of the vehicle and therefore split-second decisions which the driver may make, will not lead to vehicle response instantaneously. A risk taker in a heavy vehicle could be a very dangerous combination.

5.6 SELECTIVE ATTENTION

Selective attention is the ability to attend, on demand, to relevant information in the environment and this is related to information processing as mentioned above. Because there is too much information in the road and traffic environment for a driver to be able to process, drivers have to switch quickly from one task to another, as well as attend selectively to the information (Cumming, 1966/1967). Experienced drivers attend to features of the road and traffic environment which they believe are important to them. The actual features given attention may vary from driver to driver. Drivers concerned with direction markers will attend to them more than drivers familiar with the route. An accident may occur if a driver's attention is divided, or if a driver cannot attend to all important cues at the same time.

Because driving is a divided attention task, a driver must have the ability to attend to those aspects of the environment that are most important for the safe negotiation of the traffic situation. The ability to attend to the most relevant information could characterize a good driver, as hypothesized by Testin and Dewar (1981). Several research studies have looked at the relation between selective attention and driving performance. Using a test known as the Selective Attention Test, Kahneman, Ben-Ishai, and Lotan (1973) found a relation between auditory selective attention and accident rate in a group of professional bus drivers. This study was based on a previous study (Gopher & Kahneman, 1971) that predicted flying success from the same test, which measures the ability to focus attention on specific auditory stimuli in a meaningless jumble of stimuli). This test presents strings of words and digit names to both ears, from which the subject has to detect the digit names. North and Gopher (1976) used measures of attention to predict flight performance, and found those pilots who were better able to attend were involved in fewer accidents; this lends further support to the theory. Gopher (1982) successfully validated the Selective Attention Test as a selection instrument for pilot training.

Mihal and Barrett (1976) measured the selective attention ability and the perceptual style of a sample of non-professional drivers and found that the more attentive and field-independent the drivers were, the less likely they were to have been involved in accidents. (The selective attention test used was based on the one developed by Gopher and Kahneman (1971) mentioned above.) In this study an attempt was made to find significant accident predictors within an information-processing framework. This study points out the importance of developing an information processing model of driver behaviour in which accident involvement criteria can be established.

Applications of measures of attention to road safety research also show the relevance of the ability to attend selectively to stimuli. Brewer and Sandow (1980) have linked accident involvement and alcohol intoxication under conditions of divided attention. Those drivers that were intoxicated were more likely to have been involved in another activity immediately prior to the accident. Noble and Sanders (1980) conducted an experiment in which drivers had to look for traffic signs (on the side of the road) while performing a tracking task. The results showed that the tracking task had not been performed as well when subjects had been engaged in the visual search as when they were involved in the tracking task only.

5.7 FIELD DEPENDENCE

Field dependence (perceptual style) has been considered by several researchers to be important in driving. Field dependence/independence is the ability to extract information from a complex background and to be relatively uninfluenced by this while making a decision on other information in the perceptual field. Those people who are able to do this well are termed field independent and those whose ability in this field is poor are termed field dependent. Some research in the area of field dependence indicates that field dependent people make poorer drivers than field independent people, possibly because they are not as able to discriminate important driving cues in the dynamic driving environment (Goodenough, 1976).

Harano (1970) discovered a connection between field dependence/independence and motor vehicle accident involvement using the Embedded Figures Test (EFT) which is a measure of field dependence. The conclusion Harano arrived at was that the ability to distinguish relevant from irrelevant cues is a factor in accident liability. Thus field dependent drivers may have higher accident liabilities because they are easily influenced by irrelevant detail in the road and driving environment. Olson (1974) studied field dependent and independent drivers in a skidding and car-following experiment, and came to the conclusion that field dependent drivers are less able (or willing) to use information in the road environment than field independent drivers. Another tentative conclusion Olson made is that field independent people have a greater capability to change their behaviour when conditions are changed (they improved their performance in the skidding task).

Barrett and Thornton (1968) looked for a predictor which had a logical relation to driver behaviour in an emergency situation. Subjects were placed in a driving simulator and were presented with a suddenly emerging pedestrian. Scores relating to drivers' initial brake reaction time, deceleration rate and whether they hit the pedestrian or not, were correlated with the drivers' field dependence/independence. There was a correlation in the expected direction between field dependence and the speed at which the drivers responded to the emergency.

Shinar, McDowell, Rackoff, and Rockwell (1978) found that field independent drivers' visual searching behaviour was more efficient than that of field dependent drivers. Holahan, Culler, and Wilcox (1978) noted that reaction times to stimuli increased with increased visual distraction. This may lend support to the theory that field dependent drivers are easily distracted by irrelevant detail in the road environment. Loo (1978), found that field dependent subjects took longer to respond to traffic signals. This failure in traffic sign perception may lead to failure-to-stop and similar accidents.

Field dependence has been related to various other abilities or characteristics. Clement and Jonah (1984) tried to relate field dependence to the sensation seeking tendency and the internal/external locus of control of drivers. There was no relation between field dependence/independence and sensation seeking and the number of accidents.

Field dependence may be related to information processing and selective attention. Field independent people are better able to discriminate features in the environment, and would therefore be more likely to be able to attend to those stimuli in the environment that are important. The strategies of visual search between field dependent and field independent people differ (Shinar, McDowell, Rackoff, & Rockwell, 1978), which may be related to the ability to attend selectively to stimuli.

5.8 ATTITUDE

Attitude may be an important factor in selecting heavy vehicle drivers. Professional drivers, compared with other road users, drive very large vehicles, and this may encourage a feeling of superiority, which may in turn encourage dangerous driving practices. For the purposes of selection it would be preferable to select drivers with a healthy attitude towards road safety. This may, however, be difficult to measure. In an attitude assessment applicants would give socially desirable responses, and responses which endorse road safety.

6. THEORETICAL MODELS OF DRIVER BEHAVIOUR

6.1 ATHEORETICAL APPROACHES

Attempts at describing driver behaviour have concentrated on the differences between drivers who have had accidents (and to a lesser extent, violations) and those who have not. Typically, good drivers have been classified as good if they have had very few or no accidents, and poor drivers are those who have had many accidents. The probable reason that accidents have been chosen as the criterion of good or poor driving is that accidents are the single most obvious indicator of poor driving (Clayton, 1972). Because it is the human element that has been identified as the primary cause of road accidents, accident researchers have looked at individual differences in drivers, psychological characteristics of drivers, and "accident sites" in order to identify the causative factors. There are however few articulate theoretical conceptualizations that apply the findings of empirical research to known driver behaviour.

There are many different and apparently independent approaches in the study of driver behaviour and traffic accidents (McKenna, 1982). The fragmented statistical approach, which seems to have been one of collecting data on characteristics or abilities of drivers and the post hoc analysis of accident records (Henderson & Boyle, 1980), and offences (Michiels & Schneider, 1984), has not brought many meaningful results.

The first approach for the explanation of the human factor in traffic accidents to become popular in South Africa was the accident proneness approach. Applications of the accident proneness concept were put into practice in several transport companies in South Africa (Shaw & Sichel, 1971). However it was found that if all drivers identified as accident-prone were to be taken off driving duties, the number of drivers available would be too small to operate the organization (McKenna, 1982). The accident proneness approach relies heavily on statistics to lend it support. The statistical approach unfortunately does not give any information on psychological or other factors involved in accidents. Although the accident proneness concept is called a theory it is actually only a sophisticated atheoretical approach. The identifications made using the approach may be largely due to chance effects.

Researchers seeking other explanations for accident causation started looking at individual differences of drivers. Accident researchers and psychologists expect that because psychometric and other tests are able to predict human behaviour in various situations, they should also be possible to predict human behaviour in the driving situation. This approach often relies on "shotgun" atheoretical tactics although more emphasis has been placed on the measurement of various characteristics.

Basing research of driver behaviour purely on accidents may lead to several difficulties when applying the models to the real-life situation. Accident research itself suffers from several problems, the most important being that accidents occur rarely and consequently are difficult to investigate when they happen. This makes it almost impossible to collect detailed information about human accident behaviour. Other problems are: acquiring accurate data from accident records, low correlations between specific factors and accidents, difficulty in classifying accidents and their precursors, and inadequate models of accident behaviour (Edwards, Hahn, & Fleishman, 1977). This makes it difficult to examine relations between accidents and their underlying causative factors, or antecedent conditions. Practical applications of research results have also frequently been lacking. The purpose of research into driver behaviour should be ultimately to decrease the accident rate by increasing road safety. In order to do this the results of empirical research must be applied to the real-life situation, and the effects of the intervention evaluated (Shaoul, 1976).

A problem in accident evaluation and investigation is that it can be subject to error (England, 1981; Sheehy, 1981). A further problem is that it is almost impossible to observe actual accident-causing behaviour in real vehicles on the road, as accidents are such rare occurrences for a given individual. Consequently driving simulators have been built to assess driver behaviour and possible accident behaviour in controlled experimental environments. Because simulators allow researchers to study driver behaviour more easily than in a real vehicle, several aspects of driving have been studied by means of a simulator which could perhaps better have been done <u>in situ.</u> Examples of these aspects are emergencies (Muto & Wierwille, 1982), and abrupt onset cross-winds (Wierwille, Casali, & Repa, 1982). There are also other problems associated with using driving simulators. Firstly, simulators generally do not present a very realistic road situation. The field of vision from the cab is very narrow as it is restricted to the laboratory; if a road situation is somehow projected in front of the driver, there is very little lateral presentation. Secondly, it is not really known how closely related driving performance in simulators and real vehicles is; that is, the validity of simulated vehicles is in question. Edwards, Hahn, and Fleishman (1977) attempted to determine this relation and discovered that there was only a poor correlation between road performance and simulator performance. Blaauw (1982), however, found that simulator performance did correlate with driving a normal vehicle. Thirdly, driving in a simulator is a forced pace task, implying that subjects are driving at their maximum level of performance. An inaccurate impression may be given of subjects' abilities. This may be better or worse than the actual driving performance. Despite all the problems with simulators, the only realistic manner in which to study driver behaviour and possible behavioural antecedents of accidents may be in an experimentally controlled situation. Zimolong (1981) has attempted to observe possible antecedents of accidents, <u>in situ,</u> by looking at vehicles involved in traffic conflicts, but there are not many studies of this kind. A conflict occurs when two or more drivers wish to occupy the same road space at the same time.

Despite the fact that a number of studies suffer from weak methodology or poor research design, many of the research findings have contributed to a better understanding of driving and accident behaviour. Some of the problems with research projects may be that attempts are made to relate driving variables to remote or overly broad criteria (often accident/no accident). The relations may also be too specific; that is when attempts are made to relate discrete variables to broad criteria. A more detailed approach may be necessary to overcome these problems. A theory of driving behaviour has to be found or developed that draws together the findings of well-performed empirical research on a meaningful whole. The model will suggest which behaviour or abilities will result in accidents, violations, or safely negotiated traffic situations. An experiment to assess a specific ability or behaviour can then be conducted, or drivers observed on the road, to examine the specific relation between the ability and the behaviour related to the ability, and consequences of the behaviour.

6.2 THE ZERO-RISK MODEL

Naatanen and Summala (1974; 1976) have developed a model of drivers' decision making and behaviour. The model is a largely practical one in that the researchers suggest ways in which the accident rate can be reduced in terms of their theory, rather than simply finding correlations between individual differences and accident behaviour. They call their model the Zero-Risk model. The importance of perceptual-motor skills in this model is not denied, but driver motivations, that can influence drivers' perceptions are considered more important. The personality and cognitive aspects of driving are also incorporated into the model, but they are of a more permanent nature and do not interact dynamically with other factors in decision making on the road.

In essence the model proposes a closed-loop system, in which driver motives together with the subjective risk experienced by that driver and the expectancies based on the perception of the present situation and previous related experiences, determine the driver's current decision making.

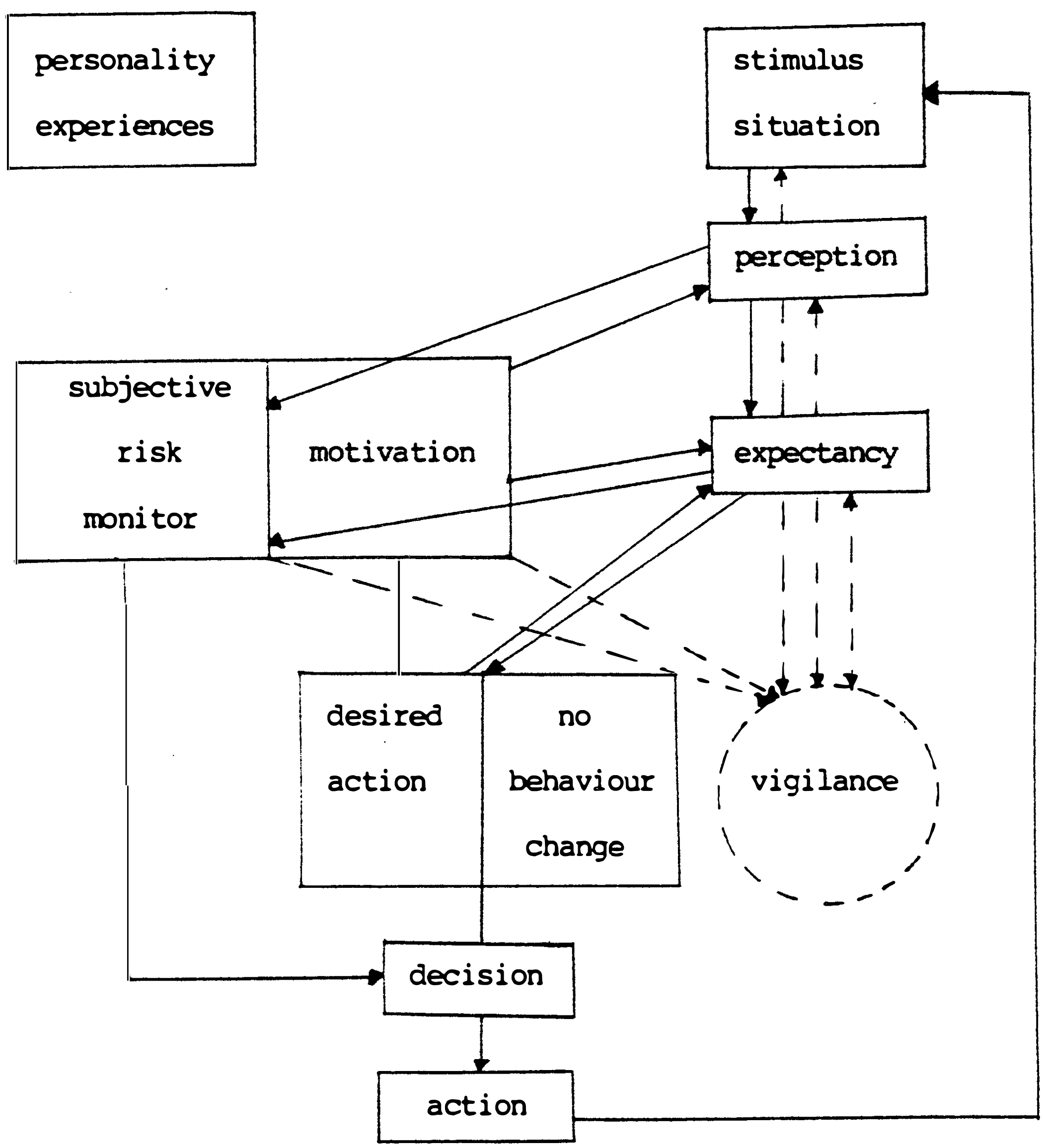


Figure 1. A flow chart relating the most important factors of drivers' decision making and behaviour in driving: Zero-Risk model.

Vigilance is considered to be a vital component of driving in this model. Vigilance is influenced by or influences most other components in this model of decision making (dashed lines). For instance the psychological and physical aspects of the stimulus inflow, "stimulus situation", "perception", and "expectancy" are partly determined by the level of vigilance, and changes in these aspects will affect the attentiveness shown by the driver. The level of vigilance must therefore be maintained at a sufficiently high level to ensure that correct decisions are made on the road.

In the Zero-Risk model subjective and objective risk are differentiated. Subjective risk is the amount of risk that drivers estimate a particular road or traffic situation contains. Objective risk is the amount of risk that, if calculated, exists in any situation or interaction between vehicles, pedestrians, and other road users on the road. The values of subjective and objective risk, if they could be quantified, are not necessarily the same for a particular situation. In fact it is when the subjective risk felt is lower than the objective risk that the probability of an accident occurring is increased. Driver motives or motivations, which have an effect on driving behaviour, can be either excitatory or inhibitory. Drivers' behaviour is seen as reflecting a balance between these excitatory and inhibitory motives.

One of the restraints represented in Figure 1 is a "subjective risk monitor". This monitor "...becomes activated and generates different degrees of risk (fear) depending on the amount and nature of risk experienced..." in current or expected traffic situations (Naatanen and Summala, 1974, p. 188). This agent is called the subjective risk monitor rather than subjective risk, as the authors maintain that the subjective risk of an accident experienced by the average road-user is minimal, and so has little effect on behaviour. This is one of three reasons which they put forward to explain the high accident rate in so many parts of the world. (The other two reasons are that the norms and values of society are in contrast to road safety, and that the "extra motives" of drivers are incompatible with road safety.) To support the theory that drivers rarely feel risk whilst driving, Naatanen and Summala mention the following four "proofs". Firstly road users continually place themselves in certain traffic situations, something which they would not do if they felt that the situation were dangerous; secondly, road users' actual driving behaviour such as leaving safety margins which are too narrow (for example following too closely) indicate a lack of subjective experience of risk; thirdly, people do not place a high priority on safety features in the vehicles they purchase, neither do they maintain them adequately; and fourthly attempts to reduce the accident rate by authorities have in large measure failed.

Colbourn (1978) suggests that the decision-making skills of drivers will affect their tendency to have accidents and that the risk drivers perceive in a traffic situation seems to determine the decisions they make about maneuvers they will or will not perform. Colbourn's study involved a computer simulated hazardous driving situation, in which subjects were required to manipulate an object through a closing gap on screen, to express an intention to stop or go through a closing gap, as well as their certainty of getting through that gap.

A much quoted study carried out by D.H. Taylor (1964) involved measuring the Galvanic Skin Response (GSR) of drivers travelling over a number of different road and traffic conditions. The GSRs of drivers, although quite variable from driver to driver, varied also with the drivers' experiences of driving in those road and traffic conditions. Taylor suggests that drivers' GSRs reflect drivers' anxiety level (subjective risk) and that they adjust their levels of risk in order to keep emotional responses constant. Naatanen and Summala (1974) indicate that GSR is not only dependent on the level of subjective risk, but can also be induced by other stimuli in the road.

N. Connell (personal communication, June, 1985) advises the use of a heart monitor rather than a GSR if a physiological activity of drivers is to be measured. Whereas the GSR is a difficult and unpredictable physiological measure to use in practice, heart rate is a reasonably reliable indicator of stress and can be measured more accurately.

6.3 RISK HOMEOSTASIS THEORY

Wilde's Risk Homeostasis Theory, (RHT), has been advanced to explain accident causation (Wilde, 1982a; 1982b). Like other homeostatic theories, RHT holds that a phenomenon (in this case the accident rate), remains constant over time due to interacting mechanisms. In other words, Wilde posits in his theory that: "...the traffic accident rate per time unit of road-user exposure is the output of a closed loop control process in which the target level of risk operates as the unique reference variable" (Wilde, 1984, p. 279). In essence the theory proposes that there is a level of risk that drivers set for themselves within which they will drive, in exchange for the benefits offered by driving. Thus it is a homeostatic mechanism which accounts for the observed accident rate and driver behaviour. The level of risk corresponds to a certain accident risk or the probability of having an accident.

In RHT the cycle of driving starts with the conditions at a certain point in time - the driver's vehicle path, the road environment, and other road users' paths. The driver then takes in information from three sources (cognitive states, motivational states, and the road and traffic conditions) and anticipates what is going to happen at some time in the future (normally a few seconds in the future). This anticipation, which may be verified in a loop back to information intake, leads the driver to estimate the accident risk, after which it is compared with the target risk level. A decision is made and the driver performs the appropriate actions. The vehicle responds and this then leads to certain other conditions at that point in time plus a few seconds.

The target level of risk is seen to be determined by four utility factors: the perceived benefits and cost of risky behaviour, and the perceived benefits and cost of cautious behaviour. It is also in part determined by drivers' motivational states. These in turn are influenced by other underlying variables. The same underlying variables influencing motivational states also influence drivers' cognitive states. These cognitive states have an effect on information intake, anticipations, and the perceived level of risk.

Risk Homeostasis Theory has come under some criticism. The theory claims that safety interventions that do not change the target level of risk in all populations will not be effective. This is because drivers will offset the safety benefits of the intervention to achieve the same level of risk tolerated before the intervention. When it is pointed out to the driving population that their chances of being seriously injured in a road accident are very high, their driving behaviour changes, for example by increased wearing of seat belts (Slovic & Fischhoff, 1982). Slovic and Fischhoff further suggest several situations in which measures to increase safety may be effective. In defense of RHT it could be argued that information on the dangers of driving increases drivers' conceptions of subjective risk. Safer road behaviour may be a homeostatic adaptation. McKenna (1985a) points out that the validity of RHT still has to be shown. A prerequisite for RHT is that people have an accurate representation of the risk of being involved in accidents. This does not always seem to be true and discrepancies exist in various situations, for example in information intake. Drivers may misperceive situations in the traffic environment, or they may not be highly skilled and therefore underestimate the danger of a traffic situation. Graham (1982) sees RHT as an application of utility theory (balancing perceived benefits and costs) to the driving situation.

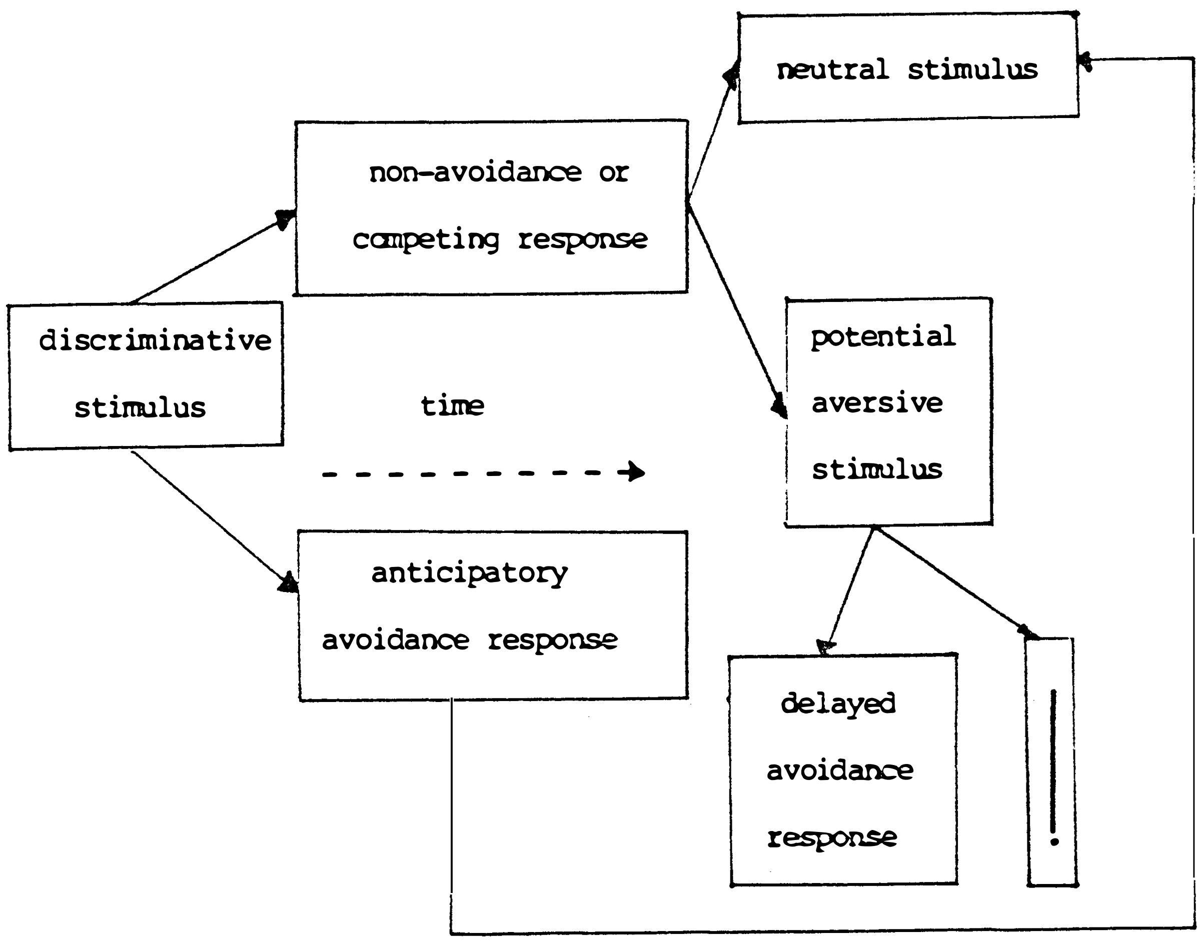
Peltzman (1975) follows a similar argument to Wilde's, by suggesting that the effects of legally mandated safety devices are almost completely negated by drivers. Peltzman has looked at accident records after vehicles were required to have safety devices installed following certain federal regulations. Peltzman states that the safety devices (seat belts and some crash protection) may save some drivers or passengers' lives, but that there will also be more pedestrian fatalities and non-fatal accidents. The implication of Peltzman's theory is that drivers feel safer in their "safer" vehicles and will therefore drive faster or more recklessly.

Robertson (1977), however, claims that there is "...no evidence to support Peltzman's contention that increased occupant protection resulted in increased hazard to pedestrians" (p. 151). Another objection to this view and Wilde's RHT is that they do not take into account the safety devices installed in vehicles that drivers are not aware of, for example shock absorbing steering columns and roll bars. Drivers, if unaware of these improvements, should theoretically not drive differently from the way they did before the new safer vehicle design or new device was introduced.

6.4 THE THREAT AVOIDANCE MODEL

Fuller (1984) performed a behavioural analysis of driving based on Wilde's Risk Homeostasis Theory and Naatanen and Summala's Zero-Risk Model. The result was a new model, known as the Threat Avoidance Model. Although this model seems to be based on the operant conditioning paradigm, there are important deviations. Fuller emphasizes the motivational aspects of driving that are not considered in the operant conditioning model of behaviour.

The model is diagrammed in Figure 2.



Note. The ! indicates an aversive result such as an accident.

Figure 2. A simple avoidance analysis

According to the threat avoidance model, when a driver is confronted by a discriminative stimulus for a potentially aversive event, his response depends on the rewards and punishments for alternative responses. Stimuli in the road acquire an aversive potential as a result of the previous interactions between the driver and the road and traffic environment. Thus driving consists of learned (or conditioned) avoidance responses. When a person drives continuous adjustments have to be made to attain the driving objective (reaching the destination) and avoiding aversive consequences (accidents and violations).

Aversive stimuli such as accidents do not have to be experienced to become aversive. The aversive experiences (high arousal) of near accidents can also become associated with avoidance responses. High arousal is often associated with negative effect (anxiety, fear, stress, panic, and tension).

Fuller distinguishes between anticipatory and delayed avoidance responses. An anticipatory response occurs before feedback of the situation can occur, whereas the delayed avoidance response takes place as a result of feedback from a potentially aversive situation. If the avoidance response is delayed for too long or if no response is made, an accident results. Fuller also distinguishes between discriminative and potentially aversive stimuli. A potentially aversive stimulus is one which may have aversive consequences if not reacted to. A discriminative stimulus is a potentially aversive stimulus which has previously been associated with a precursor to the stimulus. Thus a discriminative stimulus results in an avoidance response.

The model in Figure 2 is seen by Fuller to be too simplified to describe driver behaviour fully, and Fuller has expanded the model by including more variables. This reformulation is called the threat avoidance model, and is shown in Figure 3.

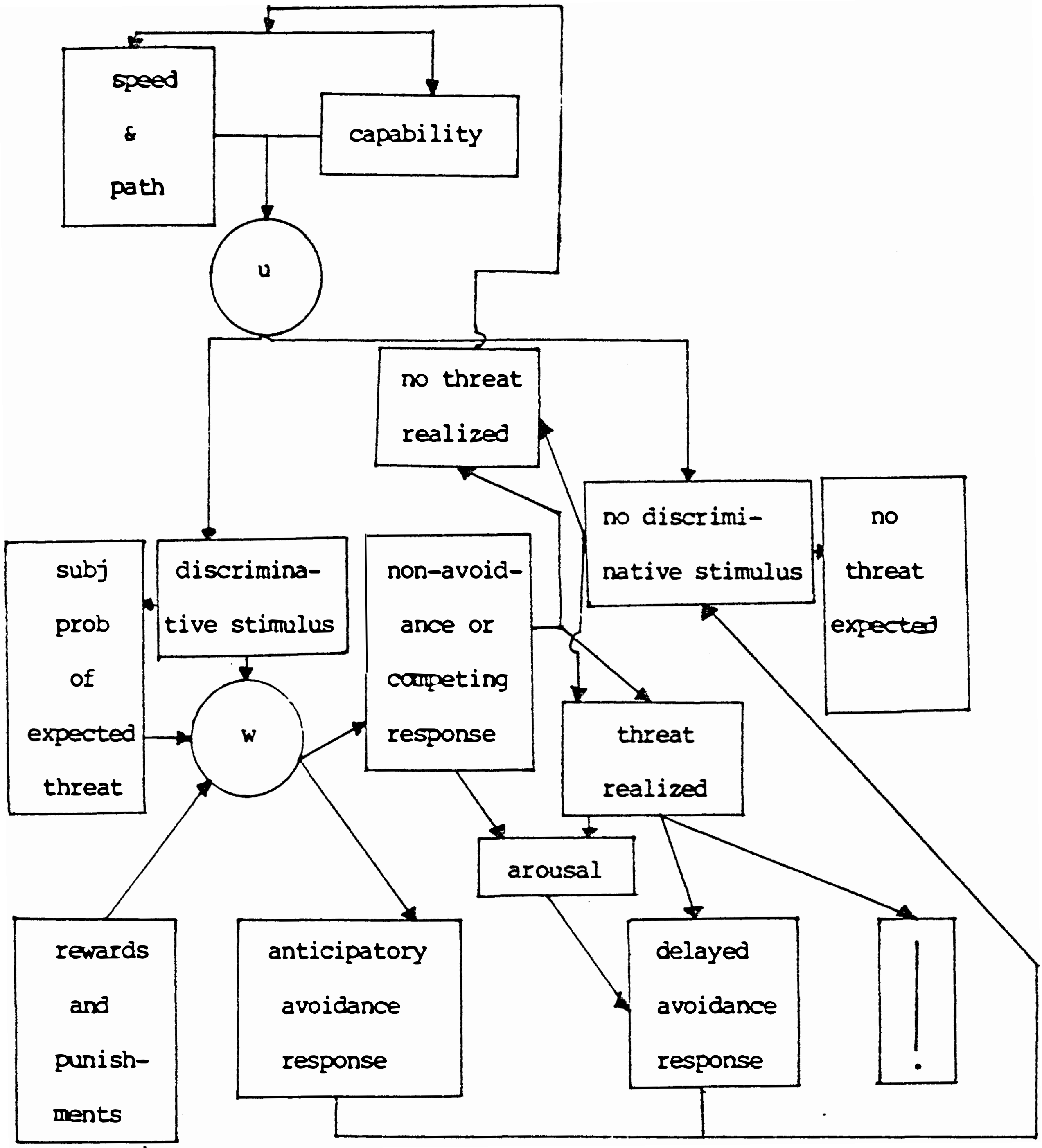


Figure 3. Threat avoidance model of driver behaviour

This extension attempts to include covert variables which may mediate between stimuli and responses. It includes abilities such as information processing and driver expectations. Competing responses are similar to Naatanen and Summala's (1974) "other motives".

Extra elements are brought into the model to explain how different influences on driving behaviour are related to each other. Fuller also describes the situation in which drivers are not confronted with a direct threat, and therefore can not predict the threat situation with certainty. Therefore an avoidance response to neutralize the threat situation cannot be made, but a partial avoidance response may.

The interaction of "speed and path" and the "capability" of the driver produces a situation "u" which may lead either to a "discriminative stimulus" or a "no discriminative stimulus". If a "discriminative stimulus" results, the actions which performed by the driver depend on the interaction, "w", between the type of discriminative stimulus or stimulus situation, the subjective probability of the threat expected in the situation, and the rewards and punishments of previous responses to the same situation. If, however, a "no discriminative situation" results, no threat is expected in the stimulus situation. This does not mean that no threat exists; the threat could be realized and avoided, or an accident may result.

This extended model is more realistic with regard to driving behaviour. It depicts driving as dynamic interacting situations. It also allows for differences in individual driver behaviour to be described, for instance in the degree of arousal that a driver may experience. Increases in arousal may prompt drivers to behave in a manner in which they would not normally behave.

6.5 THE SOCIAL ROLES MODEL

Wilde developed his theory from earlier work on social interaction patterns in driver behaviour (Wilde, 1976). Clark (1976) suggests that because car driving is performed within a social framework, social roles have an influence on driver and accident behaviour. Clark suggests this social role approach complements other theories that attempt to predict driver behaviour from personality characteristics. Research on the social influence on driving shows an age-related tendency to take risks because of peer group pressure (Clark & Prolisko, 1979). Klein (1976) suggests that accident research should operate from a social perspective, rather than from an engineering one, where individuals are seen to be involved in a large number of interacting phenomena in the environment. Examining apparently unrelated (to driving) characteristics that correlate with accidents and modifying them in some way may reduce the accident rate. Like Wilde, Klein notes that despite much research to improve the driver and the crashworthiness of vehicles, the accident rate has not dropped, but Klein attributes this to different explanations.

6.6 THE OPERANT CONDITIONING MODEL

Although there are only a few complete theories of driver behaviour, there are several formulations that attempt to describe aspects of driver and accident behaviour. These tend to be borrowed from more established psychological theories. For instance several researchers have borrowed from the operant conditioning paradigm to explain several facets of transportation. A few examples are: increasing usage of buses (Deslauriers & Everett, 1977; Everett, 1981), increasing seat belt usage (Johnson & Geller, 1984); and aspects of driving and accident behaviour (Risk, 1981).

Risk (1981) proposes a "behavioural theory" of driving and accident causation that is actually not strictly based on the operant conditioning paradigm. Risk contends that accidents occur when a configuration (an interaction between the driver, other road-users, and the road environment) arises where the driver cannot make normal adjustive responses to hazards or may not perceive hazards. Hazard, in this theory, is seen to exist to some degree in almost every configuration that the driver appears in. It is further suggested that the environmental circumstances which "cue" driver behaviour, such as steering, may not operate for behaviour such as speed control. The consequences of variations in speed are not equally as evident as variations in steering, because errors in steering will have immediate consequences for example driving off the road. Speed does not seem to the driver to be as directly related to the probability of having an accident as steering does.

To conclude Risk states that to acquire a better understanding of how accidents occur, research will have to be done on hazard perception. This research could arise from work similar to that of Older and Spicer (1976), relating to traffic conflicts. This study looked at the behaviour of drivers at certain intersections. Assessments were made on whether in a particular situation involving more than one car, a conflict was involved. Although there may be problems with the definition of conflict, the approach seems to be able to predict the locality where conflicts are likely to arise. Zimolong (1981) stresses that this approach should be validated before being used to predict accidents. The traffic conflict approach assumes that conflicts and accidents are dangerous events, and can therefore be placed on a theoretical risk continuum according to their degree of risk. But this does not take into account the risk drivers feel or the expectancy drivers have of an accident occurring.

Everett (1981) borrows more obviously than Risk from the operant conditioning paradigm. In essence Everett's study attempted to manipulate variables to increase usage of buses. People were encouraged to travel on buses more frequently by being offered coupons that could be exchanged for articles in local shops. Bus usage increased under reward conditions. The Johnson and Geller study (1984) indicated that seat belt usage increased after drivers had been rewarded when they were wearing seatbelts.

The principles of the operant conditioning paradigm could be applied to safety interventions. The method usually followed is firstly to collect baseline data on the particular behaviour under study (for example, how often people wear seatbelts), and secondly to implement the intervention procedure (for example rewarding drivers for wearing seat belts). To ascertain whether the intervention has been effective, the intervention procedure is then withdrawn for a period of time. The drivers are again observed for the presence of particular behaviour.

The intervention should be some form of positive reinforcement. A reinforcer is defined as an event which increases the probability of particular behaviour. Other principles in the paradigm could also be applied to change peoples' behaviour. Negative reinforcement for instance is defined as an event that increases the probability of a certain form of behaviour as a consequence of avoiding aversive stimuli. Punishment for exhibiting the undesirable behaviour may also be effective, although in the traffic situation, fines and other forms of punishment actually do not seem to reduce undesirable behaviour.

A criticism of this type of intervention is that its effects wear off after a short period of time (weeks or months). The intervention should try to ensure that the new safer driving behaviour becomes intrinsically reinforcing; this would maintain the new behaviour and improve the safety of driving.

7. CONCLUSION

The professional heavy vehicle driver's job is a very responsible one, irrespective of whether the vehicle driven is a bus or a truck. Therefore some care should be taken to employ the most suitable applicants for this position. Current selection procedures do not seem to select drivers adequately, as is indicated by the number and frequency of accidents in which professional drivers are involved. The abilities demanded of the professional heavy vehicle driver are varied as there are many different forms of behaviour required. The driver has to consider the safety and comfort of passengers, ensure that the load is not damaged, attend to routes, and keep to a schedule.

The driver selected therefore has to be the person who possesses the abilities and skills to be able to convey the goods or passengers from one point to another in the safest manner possible. In the selection process consideration has to be given not only to current abilities and skills, but also to the potential of the driver. For instance training is able to improve the skills of drivers, sometimes in quite a dramatic manner, therefore applicants who do not reveal good driving skills should not automatically be excluded. It is therefore important to assess abilities that may not be much affected by training. Several sources of information on the driver applicant are relevant in selection. If a driver has a "good track record" but nevertheless performs poorly on the selection criteria, a decision will have to be made as to the importance of the various sources of information.

This literature survey on driving safety covers several psychological and non-psychological abilities and characteristics that bear a relation to the driving task. The various research studies quoted have contributed to a greater understanding of the driving task and the way in which people perform this task.

Several abilities identified here as being important to driving, namely: information processing, selective attention, and risk-taking, have mostly been known to the road transport industry. Several assessments of these abilities have found their way into selection procedures in the industry, but have never been formalized in a test battery.

Investigating individual abilities and characteristics is not enough to gain a clear picture of the driver in the road and traffic environment; a broader picture is needed. The theoretical models discussed here illustrate that driving is a complex activity, with many interlinking abilities and skills required of the driver. These models indicate that driving is just part of the whole complex environment in which drivers find themselves. Driving is only part of the total behavioural repertoire of the individual. Assumptions that have always been made about the "motivations" of drivers may not necessarily be true. It has been pointed out that drivers may actually not feel any fear or perceive danger whilst they are engaged in driving. The implication, especially for heavy vehicle drivers whose exposure to traffic is much higher than that of the average driver, is that the risk of accident is misperceived and underestimated. The zero-risk model points out the need to make professional drivers aware of the unknown risks they may be taking. Another model, Risk Homeostasis Theory, suggests that drivers tolerate a certain degree of risk on the road, which in some cases can increase. This increased risk tolerance is especially dangerous in the case of professional drivers. It may be necessary to introduce measures aimed at making drivers responsible for passengers and goods more aware of the risks they are taking and the concomitant danger involved.

Certain constructs in theoretical models may have relevance in training. Aspects of driving such as decision making, threat avoidance, and perceiving possible conflict situations could be included in the training programme. This would give drivers improved or additional skills necessary to perform their job safely.

Because of the varied abilities necessary the selection procedure for professional heavy vehicle drivers should be a multidimensional one. The selection test battery should therefore include assessments of those abilities and characteristics that are relevant to the driving task. Most tests generally measure one skill only and consequently the selection should include a number of instruments so that assessments can be made of as many as possible of the skills that are important in driving.

Assessment of drivers must not include only a reference check and an assessment of the driving skills applicants display in a practical driving test, but also assessments of other abilities required in the driving tasks to be performed. In addition to the usual prescreening of applicants some additional information should be gathered from various other sources. The selection test battery should therefore include such tests which will provide the necessary information.

Selection assessments of drivers, although multi-faceted, should not take too long. Applicants may lose interest in a selection test battery if it takes too long. A compromise therefore has to be made between gathering as much relevant information as possible and obtaining the true performance potential of applicants.

It is also important for applicant drivers to feel that they are being selected accurately and fairly. Practical performance tests are mostly regarded as fair in that they seem to sample abilities and other behaviour required for the driving task. Tests that measure personality and other such pencil-and-paper tests may be seen by the driver as irrelevant to the job. Selection tests should also seem to have some relevance in driving, in other words they should have some face validity. Attention should be paid to familiarizing the subjects thoroughly with what is required of them in the tests so that they do not become flustered and perform poorly.

The assessments and abilities or characteristics identified above could be included in a selection test battery. The following is a list of recommended assessments to include in the driver selection battery.

Prescreening:

* A reference check or a check on the applicant's work history, especially driving employment, and accidents and violations incurred.

* An application form which is more or less standard in existing selection procedures. This would need slight modifications to transform it into a biographical inventory.

* A vision and medical examination should also be included for legal and health reasons.

Testing:

* Applicants should be given a practical driving test to assess the basic and potential driving ability.

* A low-level cognitive measure such as the Industrial Test Battery if training is to be given.

* A knowledge test which should include various situations that are required of the particular job applied for.

* An information processing test as the driver must have some ability to process information quickly.

* A selective attention test to assess the ability to attend to the task, while being aware of other important events in the driving environment.

* A risk-taking test to identify those applicants with a tendency to take risks.

Physiological measures of drivers may aid the selection process if used while they are driving. The literature indicates that physiological processes such as heart rate or galvanic skin response correlate with certain risk aspects of driving. Physiological processes are, unfortunately, difficult to measure accurately. The administrators of tests in transport organizations are highly unlikely to have the training to administer measures of physiological processes and to interpret the scores.

Difficulties may also occur in personality assessments as well, as these are C-level tests that may be used only by a psychologist.

Computer testing is becoming a quick and useful way to assess applicants for employment. The applicants can be tested in a short time, the performance on tests can also be scored by the computer and presented in a fashion which facilitates evaluation by the administrator. The computer may also provide a testing situation which is more face valid than assessment by means of paper-and-pencil tests. The computer can be used to present dynamic tasks that share certain characteristics with tasks required of the driver on the road. It is for these reasons that it is recommended that a driver selection battery be administered through the use of a computer. The report on this project will indicate which tests are particularly suitable for computerization

To select better quality drivers transport organizations must be prepared to put safety rather than economic considerations first. Some investment in selecting and training drivers will have to be made, but this will be rewarded by producing superior drivers and experiencing fewer accidents. Safety of drivers, passengers, goods and other road users should be the primary consideration for any transport operator.

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Regional offices

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Tel. (031) 31-6926 Teleks 6-28567 SA

NIPN Natal, Posbus 17001, Congella 4013
Tel. (031) 815851 Teleks 6-22431 SA

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