

THE IMPACT OF AN INADEQUATE ROAD ENVIRONMENT ON THE SAFETY OF NON-MOTORISED ROAD USERS

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ABSTRACT

In South Africa, as is the case in most other developing countries, a significant proportion of the population walk or cycle on a daily basis to their places of work and to other destinations. Road accident casualties (fatalities and injuries) among these vulnerable road users (VRUs) have always been high and in 2004, they constituted about 41%, i.e. 5 309 of the 12 727 road fatalities on South African roads. Non-motorised road users (NMRUs) comprise a variety of road users, mostly pedestrians or cyclists. The objective of this chapter is to highlight the research findings and those strategies and guidelines (which have been developed regarding the road environment) that should be addressed in order to improve the challenges that NMRUs have to face on a daily basis. The chapter also lists the human requirements that would ensure that people used safe facilities. Issues within the road environment that contribute to casualties among NMRUs are highlighted. These include the lack of a holistic approach to network planning; the inadequate and inconsistent provision of non-motorised transport infrastructure; poor integration of transportation and land-use planning; as well as the inadequacy of public transport planning aimed at reducing risk and exposure. Furthermore, strategies/countermeasures are discussed to promote the safety of VRUs. These include the strategies, policies, work plans and practices of government departments such as the Department of Transport (DoT) and the Department of Provincial and Local Government (DoPLG). The chapter concludes with the major shortfalls still being experienced in improving the road environment for NMRUs and also lists the areas that need to be researched. The development of proper guidelines for the provision of safe facilities for rural pedestrians and cyclists is one of the major areas that need to be researched.

Key-words: vulnerable road users; pedestrians, road environment

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INTRODUCTION

In South Africa, a significant proportion of the population walk or cycle to their places of work and to other destinations on a daily basis. In 2003, the DoT conducted a National Travel Survey (DoT 2003). This survey showed that 2 259 million or 23.0% of the workforce indicated that they walk to their working place. This figure can be differentiated by area: metropolitan - 8.7%, urban - 24% and rural - 51.8%.

Road accident casualties (fatalities and injuries) among VRUs have always been high and are a matter of grave concern for road authorities. In the early eighties, pedestrians comprised about 48% of all road fatalities, and although the figure has gradually declined over the years, by the year 2004 pedestrians still comprised about 41% of all road fatalities, i.e. 5 309 of the 12 727 road fatalities on South African roads. Table 1 shows statistics by user group fatalities released by the Road Traffic Management Corporation (RTMC 2005).

Table 1: User group fatalities in South Africa: 2003-2004

Year	User group fatalities									
	Driver		Passenger		Pedestrian		Cyclist		Total	
	n	%	n	%	n	%	n	%	n	%
2003	3 349	27,1	3 691	29,9	5 313	43,0	358	2,9	12 354	100
2004	3 351	26,3	4 066	31,9	5 309	41,8	350	2,8	12 727	100

(Source: RTMC, 2005, p.11)

However, the pedestrian statistics in the metropolitan areas are even more cause for concern as shown in Table 2 reflecting data from the eThekweni Transport Authority (2004). Unfortunately cyclist data were not available from this source.

Table 2: User group fatalities in eThekweni: 2003

Year	User group fatalities							
	Driver		Passenger		Pedestrian		Total	
	n	%	n	%	n	%	n	%
2003	134	18.1	157	21.2	451	60.8	742	100

(Source: eThekweni Transport Authority 2004)

Since the mid-nineties, there has also been a growing awareness in South African government circles that the needs of the VRU group, especially the NMRU group, i.e. pedestrians and cyclists, should be catered for. This has started to filter through the policies and strategies initiated by government departments both on the national and provincial levels. Concepts such as “safer pedestrians”, *Shova Kalula* (“Ride Easy”) and “non-motorised



transport” (NMT) have emerged. This drive implied that the needs of NMRUs would be addressed more holistically. A multitude of interventions evolved from this process, including the increased restriction of vehicle speed and alcohol abuse; the attempted improvement of road user behaviour; and the improvement of the physical environment for NMRUs alongside roads or when crossing roads.

NMRUs comprise a variety of users, ranging from child and adult pedestrians and cyclists; disabled and elderly pedestrians; people pushing wheelbarrows or pulling hand-drawn carts, both in urban and rural areas, to transport sick people or to collect firewood, water, and other commodities such as scrap metal, glass, cardboard, and building material. Animal-drawn vehicles also fall within this category, but are not specifically dealt with in this chapter. The wide spectrum of NMRUs implies that a comprehensive plan needs to be devised and implemented to accommodate each user type.

OBJECTIVE AND RATIONALE

The objective of this chapter is to highlight the research findings and those strategies and guidelines (which have been developed regarding the road environment) that should be addressed in order to improve the challenges that NMRUs have to face on a daily basis. The current shortcomings are discussed, focussing specifically on previously disadvantaged areas and other areas that need urgent attention. Remedial measures that must be implemented to correct these shortcomings are discussed. The data used in this article have been retrieved from empirical research studies conducted by the authors and other researchers in South Africa as well as from a literature review of government policies and strategies. The rationale of this chapter is to draw attention to the major disadvantages that NMT in South Africa still experiences when compared to motorised transport.

THE ROAD ENVIRONMENT CONTEXT

The road environment in South Africa, apart from a few pockets of excellence, generally does not provide a safe environment for VRUs. This is a common problem throughout Africa. In 2000, the Expert Group on Low-Cost Mobility in African Cities (IHE/World Bank 2000) concluded that in general it is impossible to cycle in big cities in Africa without taking a severe accident risk. They recommended that in order to make cycling safe in these cities, firstly, large-scale traffic calming programmes were required, and secondly, there would need to be large-scale improvement of access roads and tracks to meet NMT standards. Although some South African cities would comply with the first requirement, very few would meet the second one.

In South Africa, those townships developed prior to the mid-nineties adjacent to cities and towns, were considered as dormitory areas and in most areas only limited paved road infrastructure was provided. Despite recent upgrading in many municipal areas, many of these townships still lack proper road and pedestrian infrastructure; street lighting is poor; road storm-water drainage systems are lacking or substandard; there are inadequate open spaces, etc. During the rainy season, the poor drainage and lack of paved footways pose major problems to pedestrians. The lack of proper street lighting also presents major road safety and security problems for commuters who leave home early in the morning or arrive home late at night.

The influx of many rural residents to the bigger towns and cities has led to the establishment of various formal and informal settlements, especially next to or close to the road network in order to gain easy access to transport. In many of these areas no amenities exist for NMT. In a study along a 22 km stretch of the Golden Highway P73/1, De Beer (2002) found that the densely populated residential areas on either side of the Golden Highway generated large volumes of pedestrians throughout the day, both crossing and walking alongside the road. There were also a lot of pedestrians going to and from the schools located opposite the informal settlements, and also within the formal townships, at certain times of the day.

Pedestrians crossed the Golden Highway along the entire length of the section due to the lack of channelisation. Twenty-seven access roads have been provided over this 22 km section of the Golden Highway and three of these are stop sign controlled intersections. However, no provision has been made for pedestrian facilities at any of these intersections. Furthermore, because no paved sidewalks leading to the taxi bays have been provided, taxis stop anywhere alongside the road. Street lighting was also absent. Recently, the road authorities in Gauteng have embarked upon a community-based project to provide sidewalks along the Golden Highway.

In a similar study of Edendale Road in Msunduzi Metro in KwaZulu-Natal, commissioned by the KwaZulu-Natal Department of Transport, the University of Natal Interdisciplinary Accident Research Centre (UNIARC) found many problems (Riyad & Myeza 2002). In respect of pedestrian safety the following issues were pertinent:

- poor maintenance of the road as characterised by traffic signs, poor visibility and road markings and lack of fencing along Edendale Road to prevent stray animals from wandering on the road, both of which put pedestrians at risk from drivers taking evasive action
- structural problems associated with the Edendale Hospital pedestrian bridge



- lack of pedestrian sidewalks
- lack of visible traffic law enforcement in the area leading to perceived reckless driving, e.g. excessive speeding (especially by taxis), drinking and driving and ignoring traffic lights
- erratic use of pedestrian access ways such as the Edendale Hospital bridge, pedestrian crossings and traffic lights
- need for more road safety campaigns emphasising road-crossing skills for children and adults.

Recent studies conducted by the Council for Scientific and Industrial Research (CSIR) for the Limpopo Department of Roads and Transport (Ribbens & Makhafola 2004), showed that similar road safety problems were experienced in rural areas. This was especially so where major routes run through villages, dividing them into two. People, including school children, have to cross these roads to go to work, shops, schools, recreational facilities and the like. Although speed limits of 60 or 80 km/h are normally introduced, drivers do not adhere to these limits. A typical problem found in many urban areas and rural villages throughout South Africa is that the necessary signage and facilities for NMRUs have either not been provided, or are not properly maintained in accordance with the guidelines contained in the *SA and SADC Road Traffic Sign Manual (RTSM)* (SADC 1997) and the *Pedestrian and Bicycle Facility Guidelines Manual (PBFGM)* (DoT 2003b).

Although this chapter focuses on the deficiencies in the road environment, it would be appropriate to look briefly at road users and their requirements for a safe road environment. Jaywalking, alcohol abuse by drivers and pedestrians, speeding by motorists, not giving way to pedestrians, and lack of visibility are but a few of the human factors contributing to casualties among NMRTUs. These psycho-sociological issues were dealt with in the UNIARC study published in 2004 (Van Schalkwyk & Naidoo 2004). This study concluded that VRUs are unlikely to, (and cannot really be expected to), comply with road safety rules until the road system takes their basic needs for walking or cycling into account. The more important needs of pedestrians and cyclists that are acknowledged in the *PBFGM* (DoT 2003b) are:

- secure facilities free from criminal elements and safety hazards such as slippery surfaces
- protection from traffic, accessibility of facilities to all users
- convenience in the sense of a fast direct route
- comfortable gradients, and an attractive environment.

ENVIRONMENTAL AND ENGINEERING CONTRIBUTORS TO VRU RISK

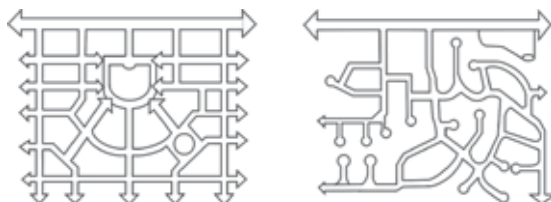
Many factors within the road environment contribute to increased risk and exposure of NMT. Factors within the planning and design frameworks which contribute to the problem include the lack of a holistic approach to network planning; the inadequate and inconsistent provision of non-motorised infrastructure; poor integration of transportation and land-use planning; and the inadequacy of public transport planning to reduce risk and exposure. These issues are discussed in more detail below.

LACK OF A HOLISTIC APPROACH TO NETWORK PLANNING (AND POOR CONNECTIVITY BETWEEN DESTINATIONS)

The *PBFGM* (DoT 2003b) states that, ideally, a pedestrian and bicycle network should be (re)developed in cities and towns to provide a high level of connectivity between origins and destinations, and to overcome barriers to walking and cycling. The ideal is to provide a complete system of interconnected pedestrian and bicycle ways between all locations in the network visited by pedestrian and cyclists. Furthermore, separating pedestrians, cyclists and traffic can reduce exposure, the ideal being to provide separate pathways for each.

“Open” and “closed” networks

The process of connectivity can be achieved by applying a number of planning principles of which the concepts of “open” and “closed” networks, horizontal and vertical separation, and the integration of non-motorised and motorised traffic are the most important. Connectivity for pedestrians and cyclists can be achieved when an open network is provided in contrast to the closed network (DoT 2003b). Examples are shown in Figure 1. The main difference between the open and closed networks is that the open network allows traffic movement in as many directions as possible, while such movements are restricted in the closed network. The open network allows traffic to disperse to a number of local streets, in contrast to the closed network which focuses traffic onto a restricted number of high order roads and discourages traffic from using low order streets.



(Source: Pedestrian and Bicycle Facility Guidelines Manual 2003)

Figure 1: *Open and closed networks*



Both open and closed networks have advantages and disadvantages.

The open network encourages community access and provides greater accessibility for pedestrians and cyclists, while the closed network has the advantage of discouraging extraneous through traffic from using the local street system. This is particularly important in residential areas where it is necessary to preserve the residential quality of the areas, and to protect the safety of residents by reducing conflicts between pedestrians and vehicles. This concept, however, places limitations on the movement patterns of pedestrians and cyclists.

An example of a system which combines the advantages of both the open and closed networks is shown in Figure 2. In this system, linkages are provided for the exclusive use of pedestrians and cyclists. Community access is encouraged, while restricting vehicular access ensures the residential quality of the area.

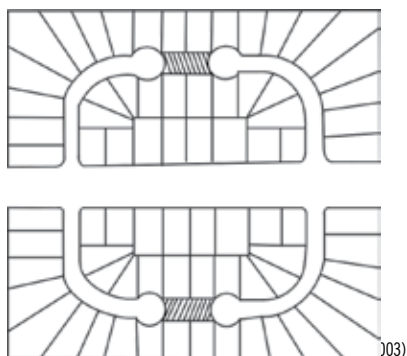


Figure 2: “Compromise” network with pedestrian/bicycle linkages

In most cities and towns with the more traditional grid open layouts, there are no proper pedestrian and bicycle networks in existence. Some do have a few network segments, but this seldom provides complete connectivity. Consequently, the pedestrian or cyclist is exposed to traffic in many ways when crossing roads and moving alongside roads.

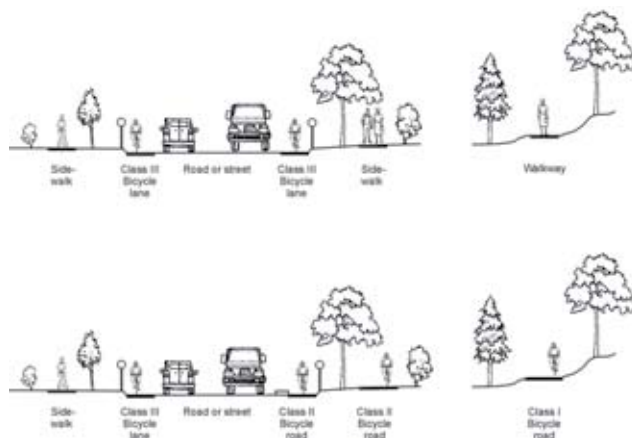
More recently, the emerging security village phenomenon where public open spaces are closed by means of palisade fencing due to increased criminal activity, has threatened the principle of connectivity. Many of these potential linkages for NMRUs have been closed off by means of fences and security gates. Park strips that normally would have provided short convenient routes

to destinations are no longer available. Pedestrians and cyclists have had to revert to the road network where safe facilities in the form of sidewalks or bicycle ways do not always exist. It should be noted that the general aim of these closures is to reduce the degree of connectivity favouring criminal activity and escape routes. However, the degree of usage is also an important factor here as pedestrians and cyclists are likely to avoid under-utilised facilities and parks for fear of falling victim to criminals. Although the traffic calming measures adopted for Durban's beachfront area some years ago initially severely curtailed connectivity for motorised vehicles, these connections were to a large extent reinstated, to enhance the security of the non-motorised sectors.

“Horizontal” and “vertical” separation

The concept of “horizontal” and “vertical” separation of pedestrians and cyclists from road traffic can be achieved either by separating these modes within the road reserve or by providing walkways and bicycle paths away from the road reserve through open spaces and parks as practised in some Asian countries (Krishna 2002). Figure 3 illustrates the different options that could be applied in South Africa.

Within the road reserve, separate sidewalks for pedestrians should be provided. Class 2 bicycle lanes on the roadway may be provided to separate the cyclists by means of a physical barrier from road traffic, whereas Class 3 bicycle lanes are located on the roadway with no barriers between road traffic and cyclists. Alternatively, a pedestrian walkway or a Class 1 bicycle road could be provided through open spaces or park strips.



(Source: Pedestrian and Bicycle Facility Guidelines Manual 2003)

Figure 3: Pedestrian and bicycle ways



The idea of the horizontal and vertical separation of non-motorised and motorised traffic has been established through the “new towns” concept developed in the United Kingdom. Ideally, these townships provided a completely separate network of pedestrian and bicycle facilities away from the road network with horizontal separation, e.g. footbridges and subways, where these facilities intersected the road network. Only a few of these holistically planned non-motorised networks exist in South Africa, e.g. Sasolburg, Secunda, Richards Bay, Atlantis, and the initial suburbs of Phoenix north of Durban (the concept was to a large extent abandoned in Phoenix due to security problems as long ago as the 1980s). It appears that adaptations to the principles used internationally are required for local conditions. Other cities and towns, e.g. Cape Town, have developed master plans to cater for the needs of cyclists.

Pedestrian malls are another form of horizontal separation between traffic and pedestrians normally associated with commercial and business centres. There are different types of pedestrian malls, e.g. modified streets, transit malls, interrupted or continuous malls, off-street sidewalk grids, multi-level malls, etc. Many of these have been used successfully in South African cities and towns.

Non-motorised and motorised traffic integration

The concept of integrating non-motorised and motorised traffic was initially developed in The Netherlands through the “woonerf” concept and later “Verkehrsberühigen” in Germany. The idea was to create a residential precinct allowing vehicles to share the road with pedestrians and cyclists under certain conditions. Apart from a general speed limit of 30 km/h, various design measures, generally referred to as traffic calming measures, were introduced to restrict the speed of vehicles in these precincts. The measures include speed humps, raised crosswalks, mini circles, chicanes, chokers and different forms of road closures at intersections (diagonal, partial, one or more legs of the intersection), and mid-block road closures.

In South Africa, as in countries such as Australia, the United States, and Canada, cities have developed more horizontally than in Europe with resultant urban sprawl. Traffic calming has proved to be effective in these countries, but applied in a different context compared to Europe. Traffic calming measures are often aimed at making an area (such as a residential area) safer for pedestrians and cyclists, and particularly for children. However, these measures do not have to be restricted to residential areas only, but can also be applied in any location where there is a high



concentration of pedestrians and cyclists, such as schools, commercial and industrial areas, sports grounds, and public transport terminals. In this respect eThekweni Metro has recently adopted a policy of providing speed humps at all school entrances.

The *PBFGM* (DoT 2003b) indicates that traffic calming is aimed at addressing two specific types of problems experienced on roads and streets, namely traffic intrusion and speeding. The *PBFGM* also recommends different types of treatment to address these problems, and it is important that the problem should be identified correctly before the appropriate treatment is selected. For cost effectiveness and holistic safety very careful planning and consideration of calming measures for each specific individual location is required. “Templates” of a “one size fits all” design should be avoided.

Traffic intrusion is being experienced on many urban streets and roads in ever-increasing volumes due to the growth of urban areas. This problem is often caused by an inadequate major road network that is incapable of handling traffic. The result is that traffic takes “short cuts” through residential areas, resulting in so-called “traffic intrusion”. This results in high volumes of traffic on roads and is often associated with a poor quality of life. In a study of the impact of traffic on liveability, Appleyard (1981) found that people living on streets with high volumes of traffic had fewer friends and acquaintances, and a low level of pride, sense of ownership and sense of place. Increased traffic causes people to retreat into buildings and their homes, thus abandoning the public space. This often results in a deteriorating environment in which vandalism and criminal activity increase and people who were neighbours now merely live in adjoining houses and buildings.

Speeding is another problem that is often experienced on residential streets. Many of the older residential areas were designed on a grid pattern, resulting in long straight streets that are an open invitation for drivers to speed. Traffic calming can be very effective in addressing speeding problems, although most measures are only effective at a point along the road or street, and must be repeated to be effective over a long stretch of road. Drivers often become irritated when they perceive that there are an excessive number of calming measures and care is required to ensure that the problem is not exacerbated by drivers detouring to take even less suitable routes.



Lack of pedestrian/bicycle infrastructure and the proper maintenance thereof

Although there has been an improvement in the provision of pedestrian facilities in South Africa over the last few decades, there are still many places where the pedestrian and bicycle infrastructure could be considered as insufficient. This includes the previously disadvantaged areas in urban and rural areas as well as the more recently established formal and informal settlements.

Although road safety problems occur in informal settlements as well as formalised townships, greater safety problems are experienced in informal settlements due to the lack of infrastructure and particularly pedestrian facilities. Such settlements often develop adjacent to major roads in order to gain access to transport, and in some cases, informal housing encroaches onto road reserves.

Although transportation facilities have been provided in some townships, many of these facilities have not been properly maintained or have been neglected due to limited budgets. This applies especially to pedestrian facilities such as sidewalks and pedestrian crossings. In many townships pedestrian facilities are completely lacking. In a study of Maunde Street, one of the main arterials in Atteridgeville, commissioned by the City of Tshwane to improve pedestrian safety along this route, De Beer (2000) reported that a number of pedestrian facilities were required, including:

- additional raised pedestrian crossings
- pedestrian walkways
- improved road markings and street lighting
- vertical kerbs at intersections to prevent minibus taxis from cutting corners
- paving for pedestrians at intersections
- taxi bays as well as additional taxi bays where required.

Similarly, a study of Edendale Road in Msunduzi Metro (Riyad & Myeza 2002) recommended that:

- vehicle speeds be reduced by introducing calming measures at schools and busy intersections
- law enforcement be improved with increased visibility of enforcement during peak hours
- road safety campaigns be targeted to provide a co-ordinated multi-disciplinary approach to road safety
- vegetation be maintained and cleared, especially on sidewalks
- a longer barrier be erected to prevent pedestrians crossing at grade



instead of over the bridge provided

- signage be improved and updated
- research be conducted into changing the behaviour of VRUs such as pedestrians.

Various common problems, which have a negative impact on road safety, are experienced in informal settlements and townships (DoT 2003b), including:

- hawkers in the road reserves which block pedestrian sidewalks
- small businesses which operate on the sidewalk such as car maintenance, telephone booths, etc.
- shacks/houses built up to the edge of the road
- minibus taxis which use the sidewalk as stops, ranking areas and even repair and washing bays
- boulders placed on the walkway to protect properties against traffic
- lack of drainage, or poorly maintained drainage systems, force pedestrians onto the roadway during the rainy season. Regular maintenance of such drainage systems would improve the plight of pedestrians walking alongside roads especially during inclement weather conditions
- non-existent or poorly maintained street lighting, which is a very important amenity for pedestrians who often leave early in the mornings or arrive home late in the evenings. A major proportion of pedestrian casualties in South Africa are recorded during the hours of darkness.

The forthcoming 2010 FIFA World Cup will provide an important incentive for NMT infrastructure in the cities and towns where qualifying matches will be played (DoT 2005). The Towards a 2010 Transport Action Agenda (DoT 2005) lists the non-motorised project opportunities for cities and towns that will assist in the acceleration of implementation and delivery, e.g. Johannesburg, City of Cape Town, eThekweni, Nelson Mandela Metro, Mangaung, Rustenburg, Polokwane, Kimberley/Sol Plaatjies Municipality, Tshwane Metro, Mbombela/Nelspruit and Orkney/Klerksdorp.

Inadequate integration of land-use and transport planning with regard to NMT

In South African cities, examples illustrating the inadequate integration of land-use and transport planning abound. This deficiency is reflected in permitting housing areas for the poor, or squatters, to be established next to freeways and other high volume roads, and positioning pedestrian generators (shops, schools, industrial areas, sport stadiums, etc.) next to major roads. Inevitably these developments lead to people crossing those roads at grade to access transport, and to go to work, school or the shops.



In a study conducted in 2000, Johnson, Davidson & De Beer (2000) identified 19 sites on national and provincial sites in Gauteng that could be considered as hazardous pedestrian locations. The study showed that some of the major issues related to these problem sites being located next to major roads were: schools (26%), high activity zones such as commercial areas (21%), squatter and low income areas (42%), and industrial areas (16%). Therefore, safe crossing facilities, such as footbridges with proper barriers to channel people to them, must be provided initially and not only after many people have been killed crossing high speed roads.

Such footbridges, unless properly designed, may actually prove disadvantageous to the 30% of the population that includes the sick, pregnant women, physically disabled, and aged and even those with a fear of heights. Thus, they must have appropriate ramps, smooth ground level access and hand railings. Mohan (2005) has argued that: "We will never eliminate carelessness, absentmindedness and even neglect in day-to-day activities, but by designing products and environment to be more tolerant of these normal variations in human performance, we can minimise the number of resulting crashes and injuries" (p. 35). It is only when society learns to put people before technology, that they will have learnt compassion and only through compassion that we can heal our prejudices (Noah 2004).

There are a number of good practice examples where the South African Roads Agency Limited (SANRAL) and other road authorities have provided footbridges and barrier walls to prevent pedestrians from adjacent settlements from crossing freeways at grade, e.g. the R300 and N2 freeways in Western Cape, the N1 freeway at Hammanskraal in Gauteng, the N4 freeway in and near Witbank in Mpumalanga, and Edwin Swales VC Drive and South Coast Road in KwaZulu-Natal.

Currently, the Integrated Development Planning (IDP) plans of most of the municipalities have yet to cover road safety issues and therefore the needs of VRUs have not been addressed. Hopefully, more emphasis will be placed on the integration of land-use and transport planning through the IDP process (in terms of the Municipal Structures Act, Act No. 23 of 2001) and the Integrated Transport Planning (ITP) process (in terms of the National Land Transport Transition Act, Act No. 22 of 2000).

The national and provincial departments of education can also play a significant role in this process as many schools have yet to be provided in the previously disadvantaged areas through the new schools provision programme.



When planning the location of school sites, due consideration should be given to the fact that these sites should preferably be located away from major roads. Liaison with responsible authorities should also take place on adjacent road design in order to ensure the provision of safe taxi and bus bays off the main route.

Inadequate public transport planning for unnecessary exposure and risk to VRUs

A number of problems have been identified at public transport facilities that contribute to the unnecessary exposure and risk of pedestrians. The *PBFGM* (DoT 2003b) highlights some of these issues. Typical problems include the offloading of passengers on major routes and the inadequate planning of facilities at public transport termini, bus and taxi stops, etc.

In many cases public transport is not routed into informal settlements and townships, thus creating the problem of passengers being loaded and off-loaded along major roads and freeways. In a study conducted on the R59 freeway, De Beer and Davison (2002) found that motor vehicle access to the service roads parallel to the freeway had been gained by removing sections of the fence. Vehicles thus stopped under freeway bridges to offload passengers, who then crossed the freeway or made their way up the embankments of interchanges. Footpaths were often seen leading from the bridge parapets down to the road shoulder under the bridges. In many other areas taxi drivers loaded or off-loaded passengers at the entrances to the main roads and returned for another load of passengers during peak hours, e.g. the R550 at Oliivenhoutbosch. A good example of integrated planning is to be found at the Nseleni Interchange near Richards Bay where a major road crosses the N2 and commuters are involved in changing taxis. In an innovative design for SANRAL, four taxi bays on route MR 231 and two on the N2 are linked by surfaced walkways and stairs.

Very high concentrations of pedestrians are often found in public transport facilities such as railway stations, bus termini and mini-bus ranks. Such concentrations typically occur in the early morning and late afternoon peak periods. Accidents tend to occur at these locations due to factors such as pedestrians running across the road to catch a bus or train. The *PBFGM* (DoT 2003b) recommends that at public transport termini and stations, sufficient and proper pedestrian facilities be provided. Due to the large volumes of pedestrians using these facilities, it is not sufficient to provide minimum designs. Wider than minimum sidewalks are typically required, while pedestrian crossings must be provided where needed. Particular attention should also be given to the provision of pedestrian refuge islands



and traffic calming measures. The *PBFGM* (2003b) also recommends that in the planning of pedestrian facilities at public transport termini and stations, it is imperative that pedestrian desire lines need to be studied in order to determine the needs of commuters. Such desire lines can be established by means of pedestrian counts or by aerial photographs.

Pedestrian crossing facilities are also often required near or adjacent to bus and mini-bus stops. The *SA and SADC RTSM* (SADC 1997) prescribes the road signs and markings required to accommodate such facilities. Pedestrian accidents at bus stops often occur because of pedestrians stepping out from behind or in front of the bus and moving directly into the path of an oncoming vehicle. This problem can be addressed by providing space for the bus to move well clear of the travelled way by painting or constructing an island between the bus lay-by and the roadway.

SECTORAL RESPONSES TO PROMOTE THE SAFETY OF VRUS

The improvement of the road environment for NMRUs depends on the co-operation of all key stakeholders. The major governmental role-players would be the DoT (and its agencies), the DoPLG, provincial and municipal road authorities. All these and the private sector should work together to refine injury prevention practices to promote safe usage of the road by VRUs especially NMRUs. The role that each of these governmental stakeholders play or should be playing will be briefly highlighted.

THE DEPARTMENT OF TRANSPORT, ITS AGENCIES AND COMMUNITIES

The DoT has taken the lead in initiating a programme for the improvement of pedestrian safety through its *Road to Safety Strategy, 2001-2005* (DoT 2001a). One of the four pillars of this programme is focussing on “safer pedestrians”. Two specific actions are contained in the Strategy to achieve this outcome, i.e. the Arrive Alive campaign and the National Pedestrian Action Plan. Both these actions are aimed at identifying hazardous pedestrian locations and improving the road environment. The Arrive Alive campaigns are intended to improve the 10 worst hazardous pedestrian locations in each province.

The *National Pedestrian Action Plan* (DoT 2002a) identified 356 hazardous pedestrian locations countrywide. The main conclusion of this analysis was that an amount of R520m - phased over a five-year period - would be required for the implementation of countermeasures at the 356 hazardous pedestrian locations identified in this business plan. The major engineering shortcomings were: lack of crossing facilities (at 164 sites); lack of roadside

facilities (at 118 sites); lack of street lighting (at 118 sites); and poor geometric design (at 77 sites). Other main findings were that more than half (53%) of the hazardous pedestrian locations were situated in metropolitan/local areas on arterial and collector roads. Another one third (35%) were located on provincial roads, especially arterials, many of which traversed formal and informal settlements. Altogether 43 sites were identified on national roads of which 25 were on freeways (dual carriageway roads). Almost half (48%) of *all* the hazardous pedestrian locations were situated on arterial roads.

Various manuals published by or with the DoT including the *PBFGM*, the *South African Road Safety Manual (SARSM)* (DoT 1999) and the *SA and SADC RTSM* (SADC 1997) contain standards and guidelines for improving the road environment for pedestrians and cyclists. Since the more general application of these manuals would significantly improve the situation, their role will be briefly highlighted. The *PBFGM* (DoT 2003b) covers a wide spectrum of engineering guidelines that could be employed to improve the road environment. The *SARSM* (DoT 1999) consists of seven volumes, which provide road authorities with tools to evaluate traffic operations and assess the road safety aspects of their road network, including the needs of VRUs. The *SA and SADC RTSM* (SADC 1997) covers all the road signage and markings required to provide safe road infrastructure, including those for pedestrians and cyclists.

The *Shova Kalula* Bicycle Programme (DoT 2001b) is part of the process to improve rural mobility. It is aimed at two target groups: first, the young - particularly the estimated 350 000 secondary school students and 445 000 primary school students who currently walk more than 3 km to school; and second, the estimated 573 000 urban workers and 472 000 rural workers who currently walk for more than 20 minutes daily to get to work.

A study by UNIARC (Mpanza 2002) aimed at developing a coherent strategy for the *Shova Kalula* Bicycle Programme covered three rural villages in KwaZulu-Natal. The study revealed that the programme was well received although possible cultural inhibitions relating to women and girls riding bicycles were indicated. Of the cyclists surveyed 89% used bicycles for commuting to school, 14% to work and 5% for recreation. One of the main issues relating to the infrastructure and safety of cyclists was the need for targeted road safety education. This is vital for the correct use of available infrastructure as internationally, Mohan (2005) has found that two thirds of cyclists killed and injured in accidents involving cars have violated a law or safety rule. Furthermore, the percentage of crashes is greatest in



the 12 and under age group. It would seem that topography played a part in that although the flat terrain around Mbazwane is ideal for cycling, it is also problematic in that heavy vehicles maintain high speeds and the high and low pressures they create endanger cyclists. The major issues relating to infrastructure in areas of gravel roads relate to: potholes which cause vehicles and cyclists to deviate from the left-hand side of the road; dust which reduces visibility and obscures cyclists; and the presence of the gravel “windrow” at the edge of the carriageway which makes riding hazardous.

Thus, one of the major problems that has yet to be resolved regarding the *Shova Kalula* Bicycle Programme is where the children who are the main supporters of the programme must ride when they go to school. Currently, there are only limited planning guidelines in South Africa to address this problem on rural roads and further research is required. In addition, in many of the areas (Izinqoleni, Bakenberg, Witpoort, etc.) theft of cycles is a problem, hence secure “parking facilities” must be considered in design. The schools must obviously be the focal point of any cycle infrastructural planning especially in rural areas.

The *Rural Transport Strategy* (DoT 2002b) is directed at the delivery of rural transport infrastructure and services. The strategy states clearly that “*Rural transport infrastructure*” does not cover access roads only, but also district roads, public transport interchanges, tracks and other NMT infrastructure - provided mainly by the provincial and local spheres of government, the National Department of Public Works (NDoPW) and SANRAL - all of which are directly or indirectly involved in communities and create local construction-related jobs.

Besides the National Land Transport Strategic Framework (NLTSF), which is a legal requirement in terms of Clause 21 of the National Land Transport Transition Act, Act No. 22 of 2000, the rural transport strategy is aligned to: the Integrated and Sustainable Rural Development Programme (ISRDP); the requirements for Integrated Development Planning (IDP) as set out in the Municipal Structures Act, Act No. 117 of 1998; and the government’s main social and economic development programmes, such as the Poverty Alleviation Programme, the Community Based Public Works Programme (CBPWP), the Local Economic Development (LED) Programme, the White Paper on National Transport Policy (1996), the Road Infrastructure Strategic Framework, and the Provincial Land Transport Frameworks (PLTFs) that have been developed in all of the provinces.

THE DEPARTMENT OF PROVINCIAL AND LOCAL GOVERNMENT

The DoPLG has initiated a number of national imperatives to improve



conditions in the previously disadvantaged areas of the country. These include the introduction of IDP, the Urban Renewal Programme (URP), the Integrated Sustainable Rural Development Strategy (ISRDS), the Municipal Infrastructure Grant (MIG), and others. The role that some of these strategies could play in improving the huge backlog of infrastructure, including NMT infrastructure, in townships and rural areas (especially the urban and rural residential nodes) will be highlighted.

Most IDPs and Integrated Transport Plans (ITPs) do not cover the issue of road safety infrastructure provision. The enabling transport legislation (the National Land Transport Transition Act, Act No. 22 of 2000), which through its National Land Transport Strategic Framework (DoT 2006) covers the field of road safety and Provincial Land Transport Frameworks, should thus be extended to cover this aspect as well. The role of NMT and its infrastructure requirements should also be catered for.

MIG is a conditional grant which supports municipal capital budgets to fund municipal infrastructure and to upgrade existing infrastructure, primarily benefiting poor households. The provision of infrastructure for NMRUS, e.g. sidewalks and footbridges, falls within the ambit of this funding, seeing that the major shortfall of these types of infrastructure lies in the areas occupied by the poor households.

CONCLUSION

The following shortcomings still exist in engineering practice and government policies as well as strategies:

First, there is no comprehensive national NMT policy in South Africa. The planning, design and provision of facilities for these VRUs are therefore not properly co-ordinated and considered. The DoT should take the lead in collaborating with the provincial and municipal road authorities and the DoPLG to develop such a policy.

Second, road authorities should consider developing pedestrian and bicycle master plans for formerly disadvantaged suburbs as part of an ITP in conjunction with the IDP process, the URP and the ISRDS. Such master plans should be based on pedestrian desire lines and major land uses that generate pedestrian traffic in the community.

Finally, the lack of pedestrian facilities in informal settlements and in many formerly disadvantaged suburbs is often a cause for many road safety problems. A summary of the most important facilities required in such areas includes:



- An internal network of pedestrian sidewalks and walkways should be provided based on pedestrian desire lines and major land uses generating pedestrian traffic in the area such as schools, sports fields, commercial centres, etc.
- Pedestrian crossings should be provided at locations where the internal network of pedestrian walkways crosses major roads.
- Land uses such as schools and other pedestrian generators should be located away from major roads, or situated in such a way that major roads do not need to be crossed. If this is not possible, provision should be made for grade separation and the channelisation of pedestrians to these crossing points. In designing these products and environment cognisance should be taken of the normal variations in human performance in order to minimise the number of resulting crashes and injuries.
- Roads should be designed in such a way to limit speeds. Where this is not possible, traffic calming measures should be included in the upgrading of settlements to safeguard VRUs.

Recommendations

The *PBFGM* (DoT 2003b) provides information and guidelines on a variety of aspects related to pedestrian and bicycle facilities. During subsequent development of the manual, however, a number of issues have been identified which require further study and research. These issues could not be adequately addressed in the current edition of the manual and most of the recommendations are based on studies undertaken in other, more developed countries.

Some of the more important areas identified that need further research are:

- The causes and types of accidents involving pedestrians and cyclists in South Africa.
- The maximum walking and cycling distances acceptable to the local population: Limited local interviews conducted by UNIARC (Van Schalkwyk & Naidoo 2004) found that children in Umlazi walked 15 km to school every day. It is likely that at least 1 to 2 hours (1.5 to 3 km) are common, although not necessarily acceptable, amongst poorer communities in South Africa.
- According to the National Road Traffic Regulations, pedestrian crossings are implicitly defined at all road junctions, i.e. they do not have to be marked. Pedestrians therefore have right of way at junctions, irrespective of whether an approach to a junction is controlled or not. In practice, most drivers do not seem to be aware that this requirement also applies to uncontrolled approaches to junctions.

- A simple system, which does not rely on the collection or availability of traffic and accident data, has been proposed for prioritising pedestrian sidewalks. However, the system should be extended to include other types of pedestrian (and cyclist) facilities.
- The provision of a separate bicycle road parallel to a street or road within the reserve boundaries in urban areas poses a serious problem when there are driveways along the road. Drivers exiting from driveways generally do not pay attention to cyclists, which increases the danger of accidents. Such bicycle roads on streets and roads with driveways will only be successful if they are provided directly adjacent to the street and road itself (similar to a bicycle lane), and if it is clear to drivers that they must yield to cyclists.
- More cost effective barricades and fences for use along roads to prevent pedestrians and cyclists entering the road reserve: The most effective form of barricade appears to be a concrete or brick wall, but the cost of such barricades is very high. Consideration of vegetated barriers may be an option.
- Traffic calming is particularly important for pedestrians and cyclists. The current national guidelines are outdated and urgently need to be updated. Local experience especially with regard to security must be incorporated.
- Current guidelines for the planning, design and provision of facilities for rural pedestrians and cyclists are very limited and should be expanded into a set of useful tools.
- When promoting cycling, especially in informal townships, designers should consider adopting the designs used by developing countries in the east where NMT predominates rather than those advocated by the more developed western societies.
- Lower order urban streets and rural roads must be viewed and designed as transport infrastructure for the entire range of transport modes, i.e. vehicles, motor cycles, cycles, animal drawn and pedestrian. No one mode should have exclusive use and priorities (if any) should be allocated according to the prevailing circumstances. NMT must be viewed as part of the solution rather than the problem of road transport.



REFERENCES

- Appleyard, D 1981, *Liveable streets*, University of California Press, Berkeley.
- Burden, D 2001, *Building communities with transportation: lecture presentation for the Transportation Research Board*, Publisher, Washington DC.
- De Beer, EJH 2000, *Evaluation of Maunde Street Pedestrian Safety Project*, CSIR, Transportek, Pretoria.
- De Beer, EJH 2002, *Pedestrian investigation Golden Highway P73/1*, CSIR, Transportek, Pretoria.
- De Beer, EJH & Davidson, J 2002, *Pedestrian safety investigation: R59 Sybrand van Niekerk freeway*, CSIR, Transportek, Pretoria.
- DoPLG website: <http://www.dplg.gov.za>.
- DoT 1999, *South African road safety manual*, Pretoria.
- DoT 2001a, *Road to safety strategy 2001-2005*, Pretoria.
- DoT 2001b, *Shova Kalula bicycle programme*, Pretoria.
- DoT 2002a, *National pedestrian action plan*, Pretoria.
- DoT 2002b, *Rural transport strategy*, Pretoria.
- DoT 2003a, *National travel survey*, Pretoria.
- DoT 2003b, *Pedestrian and bicycle facility guidelines manual*, Pretoria.
- DoT 2005, *Towards a 2010 transport action agenda*, Pretoria.
- DoT 2006, *National land transport strategic framework*, Pretoria.
- eThekweni Transport Authority 2004, *Road traffic annual report*, Durban.
- IHE/World Bank 2000, *Low-cost mobility in African cities: proceedings of the expert group meeting*, Delft, The Netherlands, 21-23 June 2000.
- Johnson, LB, Davidson, J & de Beer, EJH 2000, *Gauteng pedestrian management plan. Phase III - National and provincial roads*, CSIR, Transportek, Pretoria.
- Krishna, BG 2002, 'Improving bus transport constraints and potential in Bangalore', in *Urban transport for growing cities high capacity bus systems*, ed. W Tiwari, Macmillan, India.
- Mohan, D 2005, 'Road traffic injury as a public health problem', in *The way forward transportation planning and road safety*, ed. W Tiwari, D Mohan & N Muhlrad, Macmillan, India.
- Mpanza ZR 2002, *Developing a coherent implementation strategy for the Shova Kalula initiative: road safety and related issues*, Report 2002/10, UNIARC, Durban.
- Noah, MA 2004, *Pedestrian lament for compassionate safety on South African roads: paper presented in the programme for injury control and traffic safety training course*, 17-21 May 2004, Johannesburg, South Africa.
- RTMC 2005, *Road traffic and fatal crash statistics 2003-2004*, RTMC, Pretoria.
- Ribbens, H & Makhafola, F 2000, *Road safety improvement plan for the Dilokong Corridor at Tubatse*, Contract Report CR-2004/53, CSIR,

Transportek, Pretoria.

Riyad, I & Myeza, C 2002, *Road safety situational and apprehension analysis on the Edendale Road*, Report 2002/5, UNIARC, Durban.

SADC 1997, *SA and SADC Road Traffic Sign Manual*, viewed: 17 January 2008, http://www.nra.co.za/live/content.php?Item_ID=232.

van Schalkwyk, S & Naidoo, M 2004, *Development of a strategic pedestrian safety implementation mechanism: a psycho-sociological approach*, Report 2004/10, UNIARC, Durban.





ADVERSE DRIVING BEHAVIOURS: THE CASE OF AGGRESSION, EXCESSIVE SPEED AND ALCOHOL IMPAIRMENT

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ABSTRACT

Aggressive and “other high-risk driving behaviours”, such as driving above the speed limit or above the legal blood alcohol limit, are significant contributors to the burden of road traffic injuries in South Africa. For example, like many other countries in the world, these driver behaviours have been reported to play a role in about 80-90% of all road traffic crashes in South Africa. Using a multi-source multi-method approach, these behaviours were also shown to be very prevalent in a variety of settings and contexts. Yet, in spite of this, psychosocial perspectives are relatively neglected in research, policy and practice. In this regard, epidemiological data for these adverse driver behaviours are presented for the South African setting. These findings are discussed in the context of the country’s sectoral responses and international good practices for addressing these behaviours. Whilst a comprehensive ecological and health promotion approach is proposed for the prevention and control of these behaviours, greater attention is afforded to the active psychosocial approaches that are deemed imperative in modifying behavioural risks.

Key-words: aggressive driving behaviours, high-risk driving behaviours, South Africa

INTRODUCTION

In South Africa, approximately 6 million licensed drivers together with 6.7 million registered vehicles interact, often on a daily basis, with the physical traffic environment as well as with other fellow road users (DoT 2002). These complex interactions together with drivers’ individual pre-dispositions (e.g. drivers’ physical characteristics, such as age; psychological characteristics, such as personality and cultural norms on driving) influences motorists’ conceptualisation of the driving experience as well as their responses to other motorists. For some, this experience may be enjoyable offering the driver freedom and control, while for others, this provides an insulating and empowering opportunity to vent daily

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frustrations. Furthermore, the psycho-physiological stimulation of the driving experience (e.g. from information overload, noise and crowding) may influence the affective state of drivers and hence their behaviours in the traffic environment. These are some of the issues that contribute to the huge burden of road traffic crashes arising from driver-related factors. Risky driving behaviour is considered to contribute significantly to the huge burden of injury and death worldwide (WHO 2003). In South Africa, like in many other countries, between 80-90% of all collisions are related to driver factors (DoT 2002) and driver aggression and “other high-risk driving behaviours” are assumed to contribute significantly to collisions and associated fatalities. It is also well recognised that high-risk driving behaviours have the potential to increase the probability of a crash, the probability of injury given a crash, as well as the severity and outcomes of an injury. Hence, considering the large influence and contribution of behavioural factors in road traffic collisions, the allied psychological and sociological disciplines provide useful perspectives on behavioural responses in the traffic environment and are important considerations in our efforts to address traffic safety.

But, although human error plays a role in such a large percentage of crashes, this does not imply that the responsibility for road safety should be placed on individuals or that they should be the main target of intervention programmes. The “systems” approach to road traffic injury (RTI) prevention suggests that the cause of road traffic crashes is often multifaceted with dynamic interaction between the different components of the traffic system. Hence, while human behaviour may be a trigger factor, it is not necessarily the underlying cause. Motorists are often predisposed to crashes and injury due to their social and economic dispositions or the prevailing land use policy and practices. Hence, from this perspective, predominant strategies would be passive and structural, placing a larger responsibility on professionals that create the road systems to ensure the safety of the different users.

On the other hand, although it is well accepted that traffic systems need to be designed to accommodate human error, it is imperative that motorists, especially those at risk of engaging in adverse driving behaviours, be made aware of good driving practices and the consequences of driving irresponsibly. Besides, we cannot rely on motorists to make the safest decisions in the traffic environment. While psycho-educational and skills development programmes should be available to those that are at risk, adequate legislation and enforcement is also important to punish and deter motorists from engaging in driving behaviours that are unacceptable to society. Furthermore, the implementation of environmental and engineering



advances have to be coupled with behavioural strategies, for example, encouraging and educating the public on child seating position or the correct use of child restraints. Evans (1990) has also pointed out that many engineering-type solutions are reaching a point of diminishing return or a saturation level and suggests that greater emphasis needs to be placed on behavioural approaches. In the above regard, social-psychological solutions involving enforcement, education or other behaviour modification activities would be paramount.

The above discussion highlights some of the multifaceted issues concerning road traffic crashes and would imply that the use of a single public health strategy for intervention, for example, engineering countermeasures, is unlikely to be successful on its own. Comprehensive and multidisciplinary approaches that embrace behavioural strategies are essential to our efforts to make South Africa's roads safer.

While there are several behavioural factors that compromise traffic safety and to varying extents, in this chapter, we examine those behavioural issues among motorists that have been shown to be the leading contributors to road traffic crashes and injury, namely, aggression, excessive speed and substance impairment. The pertinent literature on these behaviours will be reviewed followed by findings in the South African context. These findings are discussed in the context of the South African sectoral responses, and priorities for prevention and control of these behaviours are discussed. Whilst a comprehensive intervention strategy is proposed, greater attention is given to the relatively neglected area of psychosocial approaches and active intervention strategies that are necessary to modify behavioural risks. A multi-source multi-method approach is used in the presentation of South African data, which is generally advocated to facilitate a comprehensive perspective on risk factors. Data used in this chapter are a combination of those from the MRC-UNISA Crime, Violence and Injury Lead Programme (CVILP) and the Department of Transport (DoT). The CVILP projects include the National Injury Mortality Surveillance System (NIMSS), the Trauma and Drug Surveillance System and a city-level study on Aggressive Road Behaviours (hereafter referred to as the Aggressive Road Behaviour Study). The DoT data are based on a national survey of road traffic offences in 2003, which was undertaken by the ITP Consortium for the DoT (hereafter referred to as the Road Traffic Offence Survey) (DoT 2003).



AGGRESSIVE ROAD BEHAVIOURS

BACKGROUND

Aggressive road behaviours are a significant traffic problem world-wide. In the United States of America (US), the National Highway Traffic Safety Administration (NHTSA) attributed 66% of all annual traffic fatalities to driver aggression (Martinez 1997). In the United Kingdom (UK), a survey by the Automobile Association established that 90% of motorists there reported at least one “road rage” encounter over a one-year period (Joint 1995). In comparison, a recent survey on aggressive driving by Synovate (Arrive Alive 2005) across 10 countries ranked South Africa the highest for “Aggressive and/or threatening driving behaviour” (67%) and for “Threatening behaviour where the person physically got out of the vehicle” (11%). The remaining countries included Brazil, Greece, France, India, Korea, Malaysia, Taiwan, the UK and the US. The total sample comprised over 4 000 participants and was based on randomised telephone interviews.

PRECURSORS TO AGGRESSIVE ROAD BEHAVIOURS

The literature on aggressive road behaviours points to an array of factors that may predispose motorists to aggression in the traffic environment and these may broadly be grouped into state factors, trait factors and other factors relating to driver demography or driving characteristics.

Aggressive road behaviours have often been related to exposure to traffic congestion (Shinar 1998; Parkinson 2001). However, a recent study by Shinar and Compton (2004) has shown that the likelihood of aggressive driving was higher when the value of time was high (as in weekday rush-hour traffic) than when the value of time was low (during weekday non-rush traffic or weekend hours). Thus, they concluded that while congestion alone may be a necessary condition for aggressive driving, it is not a sufficient condition. Other situational factors that have been shown to increase the likelihood of driver aggression include situations that confer anonymity, for example, tinted windows or increased traffic volume (Ellison *et al.* 1995; Wiesenthal & Janovjak 1992) and unfamiliarity with a particular traffic environment, which may facilitate blame being projected onto fellow road users (Lajunen, Parker & Stradling 1998; Parkinson 2001).

Emotions may lead to thoughts and behaviour that affect performance on a range of tasks. For example, several international studies examining anger in the traffic environment have suggested that aggressive driving is associated with the experience of anger (Arnett, Offer & Fine 1997; Deffenbacher *et al.* 2000, 2001; Parker, Lajunen & Summala 2002). When motorists are

angered, they may respond aggressively (behaviours related to the emotion), but they also may suffer from attention loss or decrease in reaction times as a result of anger. Anger or the inability to deal effectively with anger was also shown to be associated with higher crash involvement (Selzer, Rogers & Kern 1968; Wells-Parker *et al.* 2002). However, anger may not always be a precursor to aggressive driving behaviour and in these instances aggression may be used as a problem-solving strategy or an instrument to reach one's goals (Baron & Richardson 1994). Another postulation is that anger is associated with territoriality in that upon being threatened, a motorist may become territorial and sometimes aggressive (Whitlock 1971). Some of the significant personality traits that may predispose certain motorists to respond aggressively include sensation-seeking (Jonah 1997; Jonah, Thiessen & Au-Yeung 2001), anxiety (Spielberger 1972, 1983) and impulsiveness (Novaco 1991).

Demographic factors positively associated with aggressive driving include being of a young age and being male (Wiesenthal, Hennessy & Gibson 2000; Shinar & Compton 2004). Lajunen and Parker (2001), in their review of the driver aggression literature, concluded that younger motorists were generally less experienced and therefore more likely to engage in driver aggression.

While these factors relate to aggressive driving behaviours, the strong association between "other high-risk driving behaviours" and aggressive driving behaviours together with international literature suggests that these factors may also be extended to other related behaviours, such as driving above the speed and/or alcohol limits (see definitions below).

DEFINING AGGRESSIVE ROAD BEHAVIOURS

Due to the sensational nature of road rage and aggressive driving, their definitions are often obscured and hence, for the Aggressive Road Behaviour Study (Sukhai *et al.* 2005), aggressive road behaviours were operationalised and located on a continuum consisting of four levels including:

- (a) *Expressions of annoyance (Level 1 aggressive road behaviour)* refers to mild, verbal, but non-threatening expressions of annoyance or self-irritability, such as complaining and/or yelling to oneself and/or fellow passengers in response to another driver's behaviour.
- (b) *Aggressive driving (Level 2 aggressive road behaviour)* refers to mild, verbal or gestural expressions of anger on the road, such as the use of insensitive or obscene gestures and inappropriate and/or excessive use of the horn and lights.
- (c) *Direct threatening and/or intimidating behaviour (Level 3 aggressive road behaviour)* includes trying to cut another motorist off the road or following or chasing another motorist in anger.



- (d) *Direct confrontational behaviour (Level 4 aggressive road behaviour)* may include arguing with or assaulting another motorist.

Based on the above definitions, “road rage” may be defined as a display of uncontrolled anger, which may be manifested as Level 3 or Level 4 aggressive road behaviour. The expression of anger may, at a behavioural level, be directed at the perceived offending driver, vehicle, road signage or other objects in the traffic environment. The term, “other high-risk or hazardous driving behaviour”, refers to those instrumental behaviours that constitute deliberate and dangerous driving, but do not involve an intentional aggressive interaction and may include driving above the speed limit or above the legal blood alcohol limit.

SA FINDINGS

The Aggressive Road Behaviour Study showed aggressive road behaviours to be a significant problem in the South African context (Sukhai *et al.* 2005). The study was carried out among a representative sample of 1 006 motorists in the eThekweni Metropolitan Area (incorporating Durban) and examined the nature, extent and profiles of aggressive road behaviours in the metropole. Table 1 shows the prevalence data for victimisation and perpetration of the different levels of aggressive road behaviours in this setting.

Table 1: Prevalence of experiencing and perpetrating Level 1 to Level 4 behaviours

	Victimisation n (%)	Perpetration n (%)
Level 1 behaviours		
1.1 Say bad things to oneself or passenger		812 (84.9)
1.2 Yell at oneself or passenger		780 (81.9)
Level 2 behaviours		
2.1 Give another driver “dirty looks”	749 (74.8)	462 (46.9)
2.2 Hoot/yell at another driver	818 (83.8)	519 (53.6)
2.3 Make obscene gestures at another driver	630 (64.3)	196 (20.0)
Level 3 behaviours		
3.1 Prevent another driver from entering lane	789 (80.1)	261 (26.4)
3.2 Prevent another driver from passing	687 (69.5)	241 (24.5)
3.3 Tailgate another driver	777 (78.6)	280 (28.5)
3.4 Try to cut another driver off the road	330 (34.3)	47 (4.9)
3.5 Follow/chase another driver	89 (9.5)	35 (3.6)
Level 4 behaviours		
4.1 Get out of car and argue with another driver	174 (17.8)	71 (7.2)
4.2 Get out of car to hurt another driver	49 (5.1)	29 (2.9)
4.3 Deliberately collide with or damage another car	90 (9.2)	18 (1.8)
4.4 Point a gun or shoot at another car	57 (5.9)	3 (0.3)

(Source: Adapted from Sukhai *et al.* 2005)

Roughly eight out of ten motorists reported that they engage in Level 1 aggressive road behaviours (mild, verbal, but non-threatening expression of annoyance). For Level 2 aggressive road behaviours, the reported prevalence for victimisation ranged from 64%-84%, while for perpetration, the prevalence ranged from 20%-54%. Direct threatening and intimidating aggressive road behaviours (Level 3) were relatively diverse in severity and the reported prevalence ranged from 10%-80% for victimisation and 4%-29% for perpetration. For the most extreme direct confrontational aggressive road behaviours (Level 4), the reported prevalence ranged from 5%-18% for victimisation and 0.3%-7.2% for perpetration. These findings were found to be consistent with international research reporting high prevalence data for similar categories of behaviours (Arrive Alive 2005; Joint 1995; Miller *et al.* 2002).

The study also used multiple linear regression modelling to identify the predictors of the different levels of aggressive road behaviours. This analysis is also useful in demonstrating the link between high-risk driving behaviours, such as driving above the speed limit or above the legal blood alcohol limit. The statistically significant predictor variables for victimisation and perpetration of the different levels of aggressive road behaviours are summarised in Table 2.

Table 2: Statistically significant predictor variables for victimisation and perpetration of Level 1 to Level 4 behaviours

	Level 1 behaviour		Level 2 behaviour		Level 3 behaviour		Level 4 behaviour	
	Victim	Perp.	Victim	Perp.	Victim	Perp.	Victim	Perp.
Drive above posted speed limits					X	X		X
Speed through yellow or run red lights		X	X	X	X			X
Weave in traffic			X	X	X	X	X	
Maintain inadequate following distance		X				X		
Drive while under the influence of alcohol				X	X		X	X
Carry weapon while driving			X				X	X
Received at least one traffic fine over past year							X	
Age (young drivers)				X				
Gender (male)			X					
Drive almost every day		X						

(Source: Adapted from Sukhai *et al.* 2005)



For victimisation and speed-related behaviours (driving above posted speed limits, speeding through yellow or running through red traffic lights, weaving in traffic and not maintaining adequate following distances), weaving in traffic predicted the experience of all levels of aggressive road behaviours (Level 1 not applicable); speeding through yellow or running through red traffic lights predicted the experience of Level 2 and Level 3 behaviours; and driving above posted speed limits predicted the experience of Level 3 behaviours. Driving while impaired with alcohol predicted the experience of both Level 3 and Level 4 aggressive road behaviours.

The perpetration of all levels of aggressive road behaviours was predicted by at least two speed-related behaviours. With behaviours constituting road rage (Level 3 and Level 4), driving above posted speed limits was a predictor for both groups. Additionally, weaving in traffic and not maintaining adequate following distances only predicted Level 3 behaviours, while speeding through yellow or running through red traffic lights only predicted Level 4 behaviours. Driving while impaired with alcohol was a significant predictor for engaging in Level 2 and Level 4 behaviours.

With demographic and driving-related factors, significant associations were only found for Level 1 and Level 2 behaviours. Carrying a weapon while driving (most often a firearm) was a significant predictor for being a victim and a perpetrator of the extreme behaviours constituting road rage. Receiving at least one traffic fine over a one-year period also predicted victimisation of the extreme forms of road rage.

VEHICLE SPEED BACKGROUND

Speed per se is not a problem, but excessive speed (driving above posted speed limits) or inappropriate speed (travelling at a speed that is not suitable to prevailing road and traffic conditions) is a major contributing factor to road traffic crashes worldwide. In high-income countries, excess and inappropriate speed contribute to around 30% of fatal crashes (European Road Safety Action Programme 2003), while in Ghana, half of all road traffic crashes between 1998 and 2000 were attributed to speed-related factors (Afukaar 2003). In South Africa, excessive speed or speed too fast for circumstances plays a role in approximately 30% of all crashes and about 50% in the case of commercial freight and public passenger vehicles (DoT 2002).

The role of driving speed in traffic safety is contentious, but there is strong empirical evidence from several studies showing a significant positive



relationship between vehicle speed, crash risk and crash severity. The relationship between speed and the relative incidence of crashes may be influenced by factors, such as decreased reaction times, decreased ability to negotiate curves and obstacles and increased distance required to stop a vehicle in response to a hazard. The relationship between vehicle speed and crash severity is undeniable and governed by the laws of physics. The kinetic energy of a moving vehicle is a function of its mass and the square of its velocity. In a crash, the kinetic energy that is dissipated (and hence the severity of injuries) will be exponentially related to the speed of the vehicle. For example, a classic study by Finch *et al.* (1994) showed that an increase of 1 km/h in mean traffic speed typically results in a 3% increase in the incidence of injury crashes and an increase of 4-5% for fatal crashes. Furthermore, it has been shown that travelling at just 20 km/h above a road speed limit of 60 km/h results in an increase in the relative risk of being involved in a casualty crash that is comparable with having a blood alcohol concentration (BAC) of about four times the legal alcohol limit of 0.05 g/100 ml for driving (McLean & Kloeden 2002).

SA FINDINGS

In the Aggressive Road Behaviour Study (Sukhai *et al.* 2005), motorists also reported on the “other high-risk driving behaviours” that they engaged in over a one-year period. Table 3 shows the reported prevalence and frequency of engaging in these behaviours.

Table 3: Prevalence and frequency of engaging in other high-risk driving behaviours

High-risk driving behaviour	Prevalence (n, %)	Frequency (mean*, S.D.)
Drive above posted speed limits	524 (52.6)	4.8 (2.9)
Speed through yellow or run red lights	475 (47.6)	3.5 (2.2)
Weave in traffic	205 (20.6)	4.1 (2.8)
Maintain inadequate following distance	299 (30.1)	3.4 (2.4)
Drive while under the influence of alcohol	113 (11.4)	3.9 (2.6)
Drive above legal blood alcohol limit	81 (8.2)	4.0 (2.8)
Carry a weapon while driving	68 (7.0)	N/A
Received at least one traffic fine in the past year	384 (38.5)	N/A
*Arithmetic mean, calculated for the positive responses only		

(Source: Adapted from Sukhai *et al.* 2005)

In this study and with speed-related behaviours, just more than half the motorists (53%) reported driving above the posted speed limits and at a



frequency of about half the time that an opportunity arose (4.8 out of 10 times). Half the motorists also acknowledged to speeding through yellow or running through red traffic lights. About one-fifth and just under one-third of motorists acknowledged to weaving in traffic and not maintaining adequate following distances, respectively. Four in every ten motorists have also received at least one traffic fine (for a moving traffic violation) over a one-year period with an average number of fines of two per motorist.

The Road Traffic Offence Survey examined a range of traffic offences including speed- and alcohol-related offences (DoT 2003). Speed offences were measured in urban settings with speed limits of 60 km/h and 80 km/h, and in “rural” settings being inter-city and inter-provincial national or main roads with speed limits of 100 km/h and 120 km/h (for light motor vehicles). Taxis and buses are limited to 100 km/h on roads with a speed limit of 120 km/h while trucks that have a gross mass in excess of 3 500 kg are limited to a maximum speed of 80 km/h. Table 4 shows the percentage of vehicles exceeding the speed limit by province, type of vehicle and type of area (urban versus “rural”) for 2003. Adjusted percentages that include the 10% tolerance as required by the Judiciary for law enforcement purposes are also provided and these conservative figures are described below.

Table 4. Percentage of vehicles exceeding the speed by province, type of vehicle and type of area, 2003

		GA	KZ	WC	EC	FS	MP	NW	LI	NC	SA
Light motor vehicles, urban, 60 km/h	Sample size	500	475	542	548	589	334	389	510	442	4329
	% exceeding limit	80.2	45.5	43.4	58.2	56.7	71.3	55.0	64.2	31.2	61.0
	% incl. 10% tolerance	56.4	25.9	23.2	33.8	37.4	50.0	33.7	35.7	17.6	39.0
Light motor vehicles, urban, 80 km/h	Sample size	300	160	105	103	30	352	305	60	158	1573
	% exceeding limit	77.0	56.9	36.2	32.0	36.7	47.2	48.5	76.7	20.3	56.0
	% incl. 10% tolerance	52.7	25.6	19.0	20.4	13.3	31.0	29.5	46.7	8.9	33.0
Light motor vehicles, rural, 100 km/h	Sample size	400	525	430	306	500	174	194	446	120	3095
	% exceeding limit	44.0	36.8	51.9	33.0	53.4	34.4	54.6	41.7	41.7	43.0
	% incl. 10% tolerance	29.0	14.1	25.1	16.7	29.0	17.2	33.5	20.9	25.0	22.0
Light motor vehicles, rural, 120 km/h	Sample size	150	149	250	369	250	236	489	400	326	2619
	% exceeding limit	34.7	22.1	21.2	16.8	36.4	25.0	23.7	25.5	16.3	27.0
	% incl. 10% tolerance	9.3	8.7	9.2	6.8	9.6	11.0	7.8	6.8	6.1	9.0
	Sample size	182	90	69	74	150	140	92	114	67	978
	% exceeding limit	88.6	43.3	40.6	58.1	54.0	50.7	29.3	54.4	14.9	59.0
	% incl. 10% tolerance	50.9	30.0	20.3	28.4	38.7	32.1	13.0	24.6	7.5	34.0
Minibus Taxi, rural, 100 & 120 km/h	Sample size	92	106	28	71	67	64	72	118	41	659
	% exceeding limit	10.4	21.1	17.4	20.3	12.0	15.7	32.6	19.3	10.4	16.5
	% incl. 10% tolerance	4.1	18.5	21.0	27.5	41.0	8.5	10.0	24.5	12.0	27.0



	Sample size	116	103	76	76	40	78	84	119	*	692
	% exceeding limit	32.8	39.8	18.4	25.0	37.5	41.0	21.4	27.7	*	30.7
	% incl. 10% tolerance	19.8	28.2	7.9	11.8	17.5	26.9	7.1	15.1	*	17.9
	Sample size	126	97	108	81	140	67	163	251	*	1 033
	% exceeding limit	38.9	33.0	48.1	30.9	52.1	55.2	62.6	35.5	*	41.0
	% incl. 10% tolerance	20.6	12.4	24.1	12.3	32.9	29.4	28.0	14.7	*	20.0
Abbreviations: GA = Gauteng, KZ = KwaZulu-Natal, WC = Western Cape, EC = Eastern Cape, FS = Free State, MP = Mpumalanga, NW = North West, LI = Limpopo, NC = Northern Cape, SA = South Africa (Weighted total)											
* Information not available											

With light motor vehicles, the national offence rate ranged from 9.0% for drivers exceeding the 120 km/h speed limit to 39.0% for drivers exceeding the 60 km/h speed limit. Gauteng recorded the highest percentages for urban speed offences (60 km/h and 80 km/h), while North West had the highest percentage for exceeding the 100 km/h speed limit and Mpumalanga for exceeding the 120 km/h speed limit. With minibus taxis and nationally, about one-third of drivers were found exceeding the urban speed limits and about one-quarter were exceeding the “rural” speed limits. Gauteng recorded the highest percentages for exceeding both urban and “rural” speed limits. Nationally, roughly one in five truck drivers exceeded both urban and “rural” speed limits. KwaZulu-Natal recorded the highest percentage for these drivers exceeding urban speed limits and Eastern Cape for exceeding “rural” speed limits. Provincial speed offence data was not available for buses. However, on a national level, 23% were found exceeding the 60 km/h limit, 34% the 80 km/h limit, 4% the 100 km/h limit and 8.2% the 120 km/h limit (set at 100 km/h for buses).

In terms of reported trends between 2002 and 2003, of concern is the large increase from 28%-39% in the national average for drivers exceeding urban speed limits. The largest increases were found in Gauteng (17%-56%) and Free State (23%-37%).

ALCOHOL BACKGROUND

In the same way as for speed, there is sufficient empirical evidence supporting the positive association and the direct dose-response relationship between alcohol and the risk of road traffic injuries. For example, compared with a BAC of 0, the risk of crash involvement at a BAC of 0.05 g/100 ml is estimated at around 1.8 (McLean & Holubowycz 1980), and increases to nearly five at 0.1 g/100 ml (Allsop 1966; Moskowitz 2002). With fatal crashes, each 0.02% increase in BAC level approximately doubles the risk of involvement in a fatal single-vehicle crash (Zador 1991). Zador, Krawchuk and Voas (2000) later showed the disproportionately high relative



risks for young (16-20 year old) male drivers involved in single vehicle alcohol-related fatal crashes. The relative risk for this sub-group increased from 17 for the BAC range 0.050-0.079 g/100 ml to 52 for the 0.080-0.099 g/100 ml range and 241 for the 0.1-0.149 g/100 ml range.

Startling findings for the eThekweni Metropolitan Area showed that 37 976 (15%) of all drivers that were involved in an accident between 2000 and 2003 had been involved in at least one other accident during the same period and 181 drivers had been involved in 10 or more accidents over the four-year period (Goldstone 2005). This is particularly significant in light of recent data showing the link between engaging in risky driving behaviours and involvement in recurrent road traffic crashes. For example, a recent prospective study carried out in a hospital setting in Italy showed a positive BAC among drivers to be the leading predictor of a recurrent motor vehicle crash where levels in excess of 0.05 g/100 ml increased one's risk by nearly four times (Fabbri *et al.* 2005). Similarly, Brewer *et al.* (1994) used a case control study in the US to show that drivers who died in motor vehicle crashes and who had a BAC of at least 0.02 g/100 ml (case drivers) were more likely to have been arrested for driving while impaired than drivers who died in crashes but had a BAC below 0.02 g/100 ml (control drivers). In terms of relative risk, case drivers in the 21-34 year age group were 4.3 times more likely and in the 35 years or older group were 11.7 times more likely than control drivers to have been arrested for driving while impaired.

The effects of alcohol on the human body are generally well recognised and, essentially, alcohol has the potential to significantly affect a person's psychomotor and cognitive skills that are needed for safe and responsible driving. Also well documented is the effect of alcohol in reducing inhibition and the positive association between alcohol and risk-taking behaviours.

SA FINDINGS

Self-reported drinking and driving findings from the Aggressive Road Behaviour Study (Sukhai *et al.* 2005) showed that about one-tenth of motorists reported consuming alcohol and driving, and most reported doing so at above the legal alcohol limit. Of those that reported driving above the legal alcohol limit, more than half reported experiencing a greater likelihood of aggression on the roads (see Table 3).

Data from the Road Traffic Offence Survey (DoT 2003) on the percentage of drivers found driving "under the influence" of alcohol are presented in Table 5 below. The legal alcohol limit for driving is 0.05 g/100 ml for non-professional drivers and 0.02 g/100 ml for professional drivers. The figures

reported in Table 5 include the 10% tolerance as required by the Judiciary for law enforcement purposes and reflects on the general daily rate.

Table 5: Percentage of drivers found driving under the influence (DUI) of alcohol by province, 2003

		GA	KZ	WC	EC	FS	MP	NW	LI	NC	SA Total
All vehicles, all times	Sample	700	715	562	634	609	620	608	697	743	5 888
	% DUI	1.1	1.7	2.9	1.7	1.5	4.7	2.6	3.7	2.3	2.1
All vehicles, 18h00-21h00	Sample	151	156	123	121	91	149	105	146	128	1 170
	% DUI	2.7	4.5	8.1	2.5	4.4	13.4	2.9	8.9	4.7	5.1
Trucks, buses & taxis	Sample	208	221	195	219	200	196	215	208	243	1 905
	% DUI	1.4	0.9	0.5	2.7	0.5	6.1	1.8	1.9	1.2	1.7
Abbreviations: GA = Gauteng, KZ = KwaZulu-Natal, WC = Western Cape, EC = Eastern Cape, FS = Free State, MP = Mpumalanga, NW = North West, LI = Limpopo, NC = Northern Cape, SA = South Africa (Weighted total)											

(Source: Adapted from DoT 2003)

Nationally, and for drivers of all types of vehicles, a staggering 1 in every 50 were found to be driving under the influence of alcohol, increasing to a ratio of 1 in 20 drivers for the hours from 18:00 to 21:00. Mpumalanga recorded the highest percentage for the overall and night prevalence (4.7% and 13.4%, respectively). Also of concern is the high percentage of professional drivers found driving under the influence of alcohol. Once again the highest percentage was found in Mpumalanga (6.1%). In terms of reported trends from 2002-2003, the national percentage of drivers found driving under the influence of alcohol increased from 1.8%-2.1% and the largest increase was in Mpumalanga from 1.8% in 2002-4.7% in 2003.

The above high prevalence data from the DoT are echoed by those found in fatal and non-fatal injury settings. Blood alcohol data for vehicle drivers involved in fatal crashes were extracted from NIMSS and are presented in Table 6. NIMSS covers approximately one-third of all fatal injuries in South Africa.

Table 6: Blood alcohol results for drivers involved in fatal crashes, NIMSS, 1999-2003

	Driver cases included n (%)	BAC analysis (n)%	BAC positive (n)%	Mean BAC (g/100 ml)	Standard Deviation
1999	464	188 (40.5)	101 (53.7)	0.16	0.09
2000	590	313 (53.1)	170 (54.3)	0.15	0.09
2001	958	357 (37.3)	185 (51.8)	0.17	0.10
2002	966	499 (51.7)	276 (55.3)	0.17	0.09
2003	1021	562 (55.0)	327 (58.2)	0.18	0.09

(Source: MRC-UNISA CVILP NIMSS database)



For each of the five years from 1999-2003, between 50-60% of all driver cases tested, were positive for alcohol. Although the highest percentage of cases that tested positive for alcohol was in 2003, none of the annual variations were statistically significant. The highest average level of alcohol consumption was also in 2003 at just under four times the legal limit for driving of 0.05 g/100 ml. The increase in the mean level of consumption between 2002 and 2003 was statistically significant ($p = 0.049$).

Findings from the Trauma and Drug Study (TADS) have also shown high prevalence data for drivers involved in non-fatal collisions. TADS was carried out at sentinel trauma units in South Africa from 1999-2001. Results showed that among drivers, 45% tested positive for alcohol and 68% of them had results in excess of the legal blood alcohol limit for driving. Additionally, about one-third of drivers were classified as problem drinkers based on the CAGE questionnaire (Marais, Sukhai & Donson 2004). Similarly, international data have shown that about half the drivers arrested for driving while impaired are alcoholics (Fine & Scoles 1976).

PRIORITIES FOR INTERVENTION

A comprehensive and integrated ecological approach that embraces education (together with behavioural modification), enforcement, environmental and engineering-type interventions is recommended. However, as mentioned earlier, a larger focus is dedicated to the relatively neglected area of active intervention strategies, such as education and enforcement-type interventions, to help emphasise the importance of these strategies and also help locate them within a comprehensive approach to addressing adverse road traffic behaviours. The broad public health strategies for intervention are discussed below.

ACTIVE INTERVENTION STRATEGIES

The motivation underlying traffic behaviour is an important determinant of the degree of success of behaviour change strategies and should be an important consideration for behavioural interventions. In this regard, Goldenberg, Levett and Heidstra (2000) have identified three broad classes of motivation of driver behaviour:

- *Reasoned or planned behaviour:* Here the advantages and disadvantages of a certain behaviour and its alternatives are appraised before engaging in that behaviour. According to the related theory, behavioural change can be brought about by influencing behavioural attitudes or social norms concerning a behaviour and an example of an intervention strategy would be to convince motorists of the risks and consequences of an adverse driving behaviour.

- *Impulsive or emotional behaviour:* Refers to an immediate impulsive reaction elicited by feelings they attach to experiencing a behaviour (e.g. pleasure in driving fast) or to the expected consequences of a behaviours (e.g. fear of penalties).
- *Habitual behaviour:* This is an almost automatic response where there is no conscious appraisal of a situation and the behaviour is only analysed afterwards. These behaviours are seldom determined by attitudes and intention.

To a certain extent all of these behaviour types may be applicable to driver aggression, speed and alcohol-impairment, but education-type interventions would be more effective for reasoned or planned behaviour, while enforcement-type interventions (or the use of rewards) would be necessary to change impulsive/emotional and habitual behaviours.

EDUCATION, AWARENESS AND TRAINING

Educational interventions may include behavioural modification, skills transfer, psycho-educational support and population-wide public campaigns. Importantly, when used in isolation, several education and awareness programmes have been shown to be ineffective in reducing crashes and injuries. For example, with adults, two Cochrane reviews that dealt with school-based driver education (Roberts, Kwan, & The Cochrane Injuries Group Driver Education Reviewers 2001) and post-licence driver education (Ker *et al.* 2003) have shown no evidence of preventing road traffic injuries or crashes. In fact the former review on school-based driver education showed that this leads to early licensing and may also lead to an increase in the proportion of teenagers involved in traffic crashes. The general reasoning is that motorists often acknowledge the risks and consequences of their adverse road behaviours, but seldom believe that they may be part of the problem. Furthermore, motorists who are predisposed to adverse road behaviours, seldom act in accordance with their knowledge (O'Neill & Mohan 2002). Hence, education strategies per se are not sufficient to change behaviour. While these strategies may improve knowledge, the challenge lies in translating knowledge to improved behaviours.

However, behavioural strategies serve a vital role in traffic safety. The important condition, as mentioned earlier, is that they need to be used in conjunction with other public health strategies for intervention. For example, a recent systematic review showed educational strategies that targeted aggressive and “other high-risk driving behaviours” by way of mass media campaigns to be effective when implemented together with other types of interventions, such as legislation and enforcement (Randy *et al.* 2004).



Eight studies were reviewed and the median decrease in alcohol-related crashes resulting from the campaigns was 13% (IQR: 6%-14%).

In contributing to responsible driving practices, education and awareness strategies also have the potential to influence internal attitudes, beliefs, values and social norms. While changing awareness through educational strategies does not necessarily translate to a change in behaviour, motorists who are predisposed need to at least be made aware of the risks and consequences of their behaviours. For example, there are several behaviours that generate high levels of anger among motorists in certain contexts and have been shown to have a high likelihood of provoking aggressive reactions in the traffic environment (Sukhai, Seedat & Jordaan 2005). A further example where awareness strategies will be useful is when motorists are often “forced” into driving above speed limits due to being “pushed along” in traffic where there is a general expectation for motorists to travel at least as fast as the speed limit. Education-type interventions will also be useful as a punitive or rehabilitative measure where those prosecuted for serious driver aggression could be compelled to attend psycho-educational and skills programmes. Furthermore, education-type strategies could provide valuable support to other strategies for intervention, for example, informing the public of the appropriateness of speed limits in certain areas in order that they are respected and not flouted. The Aggressive Road Behaviour Study (Sukhai 2003) showed public support and acceptability for education-type interventions where nearly one-fifth of the motorists felt that training was required for motorists on stress/anger management; 9% felt that motorists need education on this topic in the form of workshops/courses; and 7% felt that media awareness was needed on the problem.

Three specific education-related interventions relating to graduated licensing, recidivism and harm reduction strategies that are deemed to be important considerations in the South African context, are discussed below.

Graduated driver licensing

Young and/or beginner drivers have a disproportionately higher risk of traffic crashes, essentially due to their lack of skills, experience and maturity. One possible solution lies in adopting a graduated driver licensing system that is already being used in several countries internationally. The important principle is for these novice drivers to gain their skills and experience under conditions of low risk and in a protective environment. Hence, supervision is a key feature and so are restrictions which may be placed on night-time driving, the carrying of passengers, and drinking alcohol and driving. Such a system also provides an ideal environment to introduce passive training in anger management and in dealing with issues around driver aggression. A Cochrane review by

Hartling *et al.* (2004) showed the effectiveness of graduated driver licensing programmes in reducing the crash rates of young drivers. The authors reviewed 13 ecological studies that evaluated 12 graduated driver licensing programmes and found the median decrease in overall population crash rates among 16-year-old drivers to be 31% (range 26-41%) during their first year. However, the authors also concluded that further research is required on the effectiveness of the individual components of these systems.

Recidivism

As shown earlier, research supports the idea that motorists who drive while under the influence of alcohol are likely to do so repeatedly, and in doing so, they increase their likelihood of being involved in a future alcohol-related crash. Hence, aggressive intervention is required and as early as possible when motorists are arrested for alcohol intoxication or involved in collisions and are identified at trauma centres. Furthermore, our findings (also supported by international research) suggested that a high percentage of motorists who drink and drive may have a problem with alcohol dependency and this should be an important component of rehabilitation programmes. While there is evidence for the effectiveness of drink-driving rehabilitation courses in reducing re-offending (ETSC 1995; Wells-Parker *et al.* 1995), McKnight and Tippetts (1997), in their comparison of Accident Prevention Courses (APC) and Recidivism Prevention Courses (RPC) in Arizona, showed clearly that instruction that was designed primarily to reduce recidivism was more effective in reducing both violations and collisions among repeat offenders than instruction that was directed toward accident prevention in general. In their study, offenders participating in the RPC experienced 8% fewer violations and 18% fewer collisions during the year following their offence than did participants in the APC.

Harm reduction strategies

In addressing alcohol-impaired driving, sensible drinking and harm reduction approaches by way of designated drivers and safe ride programmes, which are relatively unexplored in the South African context, would be worthwhile considerations. Importantly, the aim is not to accept and condone the consumption of alcohol, but to provide “reasonable” alternatives to driving whilst impaired. People are first encouraged not to drink and drive, but if they do drink, they are encouraged to limit their intake to within legal limits and to designate a sober driver or use a “safe ride” scheme to get back home.

Enforcement and legislative strategies that would be useful to combine with these education-related interventions are discussed below.



LEGISLATION AND ENFORCEMENT

In view of the high prevalence data for aggressive and “other high-risk driving behaviours” in South Africa, enforcement measures may be useful to supplement the above education and behavioural-type interventions. Furthermore, from the Aggressive Road Behaviour Study (Sukhai 2003), just under half the motorists were in favour of enforcement-type interventions to address aggressive and “other high-risk driving behaviours”, and recommended measures comprised “increased enforcement” (16%), “harsher penalties” (14%) and “increased police visibility” (13%).

The important role of legislation and enforcement is well documented. For example, it has been estimated that half of all traffic deaths and injuries in European Union countries could be prevented if their current cost-effective road traffic enforcement strategies were applied rigorously (ETSC 1999). Hence, legislation in itself is not sufficient and has to be backed with strict enforcement.

South Africa has first class legislation and policies, but unfortunately, these are not enforced adequately. For example, with alcohol, roadside testing is generally concentrated only during the popular holiday seasons and testing is conducted only on drivers showing overt signs of intoxication. The Road Traffic Offence Survey revealed that, on average, traffic officers were only observed five times over a total distance of 4 600 km travelled on the inter-city and inter-provincial road network (DoT 2003). Similarly, a study that examined drinking and driving habits in Durban showed that that 61% of respondents had not seen a roadblock over a one-year period (Watson 2000). Highly publicised strategies such as the “Zero tolerance, 100% compliance” strategy by the KwaZulu-Natal DoT is a bold and commendable stance, but here again, these have not been matched by adequate levels of enforcement. This creates an additional danger where motorists lose respect for these campaigns and may even erode respect for other traffic regulations that are beneficial to safety. This creates a sense of lawlessness and has the potential to undo other recognised efforts in traffic safety.

International experience has shown that there are several good practices that are almost prerequisites for enforcement to be effective. Several studies have shown the effectiveness of enforcement to be related to the perceived risk of being caught and punished (Homel 1990). In this regard, enforcement measures need to be frequent and maintained over a long period of time (Zaal 1994). Additionally, efforts should be random and widespread to increase the chances of detection (ETSC 1999). If drivers perceive their risk of being detected and punished to be low, even stricter penalties (such as higher fines or prison sentences) will be relatively ineffective (Ross 1993)



and may even reduce levels of enforcement (Bjornskau & Elvik 1992).

Importantly, once fined or apprehended, offenders need to be dealt with efficiently and timeously and hence greater support and cooperation from the South African Criminal Justice Department needs to be secured. Furthermore, as a deterrent, the proposed point demerit system for traffic offences in South Africa has the potential to contribute largely as a means of self-regulation and needs to be implemented with greater urgency.

The widespread use of speed cameras and alcohol testing, which have sufficient evidence of being highly effective, needs to be optimised in the South African setting.

Speed cameras

Due to financial restrictions and competing demands, automated enforcement systems, such as the advanced measures for the use of cameras in capturing high-risk driving behaviours, have been shown to be very cost effective (e.g. Mäkinen & Oei 1992) and their use needs to be expanded in the South African traffic environment. A recent systematic review that examined 14 observational studies showed that all but one of the studies showed that cameras were effective up to three years or less after their introduction (Pilkington & Kinra 2005). The reductions in outcomes across these studies ranged from 5%-69% for collisions, 12%-65% for injuries, and 17%-71% for deaths in the vicinity of the camera sites. Automatic speed enforcement with cameras seems to be even more efficient (Keall, Povey & Frith 2002).

Alcohol testing

Both random breath testing (RBT) and sobriety checkpoints have been shown to be highly effective in reducing road traffic injuries resulting from alcohol-impairment. An international review showed that the sustained and intensive use of these measures can contribute to a one-fifth reduction in alcohol-related crashes (Elder *et al.* 2002). In South Africa, the Road Traffic Offence Survey reported on resource allocation by offence type and showed that while 45% of resources are dedicated to enforcing speed, a mere 0.4% is dedicated to enforcing alcohol-impaired driving (DoT 2003). In light of the burden of alcohol-impaired driving and availability of evidence-based interventions to address this burden, the above allocation of enforcement resources needs to be critically reviewed. Furthermore, as mentioned earlier, an important consideration is to increase the perceived risk of being caught; hence the use of RBT methods should be prioritised over general sobriety checks, where motorists are tested irrespective of external signs of impairment.



PASSIVE INTERVENTION STRATEGIES

The main merit of passive measures is that they have an effect on all road users and their effectiveness is generally less dependent on motorists' risk-taking behaviour, skills or other limitations. This lends support to a "systems-oriented approach", as advocated for in the *World Report on Road Traffic Injury Prevention* (Peden *et al.* 2004). The basic premise of the "systems" approach is to identify and rectify the major sources of error or design weakness that contribute to fatal and severe injury crashes, as well as to mitigate the severity and consequences of injury. Countries that have taken the lead in systems approaches, such as Sweden and the Netherlands, place high priority on environmental speed control where the guiding principle is to adapt the environment to the limitations of the road users. Furthermore, physical speeding restraints are also recognised to be very cost-effective in resource-strapped settings. Traffic calming techniques, especially by way of traffic circles, have been shown to be very effective in crash reduction. For example, studies have shown area-wide traffic calming to reduce the incidence of road traffic crashes by an average of 15% and to be most effective in residential areas where accident reductions of about 25% can be achieved (Elvik 2001; Hydén & Várhelyi 2000). Other related components to area-wide traffic calming may include the use of rumble strips, speed humps, raised areas, narrowings and staggerings.

Vehicle-related strategies that are widely available and that have been shown to be effective in addressing alcohol and speed include speed limitation systems/devices and alcohol interlocks. With excessive speed, speed limitation systems that control the maximum speed that a vehicle can travel at have shown the potential to reduce fatal crashes by between 20-60% (Carsten, Fowkes & Tate 2001). These systems comprise various types and may be advisory, voluntary (where there is an option for the driver to override the warning), or mandatory. Furthermore, the mandatory-type system will be a useful consideration as a legislative adjunct for recurrent speed offenders. Speed governing devices will be particularly useful for professional drivers in the public and commercial transport industry, and in the case of heavy goods vehicles, there is evidence of a 2% reduction in the total number of injury crashes (Elvik, Mysen & Vaa 1997). However, in South Africa, especially among private enterprises, drivers are often encouraged and pressured into speeding as this determines their remuneration. Hence, the installation of these devices would most likely be resisted, and if they were installed, they might be disabled, unless creative strategies addressing these issues were used in their implementation. With regard to alcohol-impaired driving, the alcohol ignition interlock is a useful device for use in cases of recidivism or



as a routine measure for professional drivers in the public and commercial transport industry. These devices prevent a driver from starting a vehicle if he or she is above a certain alcohol level as they need to blow into the device before the vehicle will start. A study has shown evidence of reductions of between 40%-95% in the rate of repeated offending (Marques *et al.* 2000).

CONCLUSION

While aggressive and “other high-risk driving behaviours” pose a serious threat to traffic safety in the South African traffic environment, several good practices relating to driver behaviour have been shown to have the potential to significantly reduce the burden of traffic injuries. Importantly though, caution is required in adapting international good practices to the South African setting due to contextual differences in these settings.

Adverse traffic behaviours should be treated as part of a broader social problem that needs to be addressed together with other forms of injury and violence that threaten society at large. In this regard, the ideal would be to aim for prevention initiatives as opposed to the control of behaviour-related RTIs, in other words, responsible and safe behaviours should be forged early in the developmental stage rather than attempting to modify attitudes and behaviours, which is often relatively more difficult to accomplish. On the broader societal level, campaigns encouraging respect and cooperative driving behaviours, together with attempts to reduce the competitive aspects of driving, should be strengthened.

Importantly though, we need to be always questioning the value of our intervention initiatives. The use of good practices and scientific approaches together with optimising on methods that encourage the uptake of this data for policy and practice decisions will be imperative. Furthermore, formal evaluation of intervention programmes is a crucial component of injury prevention. Besides being a moral obligation to justify expenses, such an exercise provides an opportunity to identify weaknesses and strengths of these programmes which could be used to enhance their effectiveness. Very few intervention programmes in South Africa, including the national Arrive Alive traffic safety strategy, have been systematically evaluated and documented. Finally, as noted in the *World Report on Road Traffic Injury Prevention* (Peden *et al.* 2004), advocacy, political will and commitment from stakeholders in the sector would be critical for the success of intervention strategies, and importantly, to ensure the sustainability of these initiatives.



REFERENCES

- Afukaar, FK 2003, 'Speed control in LMICs: issues, challenges and opportunities in reducing road traffic injuries', *Injury Control and Safety Promotion*, no. 10, pp. 77-81.
- Allsop, RE 1966, *Alcohol and road accidents: a discussion of the Grand Rapids study*, Report no. 6, Road Research Laboratory, Harmondsworth.
- Arnett, JJ, Offer, D & Fine, MA 1997, 'Reckless driving in adolescence: "state" and "trait" factors', *Accident Analysis and Prevention*, no. 29, pp. 57-63.
- Arrive Alive 2005, *Road rage study by Synovate: Is the leisurely drive on the road to extinction?*, viewed: 24 October 2005, <http://www.arrivealive.co.za/pages.asp?nc=rrstudy>.
- Baron, R & Richardson, D 1994, *Human aggression*, Plenum Press, New York.
- Brewer, RD, Morris, PD, Cole, TB, Watkins, S, Patetta, MJ & Popkin, C 1994, 'The risk of dying in alcohol-related automobile crashes among habitual drunk drivers', *New England Journal of Medicine*, no. 331, pp. 513-517.
- Bjornskau, T & Elvik, R 1992, 'Can road traffic law enforcement permanently reduce the number of accidents?', *Accident Analysis & Prevention*, vol. 24, no. 5, pp. 507-520.
- Carsten, O, Fowkes, M & Tate, F 2001, *Implementing intelligent speed adaptation in the United Kingdom: recommendations of the EVSC project*, Institute of Transport Studies, University of Leeds, Leeds.
- Deffenbacher JL, Huff, ME, Lynch, RS, Oeting, ER & Salvatore, NF 2000, 'Characteristics and treatment of high-anger drivers', *Journal of Counseling Psychology*, no. 47, pp. 5-17.
- Deffenbacher JL, Lynch, RS, Deffenbacher DM, & Oeting, ER 2001, 'Further evidence of reliability and validity for the driving anger expression inventory', *Psychological Reports*, vol. 89, no. 3, pp. 535-540.
- DoT 2002, *The road to safety 2001-2005*, viewed: 24 October 2005, <http://www.transport.gov.za/projects/index.html>.
- DoT 2003, *Arrive alive monitoring and reporting: report on a selection of road traffic offences 2003*, DoT (prepared by ITP Consortium), South Africa.
- Elder, RW, Shults, RA, Sleet, DA, Nichols, JL, Zaza, S & Thompson, R 2002, 'Effectiveness of sobriety checkpoints for reducing alcohol-involved crashes', *Traffic Injury Prevention*, no. 3, pp. 266-274.
- Ellison, PA, Govern, JM, Petri, HL & Figler, MH 1995, 'Anonymity and aggressive driving behaviour: a field study', *Journal of Social Behaviour and Personality*, vol. 10, no. 1, pp. 265-272.
- Elvik, R 2001, 'Area-wide urban traffic calming schemes: a meta-analysis of safety effects', *Accident Analysis & Prevention*, vol. 33, no. 3, pp. 327-336.
- Elvik, R, Mysen, AB & Vaa, T 1997, *Trafikksikkerhetshåndbok, tredje*

utgave [*Handbook of traffic safety, 3rd edn*], Institute of Transport Economics, Oslo.

European Road Safety Action Programme 2003, *Halving the number of road accident victims in the European Union by 2010: a shared responsibility*, Commission report 2003, no. 311 (final), Commission of the European Communities, Brussels, viewed: 18 October 2005, http://europa.eu.int/comm/transport/road/roadsafety/rsap/index_en.htm.

European Transport Safety Council (ETSC) 1995, *Reducing injuries from alcohol impairment*, ETSC, Brussels.

ETSC 1999, 'Police enforcement strategies to reduce traffic casualties in Europe', *European Transport Safety Council, Working Party on Traffic Regulation Enforcement*, Brussels, viewed: 31 October 2005, <http://www.etsc.be/documents/strategies.pdf>.

Evans, L 1990, 'An attempt to categorise the main determinants of traffic safety', *Health Education Research*, no. 5, pp. 111-124.

Fabbri, A, Marchesini, G, Dente, M, Lervese, T, Spada, M & Vandelli, A 2005, *Annals of Emergency Medicine*, vol. 46, no. 2, pp. 161-167.

Finch, DJ, Kampfner, P, Lockwood, CR & Maycock, G 1994, *Speed limits and accidents*, Project report no. 58, Transport Research Laboratory, Crowthorne.

Fine, EW & Scoles, P 1976, 'Secondary prevention of alcoholism using a population of offenders arrested for driving while intoxicated', *Annals of the New York Academy of Sciences*, no. 273, pp. 637-645.

Goldenberg, C, Levelt, PBM & Heidstra, J 2000, 'Psychological perspectives on changing driver attitude and behaviour', *Recherche Transports Sécurité*, no. 67, pp. 65-81.

Goldstone, C 2005, 'Drivers crashed 19 times in 3 years', *The Mercury*, 3 May, viewed: 5 May 2005, <http://www.themercury.co.za/index.php?fSectionId=283&fArticleId=2505839>.

Hartling, L, Wiebe, N, Russell, K, Petruk, J, Spinola, C & Klassen, TP 2004, 'Graduated driver licensing for reducing motor vehicle crashes among young drivers', *The Cochrane Database of Systematic Reviews*, issue 2, art. no. CD003300. DOI. 10.1002/14651858.CD003300.pub2.

Hommel, RJ 1990, 'Random breath testing, the Australian way', *Alcohol Health and Research World*, vol. 14, no. 1, pp. 70-75.

Hydén, C & Várhelyi, A 2000, 'The effects on safety, time consumption and environment of large scale use of roundabouts in an urban area: a case study', *Accident Analysis and Prevention*, vol. 32, no. 1, pp. 11-23.

Joint, M 1995, *Road Rage*, Automobile Association, London.

Jonah, BA 1997, 'Sensation seeking and risky driving: a review and synthesis of the literature', *Accident Analysis and Prevention*, vol. 29,



- no. 5, pp. 651-665.
- Jonah, BA, Thiessen, R & Au-Yeung, E 2001, 'Sensation seeking, risky driving and behavioral adaptation', *Accident Analysis and Prevention*, no. 33, pp. 679-684.
- Keall, MD, Povey, LJ & Frith, WJ 2002, 'Further results from a trial comparing a hidden speed camera programme with visible camera operation', *Accident Analysis & Prevention*, vol. 34, no. 6, pp. 773-777.
- Ker, K, Roberts, I, Collier, T, Beyer, F, Bunn, F & Frost, C 2003, 'Post-licence driver education for the prevention of road traffic crashes', *The Cochrane Database of Systematic Reviews*, issue 3, art. no. CD003734. DOI.10.1002/14651858.CD003734.
- Lajunen, T & Parker, D 2001, 'Are aggressive people aggressive drivers? A study of the relationship between self-reported general aggressiveness, driver anger and aggressive driving', *Accident Analysis & Prevention*, vol. 33, no. 2, pp. 243-255.
- Lajunen, T, Parker, D & Stradling, SG 1998, 'Dimensions of driver anger, aggressive and highway code violations and their mediation by safety orientation in UK drivers', *Transportation Research*, part F1, pp. 107-121.
- Mäkinen, T & Oei, HL 1992, *Automatic enforcement of speed and red light violations: applications, experiences and developments*, Report: R-92-58, Institute for Road Safety Research, Leidschendam.
- Marais, S, Sukhai, A & Donson, H 2004, 'Monitoring alcohol and other substance use in South Africa: the alcohol & drug injury nexus', in *Crime, violence and injury prevention in South Africa: developments and challenges*, ed. S Suffla, A van Niekerk & N Duncan, MRC-UNISA Crime, Violence and Injury Lead Programme, Cape Town.
- Martinez, R 1997, 'Aggressive driving', Congressional Testimony to the US House Sub-Committee on Transportation and Infrastructure Hearings, 17 July, viewed: 5 November 2003, <http://www.nhtsa.dot.gov/nhtsa/announce/testimony/aggres2.html>.
- Marques, PR, Tippetts, AS, Voas, RB, Danseco, ER & Beirness, DR 2000, *Support services provided during interlock usage and post-interlock repeat DUI: outcomes and processes: proceedings of the 15th International Conference on Alcohol, Drugs and Traffic Safety, 22-26 May, Stockholm*, viewed: 27 October 2005, <http://www.icadts.org/proceedings/2000/icadts2000-182.pdf>.
- McKnight, AJ & Tippetts, AS 1997, 'Accident prevention versus recidivism prevention courses for repeat traffic offenders', *Accident Analysis and Prevention*, vol. 29, no. 1, pp. 25-31.
- McLean, AJ & Holubowycz, OT 1980, 'Alcohol and the risk of accident

involvement', *Alcohol, drugs and traffic safety: proceedings of the 8th International Conference on Alcohol, Drugs and Traffic Safety*, Stockholm, 15-19 June, ed. L Goldberg, Almqvist & Wiksell International, Stockholm.

- McLean, J & Kloeden, C 2002, 'Alcohol, travelling speed and the risk of crash involvement', *Proceedings of the 16th International Conference on Alcohol, Drugs and Traffic Safety*, Montreal, 4-9 August, ed. DR Mayhew & C Dussault, Société de l'assurance automobile du Québec, viewed: 18 October 2005, [http://www.saaq.gouv.qc.ca/t2002/actes/pdf/\(07a\).pdf](http://www.saaq.gouv.qc.ca/t2002/actes/pdf/(07a).pdf).
- Miller, M, Azrael, D, Hemenway, D & Solop, FI 2002, 'Road rage in Arizona: armed and dangerous', *Accident Analysis and Prevention*, vol. 34, pp. 807-814.
- Moskowitz, H, Blomberg, R, Burns, M, Fiorentino, D & Peck, R 2002, 'Methodological issues in epidemiological studies of alcohol crash risk', *Proceedings of the 16th International Conference on Alcohol, Drugs and Traffic Safety*, Montreal, 4-9 August, ed. DR Mayhew & C Dussault, Société de l'assurance automobile du Québec, viewed: 19 October 2005, [http://www.saaq.gouv.qc.ca/t2002/actes/pdf/\(06a\).pdf](http://www.saaq.gouv.qc.ca/t2002/actes/pdf/(06a).pdf).
- Novaco, RW 1991, 'Aggression on the roadways', in *Targets of violence and aggression*, ed. R Baenninger, Elsevier, North-Holland, pp. 253-326.
- O'Neill, B & Mohan, D 2002, 'Reducing motor vehicle crash deaths and injuries in newly motorised countries', *British Medical Journal*, vol. 324, pp. 1142-1145.
- Parker, D, Lajunen, T & Summala, H 2002, 'Anger and aggression among drivers in three European countries', *Accident Analysis and Prevention*, vol. 34, no. 2, pp. 229-235.
- Parkinson, B 2001, 'Anger on and off the road', *British Journal of Psychology*, vol. 92, pp. 507-526.
- Peden, M, Scurfield, R, Sleet, D, Mohan, D, Hyder, AA, Jarawan, E & Mathers C (eds.) 2004, *World report on road traffic injury prevention*, World Health Organization (WHO), Geneva.
- Pilkington, P & Kinra, S 2005, 'Effectiveness of speed cameras in preventing road traffic collisions and related casualties: systematic review', *British Medical Journal*, no. 330, pp. 331-334.
- Randy, W, Elder, RA, Shults, DA, Sleet, FAAHB, James LN, Robert, S, Thompson, WR & Task Force on Community Preventive Services 2004, 'Effectiveness of mass media campaigns for reducing drinking and driving and alcohol-involved crashes: a systematic review', *American Journal of Preventive Medicine*, vol. 27, no. 1, pp. 57-65.
- Roberts, I, Kwan, I & The Cochrane Injuries Group Driver Education Reviewers 2001, 'School based driver education for the prevention of



- traffic crashes', *The Cochrane Database of Systematic Reviews*, issue 3, art. no. CD003201.DOI.10.1002/14651858.CD003201.
- Ross, HL 1993, 'Punishment as a factor in preventing alcohol-related accidents', *Addiction*, no. 88, pp. 997-1002.
- Selzer, ML, Rogers, JE & Kern, S 1968, 'Fatal accidents: the role of psychopathology, special stress, and acute disturbance', *American Journal of Psychiatry*, no. 131, pp. 903-906.
- Shinar, D 1998, 'Aggressive driving: the contribution of the drivers and situation', *Transportation Research*, part F1, pp. 137-160.
- Shinar, D & Compton, R 2004, 'Aggressive driving: an observational study of driver, vehicle, and situational variables', *Accident Analysis and Prevention*, no. 36, pp. 429-437.
- Spielberger, CD 1972, *Anxiety: current trends in theory and research: I*, Academic Press, New York.
- Spielberger, CD 1983, *Manual for the State-Trait Anxiety Inventory (STAI)*, Consulting Psychologists Press, PaloAlto, CA.
- Sukhai, A 2003, *An exploratory study of road rage, aggressive driving and other hazardous driving behaviour among a representative sample of motorists in Durban, South Africa*, Technical report, MRC-UNISA CVILP and The University of Natal Interdisciplinary Accident Research Centre (UNIARC), Durban.
- Sukhai, A, Seedat, M & Jordaan, E 2005, 'A study of anger and aggression in an African city's traffic environment', *Environment and Behaviour*, Submitted.
- Sukhai, A, Seedat, M, Jordaan, E & Jackson, D 2005, 'A city-level study of aggressive road behaviours: magnitude, predictors and implications for traffic safety', *South African Journal of Psychology*, vol. 35, no. 2, pp. 244-269.
- Watson, S 2000, *Results of a baseline survey on drinking and driving habits, conducted in bars, clubs and shebeens in the Durban Metro region, during September, October and November 2000*, Research report no. 2000/4, UNIARC, Durban.
- Wells-Parker, E, Bangert-Drowns, R, McMillen R & Williams, M 1995, 'Final results from a meta-analysis of remedial interventions with drink/drive offenders', *Addiction*, no. 90, pp. 907-926.
- Wells-Parker, E, Ceminsky, J, Hallberg, V, Snow, RW, Dunaway, G, Guiling, S, Williams, M & Anderson, B 2002, 'An exploratory study of the relationship between road rage and crash experience in a representative sample of US drivers', *Accident Analysis and Prevention*, vol. 34, no. 3, pp. 271-278.
- Whitlock, FA 1971, *Death on the road: a study in social violence*, Tavistock, London.
- Wiesenthal, DL, Hennessy, D & Gibson PM 2000, 'The driving vengeance

questionnaire (DVQ): the development of a scale to measure deviant drivers' attitudes, *Violence and Victims*, vol. 15, no. 2, pp. 115-136.

Wiesenthal, DL & Janovjak, DP 1992, 'Deindividuation and automobile driving behaviour', *The LaMarsh Research Program Report Series*, no. 46, Toronto, Ontario.

WHO, *Facts about injuries: road traffic injuries*, WHO, Geneva.

Zaal, D 1994, *Traffic law enforcement: a review of the literature*, Report no. 53, Monash University Accident Research Centre, Melbourne, viewed: 31 October 2005, <http://www.monash.edu/muarc/reports/muarc053.pdf>.

Zador, PL 1991, 'Alcohol-related relative risk of fatal driver injuries in relation to driver age and sex', *Journal of Studies on Alcohol*, no. 52, pp. 302-310.

Zador, PL, Krawchuk, SA & Voas, RB 2000, 'Alcohol-related relative risk of driver fatalities and driver involvement in fatal crashes in relation to driver age and gender: an update using 1996 data', *Journal of Studies on Alcohol*, vol. 61, no. 3, pp. 387-395.



