

# Behavioural Research in Road Safety 2008 Eighteenth Seminar



September 2010



# Behavioural Research in Road Safety 2008:

## **Eighteenth Seminar**

Although this report was commissioned by the Department for Transport (DfT), the findings and recommendations are those of the authors and do not necessarily represent the views of the DfT. While the DfT has made every effort to ensure the information in this document is accurate, DfT does not guarantee the accuracy, completeness or usefulness of that information; and it cannot accept liability for any loss or damages of any kind resulting from reliance on the information or guidance this document contains.

Department for Transport  
Great Minster House  
76 Marsham Street  
London SW1P 4DR  
Telephone 020 7944 8300  
Web site [www.dft.gov.uk](http://www.dft.gov.uk)

© Queen's Printer and Controller of Her Majesty's Stationery Office, 2010, except where otherwise stated

Copyright in the typographical arrangement rests with the Crown.

This publication, excluding logos, may be reproduced free of charge in any format or medium for non-commercial research, private study or for internal circulation within an organisation. This is subject to it being reproduced accurately and not used in a misleading context. The copyright source of the material must be acknowledged and the title of the publication specified.

For any other use of this material, apply for a Click-Use Licence at  
[www.nationalarchives.gov.uk/information-management/our-services/click-use.htm](http://www.nationalarchives.gov.uk/information-management/our-services/click-use.htm)

To order further copies contact:  
DfT Publications  
Tel: 0300 123 1102  
[www.dft.gov.uk/orderingpublications](http://www.dft.gov.uk/orderingpublications)

ISBN 978 1 84864 010 8

If you would like to be informed in advance of forthcoming Department for Transport priced publications, or would like to arrange a standing order, call 020 7944 4673.



Printed in Great Britain on paper containing  
at least 75% recycled fibre.

# Contents

1	Sustainable Safety: the safe system approach of the Netherlands <i>L. Aarts and F. Wegman</i>	1
2	Road safety strategy and targets: a retrospective and prospective view <i>K. McMahon</i>	16
3	<i>Foresight: Intelligent Infrastructure Futures</i> – implications for road safety <i>B. Lawton, J. Broughton and B. Johnson</i>	38
4	Truck drivers' compliance with road laws, regulations and researchers <i>D. Crundall, D. Poulter, P. Bibby, D. D. Clarke and P. Chapman</i>	69
5	A poor way to die: social deprivation and road traffic fatalities <i>D. D. Clarke, P. Ward, W. Truman and C. Bartle</i>	81
6	Ethnicity and injury risk in deprived areas: why a social marketing approach is needed <i>N. Christie, R. H. Kimberlee, R. Lyons, E. Towner and H. Ward</i>	94
7	A discussion-based module for learner driver training <i>B. Lang</i>	105
8	Has the introduction of hazard perception testing produced safer drivers: evidence from the Cohort II study <i>B. Sexton</i>	118
9	Influences on speeding in young male drivers <i>M. Gormley and R. Fuller</i>	133
10	EU research projects IMMORTAL and DRUID: epidemiology of drink and drug driving <i>R. Mathijssen and S. Houwing</i>	150
11	The UK Interlock demonstration project <i>A. Clayton</i>	163
12	Roadside surveys of drivers' alcohol levels: some issues of methodology <i>R. E. Allsop</i>	169
13	The deterrent effect of penalty points on speeding drivers <i>C. Corbett, E. Delmonte, A. Quimby and G. Grayson</i>	175
14	Low-cost engineering measures for speed management <i>S. L. Jamson, F. C. H. Lai and O. M. J. Carsten</i>	196

15	The psychology of speeding <i>F. P. McKenna</i>	213
16	Risk and the driving of emergency vehicles <i>T. Walsh, B. Hannigan and R. Fuller</i>	222
17	Driver behaviour on rural roads in Scotland <i>S. Stradling, E. Collins, C. Eynon and P. McLeod</i>	234

# 1

## Sustainable Safety: the safe system approach of the Netherlands

Letty Aarts and Fred Wegman  
SWOV Institute for Road Safety Research  
Leidschendam  
The Netherlands

### Introduction

We all want safer roads, but how do we achieve this? How can we build on a safer road system for ourselves and our children? We define road safety targets in time and we plan all kinds of road safety measures, but the question is what are we really aiming for? In other words, what is the vision behind our policy? Just as with other countries, the UK is facing a new strategic plan towards 2020. This raises special interest in the road safety policies and visions of other countries, such as Sweden and the Netherlands. This paper is about the road safety vision of the Netherlands – Sustainable Safety. This vision was implemented in the last decade and revised a few years ago. This paper presents the history of the vision and its implementation, the lessons that we learned, and how we are facing the road safety future in the Netherlands.

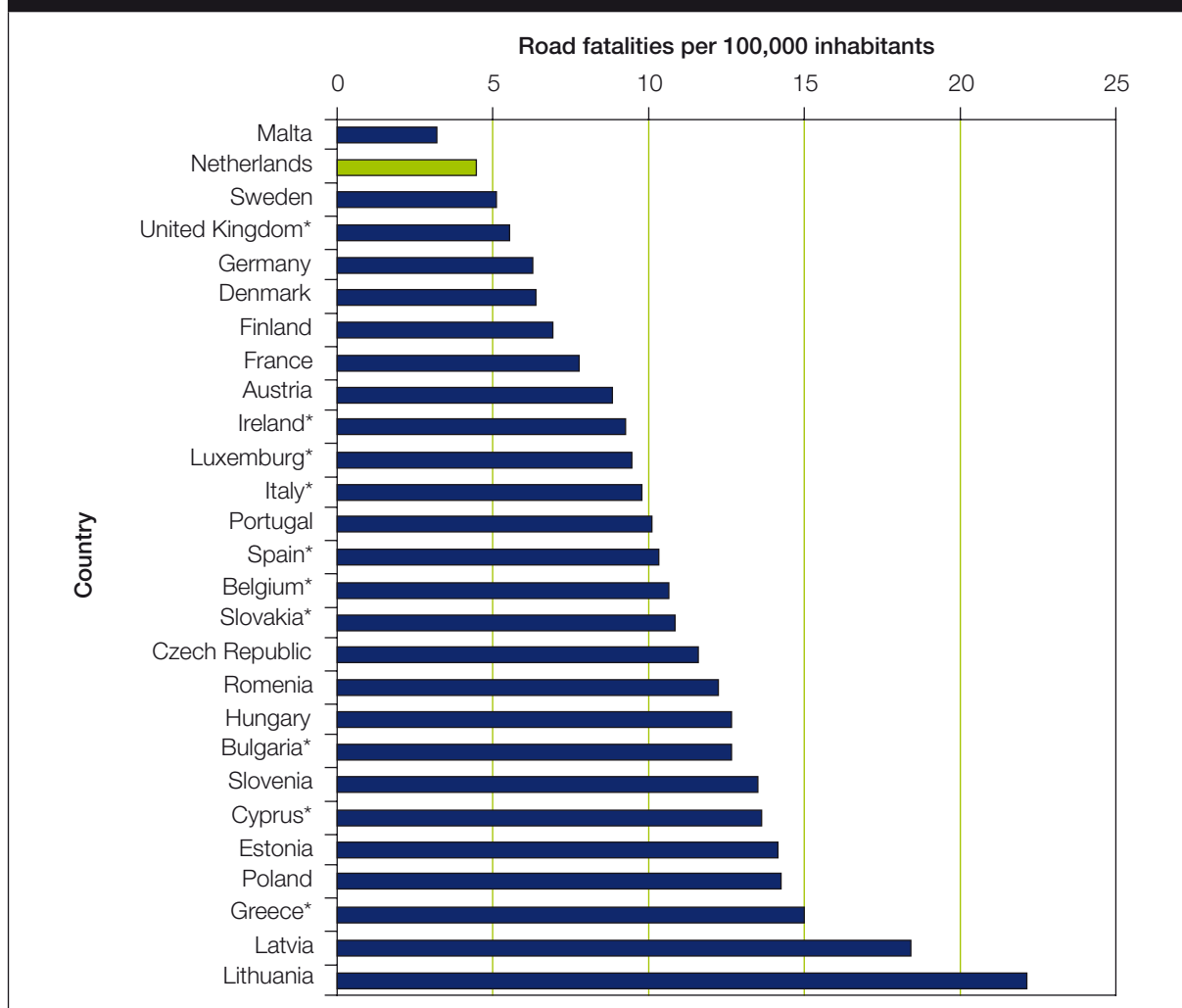
### Road safety developments and targets in the Netherlands

In the Netherlands about 800 road traffic participants are fatally injured and about 20,000 are hospitalised out of a population of somewhat less than 16.5 million inhabitants. Compared with the other countries in the EU, and even the world, the Netherlands has one of the top positions in road safety, followed by Sweden and the UK (see Figure 1).

Based on the development of a still decreasing number of road traffic victims, road safety targets have been defined for 2010 and 2020 (see Figure 2; V&W and VROM, 2006 – updates available at [www.verkeerenwaterstaat.nl/english](http://www.verkeerenwaterstaat.nl/english)). These

targets are a combination of ambitious targets for road safety authorities and the price society is willing to pay for a safer road system as far as restrictions in freedom on the road is concerned.

**Figure 1: Number of road fatalities per 100,000 inhabitants for the current 27 Member States averaged over 2005–07 (\* = 2004–06) (source: IRTAD, CARE, Eurostat)**



**Figure 2: Development of road traffic fatalities and road safety targets of the Netherlands (source: DVS Centre for Transport and Navigation/Ministry of Transport, Public Works and Water Management)**





# Key elements of road safety and the proactive system approach

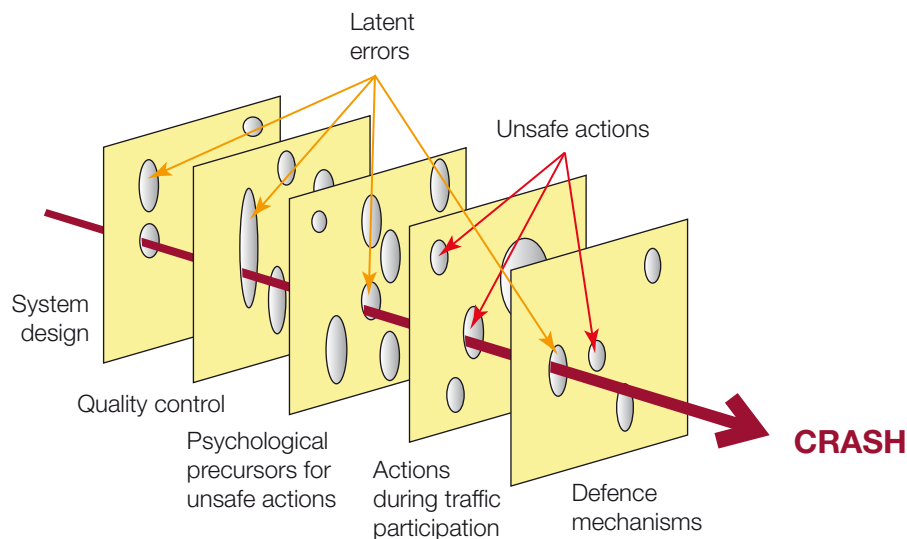
Transportation brings along a number of inherent and fundamental risk factors, which can be influenced by the way the traffic system is designed in all its aspects. In order to know how to achieve lower casualty rates and improve road safety targets, it is important to understand these risk factors and what can be done to decrease casualty rates or their consequences.

The key element in road safety is the human being. As long as a person is behind the wheel or transporting himself, traffic has to deal with the physical vulnerability of the person and also his psychological features: a human being is fallible and not always willing to abide by the rules. Human factors that increase the risk of a crash are: inexperience, psychoactive substances such as alcohol and drugs, (mainly visual) ailments, fatigue and distraction.

Other key elements are the physical and social environment of the human being. Our environment can give us protection and can be forgiving to any failures that we make. The environment also influences our behaviour and the consequences of it. The interaction between the human being and the environment makes three fundamental risk factors. These factors are speed and mass in combination with protection. Speed is related to crash risk as well as to the severity of the outcome of a crash. It is not only absolute speeds that have been found to be important in these relationships, also differences in speed (for an overview, see Aarts and Van Schagen, 2006). While in motion, the total mass of a vehicle combined with its speed produces kinetic energy, which is converted into other energy forms during a crash and can cause material and/or bodily damage. In a crash between two incompatible parties, the lighter party is at a disadvantage because this party absorbs a lot more kinetic energy and the vehicle generally offers less protection to its occupants than a heavier vehicle. Furthermore, in view of their stiffness and structure, heavier vehicle types generally offer better protection to their occupants in the event of a crash. The injury factor increases to 1.4 if the crash opponent weighs 1,000 kg, and increases to a factor of 1.8 if the crash opponent weighs 1,500 kg (Elvik and Vaa, 2004).

The most important feature of inherently or sustainably safe traffic is that **latent errors** in the traffic system (gaps in the system that result in human errors or traffic violations causing crashes) are, as far as possible, prevented (Reason, 1990; see Figure 3). This approach ensures that **road safety depends, as little as possible, on individual road-user decisions**. The responsibility for safe road use should not be placed solely on the shoulders of road users, but also on those who are responsible for the design and operation of the various elements of the traffic system (such as infrastructure, vehicles and education).

**Figure 3: Schematic representation of the development of a crash (large arrow) caused by latent errors (system gaps) and dangerous actions in different elements of the road traffic system (after Reason, 1990) – if the arrow encounters ‘resistance’ somewhere, a crash will not occur**



## The Sustainable Safety vision: history, implementation and lessons

The Sustainable Safety vision was launched in 1992, as a cooperative product of SWOV (the Dutch national road safety research institute (Stichting Wetenschappelijk Onderzoek Verkeersveiligheid)) and other research institutes (Koornstra *et al.*, 1992). Before Sustainable Safety really became a leitmotif behind improving road safety in the Netherlands, demonstrations projects were started in 1995. Two years later the Start-up Programme ‘Sustainable Safety’ followed, which provided the biggest impulse to the implementation of the Sustainable Safety vision. The following sections describe the background of each of these phases, their content and the lessons that were learned.

## The core of Sustainable Safety – its introduction

The goal of inherently or sustainably safe road traffic is to prevent crashes and, where this is not possible, to reduce the probability of severe injury. This is achieved by means of a proactive approach, with ‘man as the measure of all things’ as a starting point. This approach recognises people’s physical vulnerability and fallibility. The human characteristics are dealt with in a proactive approach of the elements ‘road’, ‘vehicle’ and ‘man’. First, the surroundings, such as the road and

the vehicle, must be modified to meet human characteristics. In addition, education should ideally prepare people for the traffic task and, finally, their behaviour must be supervised.

In the original Sustainable Safety vision, three safety principles were central:

- **functionality** of roads;
- **homogeneity** of masses and/or speed and direction; and
- **predictability** of road-user behaviour by a recognisable road design.

Traffic flow organisation manifests itself in many ways, and with various and different objectives. As long ago as the 1960s, a functional road categorisation system was introduced (Buchanan, 1963), which formed the basis for the Sustainable Safety **functionality principle**. This principle starts from the premise that roads can only have a single function (**mono-functionality**) and that they must be designed and used in keeping with that function. The road function can, on the one hand, be ‘to facilitate traffic flow’ (associated with ‘through roads’), and, on the other hand, ‘to provide access to destinations’ (associated with ‘access roads’). In order to provide a proper transition between ‘giving access’ and ‘facilitating traffic flow’, a third category of function was defined: the ‘distributor road’. These road types are implemented in a hierarchical road structure (Figure 4).

Figure 4: **Functional categorisation of roads – example of the province of Fryslân, the Netherlands**



The principle of **homogeneity** is based on biomechanical research. Research by Ashton and Mackay (1979), for instance, has shown that the fatality risk for pedestrians is low when they are involved in a car crash at 30 km/h. With crash speeds higher than 30 km/h, fatality risk increases dramatically. A crash at 70 km/h or faster is almost always fatal for the pedestrian. In order to deal with the issue of vulnerability in a proactive way, it is important to control differences in speed,

direction and mass. This forms the foundation of the **homogeneity principle**: where traffic is moving at high speeds (for instance on through roads), road users should be separated spatially. Where vehicles or road users with great differences in mass have to use the same road space, such as on access roads and at distributor road intersections, speeds will have to be so low that, should a crash take place, the most vulnerable road users involved should not sustain fatal injuries.

The road planning and design not only has a function in preventing the severity of a potential crash, it also has a function in a psychological way. If the road design supports the expectations of road users, they will behave in a less insecure way and make fewer errors that could lead to road crashes. Their behaviour will become more homogenous and, therefore, more predictable for other road users. Ideally, the picture of the road is so clear for road users that it can be considered to be 'self-explaining' (Theeuwes and Godthelp, 1993). In such a case, the road user needs no additional information to use the road safely. Conversely, if the road environment meets user expectations insufficiently, road users may miss relevant objects and delay the action needed to prevent a crash (e.g. see Theeuwes, 1991; Theeuwes and Hagenzieker, 1993).

For the design and layout of roads, the Sustainable Safety vision strives towards 'essential characteristics' that include all sustainable safety principles that can be applied to road infrastructure. A few years ago, it was decided to try to make roads at least more recognisable by giving each road type unique characteristics: the so-called 'essential recognisability characteristics'. They are an example of mainly sober infrastructure design because they mostly consist of markings and do not separate traffic physically at high speeds. Furthermore, due to a lot of variation in implementation, the recognisability of roads for road users is not guaranteed (Aarts and Davidse, 2008).

## Aims and lessons from the demonstration projects

After the original Sustainable Safety vision had gained political support, four Sustainable Safety demonstration projects were started from 1995. They were located in different parts of the Netherlands. The main aim of the demonstration projects was to gain experience through the implementation of the vision at a local authority level. Although the projects were still ongoing in 2001, the experiences were re-evaluated (Heijkamp, 2001).

The main lesson of the demonstration projects was that cooperation between the different parties needed to be improved, for instance between road authorities and the police. It also became clear that it was important to be transparent about the tasks and the available budgets of the different parties from the beginning of a project. The third lesson was that communication about the intended projects was essential in order to get public support, which appeared to be required in order to enable projects to be successful. A final comment that could be made about the demonstration projects is that, although it was not the primary aim to invent the best solutions, it could be seen as a missed opportunity that the implemented measures were not evaluated structurally. This would have delivered even more important information for future projects.

## The Start-up Programme

Perhaps the most important step taken since the launch of the Sustainable Safety vision was the Start-up Programme Sustainable Safety of 1997 (VNG *et al.*, 1997), a covenant between central government and regional and local authorities. The covenant comprised a package of 24 road safety measures that could be implemented comparatively quickly, coupled with a declaration of intent to make a policy agreement for a second phase of Sustainable Safety after the Start-up Programme was completed (foreseen in 2001). In parallel with the measures in the Start-up Programme, other measures have been taken during the period 1990–2005 (and some even earlier) that fit very well with Sustainable Safety.

The parties cooperated successfully, both in the preparation and in the implementation of the Start-up Programme. Regional and local authorities spent even more money on the implementation than was actually planned in the subsidy arrangement. As a result of the Start-up Programme, road authorities managed to categorise the entire road network in the Netherlands into three Sustainable Safety road types. The Start-up Programme chose to target access roads because of the wide support among the population to do something about these roads. This led to the large-scale implementation (even more than was planned) of urban 30 km/h and rural 60 km/h access roads. Furthermore, a number of regulatory measures were taken, such as moving mopeds from bicycle paths onto the carriageway.

Does the Sustainable Safety Start-Up Programme provide a good synthesis of the Sustainable Safety vision? In broad terms it does, provided we accept that the objective was to implement measures relatively quickly. For instance, the basic agreement concerning the categorisation of roads has been of great importance. Putting access roads to the fore has been a conscious choice within the Start-Up Programme. This was an attractive idea because there was much support within the population in general to do something about the problems on this type of road. It also created the opportunity to categorise the whole road network, which has now been completed. However, the emphasis on access roads has drawn attention away from distributor roads, which have a comparatively high crash risk. Despite the fact that this was understandable and reasonable (the problems are great and the possibilities for solutions limited), this meant that a large part of the problem on distributor roads has not yet been tackled, apart from the construction of roundabouts. Also, due to the emphasis on infrastructural measures, other types of measure, such as education and enforcement, have been developed quite independently from the rest.

We must also acknowledge that, although access roads were targeted, they have only been partially dealt with. Implementation was mostly carried out in a low-cost way as a consequence of the limited funds and the desire to implement Sustainable Safety on a large scale. However, we must now ask ourselves whether this was all too low-cost (see Figure 5).

With respect to accompanying policy, the Start-Up Programme has greatly facilitated the dissemination and sharing of acquired knowledge, particularly between local authorities. Websites, brochures, newsletters, platforms and working groups provided ample evidence of this. The Info Point Sustainable Safety has played a central role here. However, one point that was missing was a structural

Figure 5: Example of a sober 60 km/h zone



evaluation of measures on which the continuation of Sustainable Safety could build. A lack of knowledge of education is also worth noting. Much knowledge can still be gained concerning infrastructural measures. This knowledge is necessary in order to make cost-effective advances in the battle for road safety. Ad hoc evaluations indicate moderate to very positive effects of various (infrastructural) measures. We have estimated that all the infrastructural Sustainable Safety measures taken at the time of the Start-up Programme have together saved 6% of severe casualties (fatalities and in-patients) in the Netherlands (Wegman *et al.*, 2006).

## The advanced Sustainable Safety vision

More than a decade after the launch of Sustainable Safety and the start of the implementation, the time was right to update the vision. This has resulted in the advanced Sustainable Safety vision (Wegman and Aarts, 2006). The advanced vision critically examines the original Sustainable Safety vision. Amendments have been made where necessary because we have learned from our initial steps on the way towards a sustainable and safe road traffic system. Advancing insights and new developments also necessitated an update of the Sustainable Safety concept. The advanced vision also emphasises non-infrastructural aspects of the vision, such as the embedding of education and enforcement, the new possibilities of 'Intelligent Transport Systems' (ITS), and the integrated approach of all these elements. The advanced vision is meant to inspire the policy agenda of government and local authorities, social organisations, etc. It contains many recommendations that provide points of departure for further elaboration into road safety measures for the coming 15 to 20 years.

One of the new contents of the advanced vision is the extension of the three original Sustainable Safety principles with two extra principles:



- **forgivingness** of the environment in a physical and social way; and
- **state awareness** (awareness of their own task capability) of the road user.

These new principles address the issue that not all road users are similar. The advanced Sustainable Safety vision emphasises that traffic should be sustainably safe for **everybody** and not just for ‘the average road user’. This is illustrated by the task capability model of Fuller (2005). This model states that the task capability level of road users is the result of their competences and their situational state (e.g. influenced by fatigue, stress, drugs, etc.). To be a safe road-user, the task capability should be good enough to cope with the task demands. These task demands are dominated by the environment, but may be altered by the road user himself, for example by driving faster or slower.

People differ in their task capability. For example, inexperienced road-users and the elderly have poorly developed or declining competences and thus a lower task capability (see Figure 6). The average road-user also has a lower task capability if he/she is tired or under the influence of alcohol or drugs, for example. This is why basic **generic road safety measures** must be supplemented with **specific measures** targeted at groups with a diminished task capability. These specific measures are mainly a matter of education and ITS aimed at the new Sustainable Safety principle of **state awareness**. If road users can correctly assess their own task capability (or state), they can decide not to travel or make fewer demands on themselves when they assess themselves as being insufficiently capable of driving a car – examples are not having enough driving experience, being too tired, having drunk too much alcohol, etc. Because state awareness is a new principle, it has to be elaborated further (Figure 7).

Figure 6: Age- and sex-related risks, particularly as a result of competencies that have to do with experience and risk-seeking behaviour – for elderly people, increased physical vulnerability plays an important role

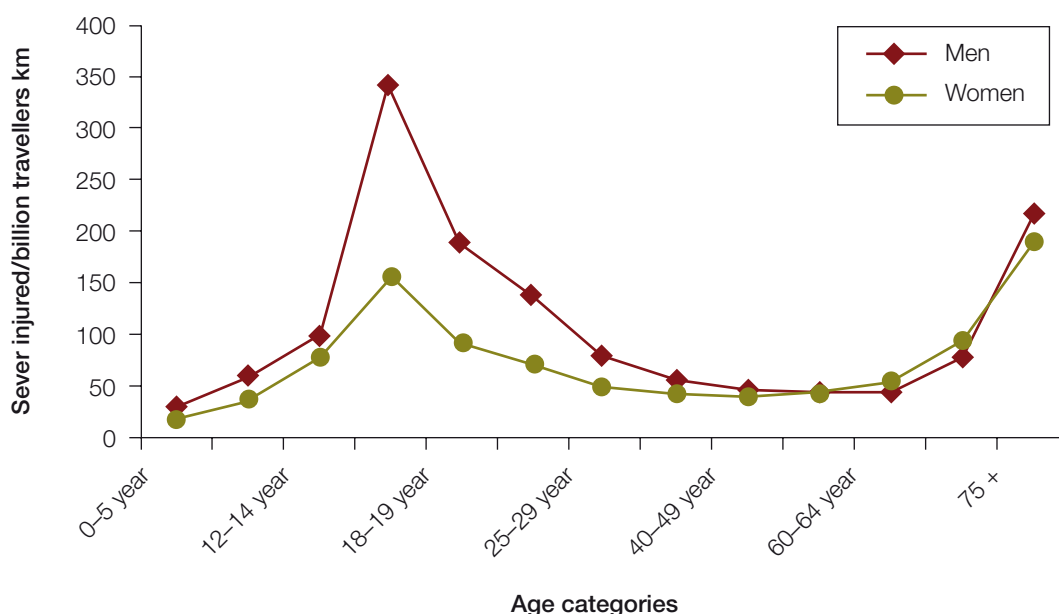
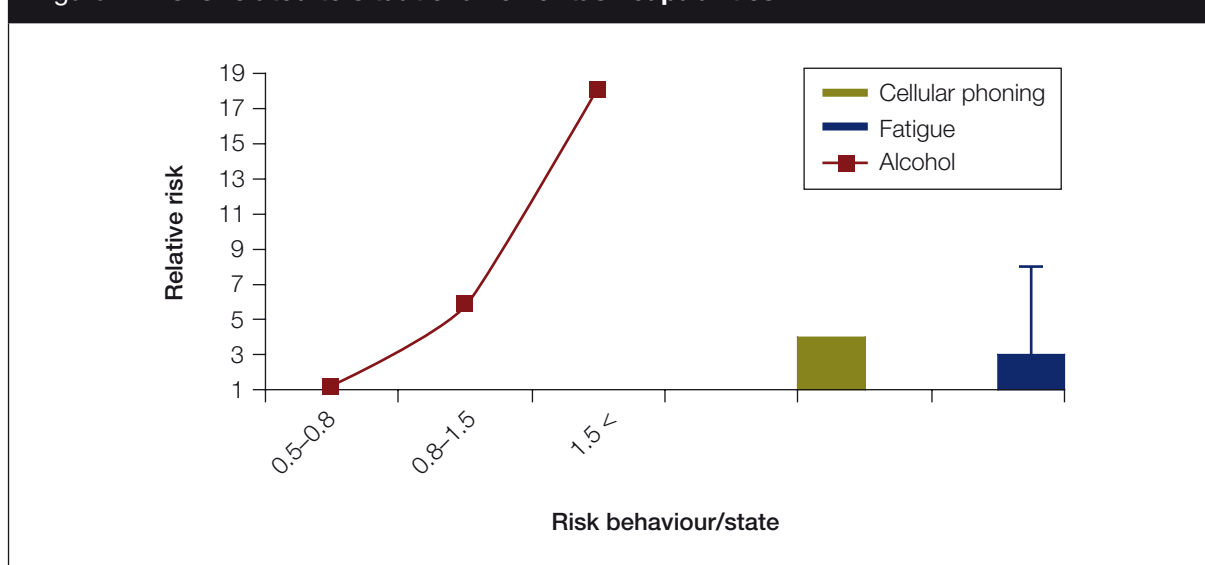


Figure 7: Risks related to situational lower task capabilities



The principle of forgiveness is not so much directed at the individual road user, but more at his environment. At the social side of this principle, it is stated that, by being engaged consciously in a safe, anticipating driving style, other road-users could profit from each other because possible errors from their side can be absorbed by the other road-user if a potential conflict arises. Forgiving road-user behaviour (e.g. anticipating behaviour of other road-users and giving more space) by more capable road-users should enable less capable road-users to make errors without serious consequences. In order to work correctively, the less capable should recognise their errors as such and still get feedback on their behaviour, but the errors should less often result in a crash. As this principle is new, we need to elaborate on this further in the future.

Although the forgiveness principle is new in Sustainable Safety, road authorities have been experimenting with forgiveness by implementing various forms of safe shoulders, as a means of physical forgiveness. Calculations teach us that the large-scale implementation of safe shoulders would save many traffic casualties. The Dutch Government now has initiated a national programme on safe shoulders.

## Safe speeds and credible speed limits

One of the central issues within road safety is the management of speeds. In the advanced vision, special attention is directed at the management of speed as a perfect example of how an integral approach could be taken. The speed management vision of the advanced Sustainable Safety vision is divided into a number of steps. First of all, safe speed limits should be taken as a point of departure for the whole road network. The safe speeds that were defined in the advanced Sustainable Safety vision are adapted from the Swedish approach (Tingvall and Haworth, 1999) and are shown in Table 1.

However, one should not be blind to the fact that many current speed limits are being very widely flouted, and some individual road-users experience 'going fast' as fun, exciting and challenging. SWOV estimated that if everyone were to comply with existing speed limits, this would lead to a reduction of 25–30% in the number



**Table 1: Proposal for safe speeds in particular conflict situations between traffic participants (Tingvall and Haworth, 1999)**

Road types combined with allowed road-users	Safe speed (km/h)
Roads with possible conflicts between cars and unprotected road-users	30
Intersections with possible conflicts at right angles between cars	50
Roads with possible frontal conflicts between cars	70
Roads with no possible frontal or lateral conflicts between road users	$\geq 100$

of casualties (Oei, 2001). If safe speed limits were to be introduced, and if road users complied with them, the benefits could be even greater. Speed limits have to be credible for the road user; that is, they have to be seen as logical in the given circumstances. In the short term, apart from setting safe and credible limits, good information needs to be given to road users (the principle of **predictability**). Next, we have two instruments that have proved effective in the past and that, if put into practice appropriately, will also be usable in the future: physical speed-limiting (physical) measures and police enforcement. In the longer term, and making use of ITS, we recommend that speed limits are made dynamic. This will result in speed limits that are not coupled inflexibly with a given road, but that are adapted to the prevailing conditions.

In order to attain sustainably safe speeds, the following phased plan can be used:

- identify criteria for safe speeds and credible speed limits and minimum requirements for road-user information;
- survey the road network in order to assess whether the road environment and the existing speed limits are in conformity with each other (see Figure 8), and implement adaptations (to the road environment or the speed limit) where necessary;
- re-orientate regarding the enforcement of speeds of intentional violators; and
- prepare for and introduce dynamic speed limits.

**Figure 8: Similar speed limits of 50 km/h with very different road design, environment and traffic circumstances.**

We recommend looking for the appropriate harmonisation of speeds that serves safety, credibility, the environment and accessibility.

## Policy issues in the advanced vision

At the beginning of Sustainable Safety, the view of implementation had the following characteristics (Koornstra *et al.*, 1992; Wegman, 2001):

- Sustainable Safety is a scientifically founded, integrated approach to the traffic system, aimed at reducing the possibility for road-user error. The approach strives, among other things, for a functionally established road network, predictable traffic situations and homogeneous traffic behaviour, where subsequent implementation needs to be sustained over many years, leading to the maximum possible reduction of road traffic casualties.
- Sustainable Safety requires coordination of different tasks, whereby the degree of freedom of the public organisations involved to deviate from the content of Sustainable Safety is limited to some extent, and where the necessary funding has to be provided based on rational considerations (often expressed in cost/benefit and cost-effectiveness considerations).

Since the end of the 1980s, the Dutch Government can be characterised by a distinct trend towards decentralisation. In a variety of policy areas, policy design, development and implementation have been delegated to regional and local levels. This also applies to road safety policy. Local and regional authorities can, independently, undertake the implementation of road safety measures and deliver tailor-made solutions for their areas. At the same time, the idea has taken hold that organisations other than local and regional authorities are also important actors in road safety policy. For example, non-governmental organisations and pressure groups, driving schools, professional drivers and transport companies also determine what happens in road traffic. The implementation of Sustainable Safety has, therefore, become much more complex in recent years, and in the hands of local and regional authorities and pressure groups to an increasing extent. We can speak of a network of decision making that runs across society.

We expect that the implementation of Sustainable Safety to be better and easier if attention is devoted to four related topics. These are brought together under the term of 'flanking policy': integration, innovation, knowledge development and knowledge dissemination. Using a variety of criteria, it is plausible that the implementation of Sustainable Safety will not so much take place within sectoral policy, but rather as an element of other policy areas (facet policy). Here we see two lines of development: enlargement of the area of work, and possibly organisational integration with other topics. Integral considerations are desirable regarding traffic and transport (quick, clean and safe) and road infrastructure investment decisions. Integral considerations and cooperation in implementation are complicated in terms of content and organisation. We recommend conducting a survey first, and based on this survey carrying out the practical implementation of this enlargement and integration, and using the results as a starting point for targeted and practical implementations.

Both the advanced Sustainable Safety vision, the wish to enlarge the area of work (more facet, less sector), and the new institutional setting ('decentralised where possible, centralised where needed') ensure that in the further implementation of Sustainable Safety new and unknown paths will have to be followed. This requires much 'policy energy', especially if the wheel is reinvented in many places. Therefore, stimulating policy innovation is important.

Based on experiences in the implementation of Sustainable Safety up till now, we can draw the conclusion that the learning capacity of road safety professionals has been modest. This makes it difficult for us to take the next steps. Reinforcing knowledge development is therefore required. Given the broad character of Sustainable Safety, knowledge development on all facets and aspects of Sustainable Safety can best be delivered in a structured way. We need to give attention to the availability and quality of basic data, and to cluster research activities. Here we recommend fostering international cooperation.

Existing forms of knowledge dissemination should be better harmonised in order to efficiently provide road safety professionals with high-quality knowledge. Special attention should be devoted to professional education. We recommend using Sustainable Safety as a road safety communication carrier to citizens and road users. In this way we can obtain more societal recognition for road safety, the Sustainable Safety principles will become better known and support can be built up for tangible measures.

## Recent developments and conclusions

The advanced Sustainable Safety vision has been disseminated throughout the Netherlands, and also abroad. Some elements are already adopted, while some have to be elaborated first before implementation can begin. Recently, the Netherlands Ministry of Transport, Public Works and Water Management has been involved in the making of a new strategic road safety document towards 2012 and 2020. This strategic document has the Sustainable Safety vision as one of its pillars – Sustainable Safety is the vision within this document. In the process of coming to a strategic plan that is both acceptable from the point of view of what can be done on the road safety problem and what is (supposed to be) accepted by the public, SWOV has defined five viewpoints from which road safety may be improved further (Wegman, 2007). First of all, it is important to have public support for road safety as a social problem. This may be done by giving continuous attention to road safety issues and to address the issues in a compelling way. Secondly, government should take and maintain all road safety measures that are known to be effective at the moment. Thirdly, latent errors have to be eliminated from the system. Road safety should be embedded within other policies and, finally, safe access to traffic should be regulated. By taking these five viewpoints into account in road safety policy, a 'Sustainably Safe' road system may become a reality. They may ask for social debates and political choices, but will return in reaching ambitious road safety targets.

# References

- Aarts, L. T. and Davidse, R. J. (2008) Behavioural effects of predictable rural road layout. A driving simulator study. *Advances in Transportation Research. An International Journal*, Section A 14, 25–34.
- Aarts, L. T. and van Schagen, I. N. L. G. (2006) Driving speed and the risk of road crashes: a review. *Accident Analysis and Prevention*, 38, 215–224.
- Ashton, S. J. and Mackay, G. M. (1979) Some characteristics of the population who suffer traumas as pedestrians when hit by cars and some resulting implications. *Proceedings of the Conference of the International Research Committee on Biokinetics of Impacts (IRCOBI) on the Biomechanics of Trauma*, 5–7 September 1979, Göteborg.
- Buchanan, C. (1963) *Traffic in Towns: A Study of the Long-term Problems of Traffic in Urban Areas*. London: Her Majesty's Stationery Office.
- Elvik, R. and Vaa, T. (2004) *The Handbook of Road Safety Measures*. Amsterdam: Pergamon Press.
- Fuller, R. (2005) Towards a general theory of driver behaviour. *Accident Analysis and Prevention*, 37(3), 461–472.
- Heijkamp, A. H. (2001) *Duurzaam veilig: 5 jaar gedemonstreerd. (Sustainable Safety: 5 Years of Demonstration.)* (In Dutch.) Rotterdam: DVS Transport Research Centre.
- Koornstra, M. J., Mathijssen, M. P. M., Mulder, J. A. G., Roszbach, R. and Wegman, F. C. M. (red) (1992). *Naar een duurzaam veilig wegverkeer: Nationale Verkeersveiligheidsverkenning voor de jaren 1990/2010. (Towards Sustainably Safe Road Traffic: National Road Safety Survey for 1990/2010.)* (In Dutch.) Leidschendam: SWOV Institute for Road Safety Research.
- Oei, Hway-liem (2001). *Veiligheidsconsequenties van intelligente snelheidsadaptatie ISA. [Safety consequences of intelligent speed adaptation ISA.]* (In Dutch.) R-2001-11. SWOV, Leidschendam.
- Reason, J. (1990) *Human Error*. Cambridge: Cambridge University Press.
- Theeuwes, J. (1991) *Visual Search of Traffic Scenes*. IZF 1991 C-18. Soesterberg: TNO Human Factors.
- Theeuwes, J. and Godthelp, H. (1993) Self-explaining roads. In J. L. de Kroes and J. A. Stoop (eds), *Safety of Transportation*. Delft, The Netherlands: Delft University Press. pp. 56–66.
- Theeuwes, J. and Hagenzieker, M. P. (1993) Visual search of traffic scenes: on the effect of location specifications. In: A. R. Gale (ed.), *Vision in Vehicles IV*. Amsterdam: Elsevier. pp. 149–158.

Tingvall, C. and Haworth, N. (1999) *Vision Zero: an ethical approach to safety and mobility. Proceedings of the 6th ITE International Conference – Road Safety and Traffic Enforcement: Beyond 2000*, Melbourne.

V&W and VROM (2006) *Mobility Policy Document. Part VI. Officially adopted policy document*. The Hague: Ministry of Transport, Public Works and Water Management & Ministry of Housing, Spatial Planning and the Environment.

VNG, IPO, VenW and UVW (1997) *Intentieverklaring van de Minister van Verkeer en Waterstaat, het Interprovinciaal Overleg IPO, de Vereniging van Nederlandse Gemeenten VNG en de Unie van Waterschappen UVW over het Startprogramma Duurzaam Veilig*. (Declaration of intent by the Minister of Transport, the Inter-provincial Round Table, Association of Netherlands Municipalities, and the Union of Water District Boards concerning the Start-up Programme Sustainable Safety.) (In Dutch.) The Hague: Ministry of Transport, Public Works and Water Management, Inter-provincial Round Table, Association of Netherlands Municipalities, and the Union of Water District Boards Den Haag.

Wegman, F.C.M. (2001). *Veilig wat heet veilig: SWOV-visie op een nóg veiliger wegverkeer*. [Safe, what is safe: SWOV vision on even safer road traffic.] (In Dutch.) R-2001-28. SWOV Institute for Road Safety Research, Leidschendam.

Wegman, F. C. M. (2007) *Neem het zekere voor het onzekere. (Take the Certain Way Instead of the Uncertain Way.)* (In Dutch.) R-2007-10. Leidschendam: SWOV Institute for Road Safety Research.

Wegman, F. C. M. and Aarts, L. T. (ed.) (2006) *Advancing Sustainable Safety. National Road Safety Outlook for 2005–2020*. Leidschendam: SWOV Institute for Road Safety Research.

## 2

# Road safety strategy and targets: a retrospective and prospective view

Kate McMahon

Independent Road Safety Consultant, formerly Head of Road Safety Strategy Division DfT

## Introduction

A casualty reduction target was first set in Great Britain in 1987. This target was to reduce all road traffic casualties by a third by 2000 compared with the average for 1981–85. The target followed an Interdepartmental Review of Road Safety that was set up in 1983 in the light of concern that progress on reducing casualties appeared to have plateaued. Between 1981 and 1985 casualties of all severities fell from 325,000 to 318,000, an average of 322,000 over the five-year period. At the same time, deaths in road crashes fell from 5,846 to 5,165, averaging 5,598, and killed and seriously injured (KSI) together averaged 124,000.

The Review identified factors that would influence the number of casualties, such as an increase in the elderly population and rising levels of car ownership. Three priority concerns were established: the protection of vulnerable road users, reconciling the demands of mobility with the need for safety, and reducing the contribution of human error to accident causation. The Report *Road Safety: The Next Steps* (Department of Transport, 1987) proposed that a road casualty reduction programme should be established:

- (a) to reduce casualties to two-thirds of the current level by the end of the century, through the sustained application of existing measures (including newly-developed measures not yet fully applied); and
- (b) to seek further reductions beyond those outlined in (a) by the identification of new measures and by the creation of a climate of opinion and understanding which is more sympathetic to the effective promotion of road safety.

The numerical casualty reduction target of about 220,000 was based on a table listing possible new countermeasures and estimates of the casualty reductions that they might achieve. The estimates combined the results of analysis with more judgemental assessment in areas such as education and publicity.



Although setting a target was effective in generating new interest and activity in road safety post-1987, and real progress was made in reducing fatal and serious casualties, the total number of casualties remained stubbornly above 300,000 as a result of an increasing number of slight casualties. By 1995, all casualties had fallen by just 3% to 311,000 compared with the baseline, but KSI had declined by 60% to 49,000. It was in the light of this differential progress that the Department of Transport began to consult in August 1996 about a new road safety target for the post-2000 period.

## The development of the strategy and targets for 2010

There were four key elements to the work that was carried out between 1996 and 2000 prior to the announcement of the new strategy and targets in March 2000:

- consultation;
- detailed analysis of road safety priorities and policy options;
- casualty forecasting and the development of options for targets; and
- the development of the Road Safety Strategy and the choice of targets for 2010.

### Consultation

The first step in the process of consultation on a new target was the publication, in August 1996, of *Targeting the Future* (Department of Transport, 1996), which set out the case for a new target and the possible options for the form of the target. Issues such as the target date, the level of disaggregation and types of target were discussed in the paper. The comparative success in reducing deaths and serious injuries, and the seemingly inexorable rise in slight casualties in step with traffic growth, were major factors to be considered. There was also discussion of the merits of a simple numerical target compared with a more complex rate-based one that would reflect performance relative to traffic growth.

In October 1997, the Department of the Environment, Transport and the Regions (DETR) announced that a new national casualty reduction target would be set for 2010. There would be separate targets for KSI and slight casualties. The new targets would be supported by a road safety strategy and progress would be monitored every three years.

The next stage in the consultation process was the setting up of the Safety Targets and Accident Reduction (STAR) Group to assist in the development of the new road safety strategy and targets. Membership was drawn from a wide range of organisations involved in road safety, reflecting recognition of the importance of advice and support from stakeholders. Members included representatives from other government departments, local government, the police and road safety experts (see

Appendix 1). This involvement with the wider road safety community was a different approach from the previous, largely internal, review process, and it built on the achievement of the casualty reduction target for 2000 in generating both government and non-government activity.

Ten sub-groups were set up to work on specific issues:

- pedestrians and cyclists;
- vehicle engineering;
- numerical targets;
- education and publicity;
- driver impairment;
- driver training;
- motorcyclists;
- speed and civil engineering;
- enforcement; and
- consultation.

The sub-groups drew on the main STAR membership but also included wider representation from road-user groups, researchers and non-governmental organisations (NGOs). The work of the STAR sub-groups was underpinned by detailed analysis that is described in the next section.

## **Detailed analysis of road safety priorities and policy options**

A broad review of the current casualty position was carried out in 1996–97. It focused on specific road-user groups' casualty trends and likely policy options that would be effective in reducing casualties over the next decade. The full review, *Road Safety Strategy: Current Problems and Future Options* (DETR, 1997a), and a summary document that drew together the main conclusions, *Road Safety: Towards Safer Roads* (DETR, 1997b), were published in 1997. These documents were the starting point for the development of the new road safety strategy, and they presented the current view of where road safety policy should be directed over the next target period.

In parallel with this broader analysis, the Transport Research Laboratory (TRL) was contracted to produce three expert reviews of specific topics:



- road engineering measures (Lines and Woodgate, 2000);
- vehicle safety measures (Lowne, 2000); and
- road-user measures (Maycock, 2000).

These detailed reviews summarised recent developments and assessed the potential for innovatory measures to achieve casualty reductions by 2010.

This analytical process, together with the results from the wider road safety research programme, formed the evidence base for the strategy and targets development.

A third strand of analysis that informed the new strategy was the review of speed policy, *New Directions in Speed Management*, that was published in March 2000 (DETR, 2000) at the same time as the Road Safety Strategy. The Speed Review was set up in October 1998 following the publication of the White Paper *A New Deal for Transport: Better for Everyone* (DETR, 1998). It had the objective ‘to develop a speed policy that takes account of the contribution of reduced speeds to environmental and social objectives as well as to road safety’. Wide consultation with representatives of environmental interests, motorists, local authorities, the police, academics and other interested parties was undertaken as part of the review process.

## Forecasting and development of options for targets

The Next Steps Review in 1987 and the target for 2000 resulted in the bringing forward of a range of road safety measures. Despite this, by 1997 the target was clearly unlikely to be achieved for all casualties, and an aim of the target setting process for 2010 was to develop a more robust methodology for forecasting future casualty trends, and for developing options for targets to reflect possible future transport scenarios and policy options.

The STAR Numerical Targets Sub-group was charged with this work. The group included membership from the DETR, University College London, TRL, the Scottish Office and an independent consultant (see Appendix 2). The methodology that was developed has been described in detail in the TRL report *The Numerical Context for Setting National Casualty Reduction Targets* (Broughton *et al.*, 2000). The main elements of the methodology are summarised in this section.

Previous TRL analysis had shown that a simple statistical model based on trends in casualty rates could be used to describe the relationship between traffic volume and number of casualties. Traffic volume reflects such factors as population, economic activity, employment rates and costs of travel, so that it also acts as a proxy for other factors that are likely to influence casualty trends. Uncertainty over the future growth of traffic can be handled by preparing forecasts for a range of transport scenarios.

The forecasting methodology operated in two main stages:

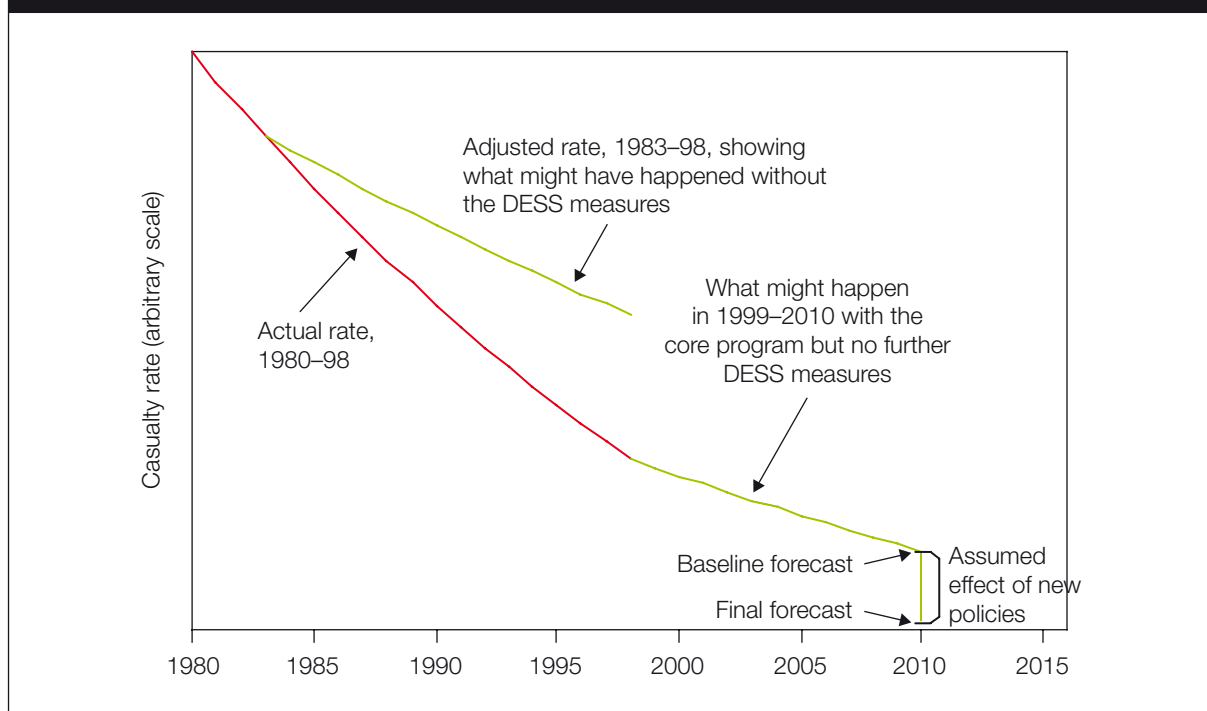
- prediction of the number of casualties that might be expected in 2010 with various volumes of road traffic if current road accident trends continue; and
- the incorporation of assessments of the likely effectiveness of further developments in the various areas of road safety.

A key element of the first stage was to identify the contribution of past road safety measures to the casualty reductions of the past decade. It was possible to identify separately the effects of three sets of measures: drink-drive policy, road safety engineering and vehicle secondary safety measures, the DESS measures. The combination of all other road safety activities was termed the 'core programme'. The future road safety strategy would contain DESS measures, measures from the core programme and new measures.

Disaggregated forecasting models were developed for the main road-user groups based on trends in casualty rates adjusted to remove the effects of the DESS measures. This procedure produced 'baseline' forecasts for casualty rates in 2010. These casualty rates were then combined with predictions of the volume of traffic for a range of scenarios to produce 'baseline' forecasts of casualty numbers in 2010 for car users, pedestrians, cyclists, motorcyclists and others, for KSI and slight casualties separately.

The final stage in the forecasting process was to apply the assumed effects of measures in the new road safety strategy (including further DESS measures) to the baseline forecasts to produce forecasts for 2010 that reflected the likely effects of new policy measures. Figure 1 illustrates this process.

Figure 1: Illustration of forecasting method (source: Broughton *et al.*, 2000)



The traffic scenarios reflected a range of assumptions on levels of activity for each road-user group. For example, for car occupants it was assumed that traffic would be

at the levels (high, medium or low) in the 1997 National Road Traffic Forecasts, or would remain at 1996 levels. For pedestrians, scenarios assumed a continued decline in walking, stability at the 1996 level, or increased walking. Similarly, for other road users, assumptions were made to reflect the likely ranges of activity.

The effects of new measures were based on discussions in the STAR sub-groups of the measures in *Road Safety Strategy: Current Problems and Future Options* (DETR, 1997a), the analysis in the three expert review papers (Lines and Woodgate, 2000; Lowne, 2000; Maycock, 2000), and a process of evidence review and informed judgement by the members of the Numerical Targets sub-group. The TRL report *The Numerical Context for Setting National Casualty Reduction Targets* (Broughton *et al.*, 2000) gives details of the assumptions that were made. It was desirable that the future target should be seen to be achievable and therefore evidence-based, but also demanding in order to encourage activity. The assumed effects of new measures therefore incorporated an aspirational element as well as building upon existing measures. The resulting assumptions are shown in Table 1.

**Table 1: Assumed effects (%) of new policies (source: Broughton *et al.*, 2000)**

	KSI	Slight
New road safety engineering programme	7.7	6.9
Improved secondary safety in cars	8.6	
Other vehicle safety improvements	4.6	3.6
Motorcycle and pedal cycle helmets	1.4	
Safety on rural single-carriageways	3.4	1.2
Reducing accident involvement of novice drivers	1.9	2.6
Additional measures for		
pedestrian and cyclist protection	1.2	0.8
speed reduction	5.0	5.0
child protection	1.7	1.1
improved driver behaviour	1.0	1.0
Reducing casualties in drink/drive accidents	1.2	0.8
Reducing accidents during high-mileage work driving	1.9	2.3
Combined effect	35	23

The output of the forecasting methodology was a set of forecasts by road-user groups for KSI and slight casualties for 36 transport scenarios. The forecasts were expressed as numbers of casualties in 2010 relative to the 1994–98 average. The forecast range was 42–57% of the baseline average for KSI, i.e. a reduction of 43–58% based on the optimistic assumption that all the policies assumed in the forecasting modelling procedure would be adopted and would have the assumed effects. For slight casualties, the forecasts ranged from a reduction of 9% to an increase of 21%.

Although it was not proposed to have a separate target for fatality reduction, the forecasting models were also applied to fatalities to produce forecasts for 2010. Overall, the fatality forecasts were highly correlated with those for KSI, which was considered to be confirmation of the decision to focus on KSI for the target.

# Development of the Road Safety Strategy and choice of the targets

The Road Safety Strategy that was published in March 2000, *Tomorrow's Roads: Safer for Everyone* (DTLR, 2000), contained the Government's policy framework for improving road safety in 10 main themes:

- safer for children;
- safer drivers – training and testing;
- safer drivers – drink, drugs and drowsiness;
- safer infrastructure;
- safer speeds;
- safer vehicles;
- safer motorcycling;
- safer pedestrians, cyclists and horseriders;
- better enforcement; and
- promoting safer road use.

For each theme an Action Plan containing main policy proposals was set out, together with an implementation timetable. The policy measures in the Strategy were based on the evidence from research and analysis, and on the consultation process within the STAR group and with the wider road safety community. The aim was to produce an evidence-based Road Safety Strategy that would engage the community, encourage working in partnership, and would be supported by effective cross-governmental thinking and action. Although some of the policy measures that were proposed were relatively specific and detailed, others were, in broader terms, recognising that within the overall framework, detailed policy development would be required.

*Tomorrow's Roads* also contained the new casualty reduction targets. The selection of the targets was informed by the casualty reduction forecasts and the range of transport scenarios. The selection process involved judgement about the likelihood of the various scenarios, as well as the likelihood of implementation, and confidence in the predicted effectiveness of the various elements of the strategy. Ultimately the choice of targets was the culmination of a political process, but one which was based on detailed forecasting and analysis.

Three targets were chosen for 2010 compared with the average for 1994–98:

- a 40% reduction in the number of people killed or seriously injured in road accidents;

- a 50% reduction in the number of children killed or seriously injured; and
- a 10% reduction in the slight casualty rate, expressed as the number of people slightly injured per 100 million vehicle kilometres.

The 40% KSI target is at the lower end of the forecast range. This was deemed a stretching but achievable target, that allowed for the element of optimism in the forecasts as described above. The 50% target for children recognised the relatively poor performance in the UK compared with some other European countries and signalled the priority that the Government wanted to be given to child safety. The rate-based target for slight casualties was chosen because the forecasts had indicated that any reduction in the actual number of slight casualties was unlikely given the likelihood of continued traffic growth.

A key element of the Strategy was the undertaking to review the Strategy and targets every three years. This monitoring process was to be assisted by the setting up of a Road Safety Advisory Panel (RSAP) that included representatives from the main road safety stakeholders. Progress was monitored throughout each three-year review period by TRL using the forecasting methodology that had been developed for the target-setting process.

## Strengths and weaknesses of the process for development of the 2010 Strategy and targets

Casualty trends over the 1990s had shown a very clear divergence between reduction in KSI and an increase in slight casualties, resulting in the 2000 target for all casualties being far from being achieved. However, the major progress in reducing KSI meant that the overall verdict was one of significant success. It was clear that, for 2010, it would be essential to have separate targets for KSI and slight casualties, in the expectation that there would be continuing reduction in KSI, but that 'slights' could well increase in number, while the slight casualty rate fell indicating improved safety. This was a major improvement over the approach taken in 1987.

The decision that a separate target for fatalities was unnecessary was entirely logical on the evidence available in 1999 since both deaths and serious injuries were declining in parallel. However, it soon became clear post-2000 that this relationship was changing, and that fatalities were declining much more slowly than serious injuries. This change in trend had started around the mid-1990s for car occupants, but was not yet well enough established on the basis of the data available up to 1998 to affect the forecasts for 2010. In retrospect, with the benefit of hindsight, the importance of the headline figure for deaths on the road should have been taken into account and a separate fatality target set. This would have had the advantage of being in line with practice in most other countries and with international targets set by the European Conference of Ministers of Transport (ECMT) and the EU. Detailed sensitivity analysis on the recent trends in car occupant deaths, in particular, might have shown the emerging trend. But the question of a fatality target

was raised, discussed and rejected because the forecasting model predicted that it would have been the same as for KSI, and it was therefore considered to be an unnecessary complication.

The Strategy and targets were strongly evidence-based, being rooted in statistical analysis and research. The targets were ‘bottom-up’ and had credibility. This approach is in contrast to that adopted in many other countries where targets were ‘top-down’ and more aspirational. The benefit of the UK approach is that stakeholders have confidence that the targets are achievable with sufficient effort, and they are supported by a Strategy for delivery. The possible downside is that they are too closely linked to past trends and lack the ‘vision’ that deaths and serious injuries are unacceptable, and therefore are not sufficiently innovative and stretching.

The forecasting methodology relies on the continuation of past relationships between casualties and traffic trends. It also contains the implicit assumption that the level of under-reporting will remain constant. It is well known that the published road traffic casualty data are incomplete, with the level of under-reporting rising with the decline in severity. Since what is of interest in forecasting is long-term trends, reporting levels do not matter unless they change. The trend in slight injuries has been very different from that which was expected, which is plausibly due, at least in part, to a fall in reporting of slight accidents. Something similar may have happened in the case of serious injuries, contributing to the divergence between fatal and serious trends, but the evidence is much less clear.

A strength of the strategy development process up to 2000 was its consultative nature, with the clear objective of bringing all stakeholders on board in order to obtain buy-in and support for the delivery of the new Strategy. Setting up RSAP and its sub-groups has continued this openness, and together with the three-year Reviews has ensured that the implementation of the Strategy has been monitored. Continuing statistical analysis and research have contributed to performance monitoring and the understanding of emerging trends.

Although in-depth research has been carried out into fatal accidents involving car occupants and motorcyclists, and this research has increased understanding, there is still some uncertainty about the reasons for the divergence between the trends for fatal and serious casualties. In particular, the part played by the possible decline in reporting rates for serious casualties is not yet fully established. Research has indicated that, for car occupants, a contributory factor is declining driving standards as indicated by increases in drink-drive and loss of control accidents. Changes in the composition of the car fleet are a minor factor.

The divergence in the fatal and serious casualty trends has resulted in an upward trend in the severity ratio for both car occupants and motorcyclists. By 2006, car occupants had a higher severity ratio than any other road-user group, which raises the question of whether there had been some differential shift in reporting rates for serious casualties.

The 2010 Strategy and targets have delivered considerable gains in safety. The profile of road safety has been raised, and on many issues there has been an overall cultural shift towards safety. In urban areas there has been a significant benefit from



engineering solutions, particularly for vulnerable road users. The Strategy has benefited from being soundly based on research and statistical evidence.

However, despite these gains much remains to be done. The poor performance in reducing car occupant and motorcyclist deaths will need to dominate policy development over the next decade if the position of the UK relative to countries such as Sweden and the Netherlands is not to decline. Driver behaviour has been identified as a contributory factor, though for motorcyclists the dominant factor has been a resurgence in the popularity of motorcycling, particularly as a leisure activity. Despite support in principle for road safety policies, reluctance to accept the need for speed control, combined with reductions in police enforcement other than by cameras, has meant that excess and inappropriate speed remains a widespread problem and anti-social behaviour, such as drinking and driving, has risen among a minority of drivers.

A degree of complacency has been detectable, due in part to the success in delivering the targets. It is arguable that if the headline target had been for deaths, the failure to achieve a fast enough decline would have triggered more concern sooner. This has not been helped by vociferous media campaigns against speed cameras and the impression that has been engendered of an anti-motorist policy agenda.

## Looking ahead beyond 2010

### Monitoring performance against the targets

Performance in the delivery of the Strategy and achievement of the targets has been regularly monitored with annual monitoring reports from TRL (Broughton *et al.*, 2005, 2006, 2007, 2008) and two three-year reviews (Department for Transport, 2004 and 2007).

By 2006, KSI casualties were 33% below the baseline, and the forecasting model indicated that the 2010 target of a 40% reduction in KSI was likely to be exceeded. The reduction of 52% in child KSI already exceeded the 50% target. The target to reduce the slight casualty rate by 10% was achieved in 2002, and by 2006 the rate had fallen by 27%. However, deaths were only 11% below the baseline average, and the forecasting model predicted that the number of deaths in 2010 was likely to be 19% below the baseline.

The second three-year Strategy Review that was published in 2007 set the agenda for the issues and priorities that will need to be addressed post-2010 (Department for Transport, 2007):

- despite good progress on KSI, slow progress on reducing deaths;
- divergence in trends for deaths and serious injuries mainly for car users and motorcyclists;

- female deaths falling much faster than male deaths (24% against 5% by 2005);
- increase in crashes involving bad driver behaviour, for example single-vehicle crashes involving loss of control;
- upturn in deaths in accidents involving drink-driving;
- high-risk groups: motorcyclists, young drivers, those who drive for work;
- low seat-belt wearing rates among fatalities; and
- for children, boys and 11–15-year-olds are the key targets.

The Review also set out future policies to address the priority issues:

- continue with proven policies: improvements in road infrastructure, technology within cars and speed management;
- increase enforcement activity to address bad driver behaviour, for example drink-drive;
- enhance publicity campaigns;
- review and improve the consistency of local speed limit setting and promote more 20 mph limits;
- improve the driver training and testing system:
  - new competency and knowledge framework;
  - modern training syllabus; and
  - systematic assessment criteria to demonstrate the required level of competence;
- implement the Government's Motorcycling Strategy in partnership with industry and user groups; and
- create a culture change in employers on driving for work issues through education, the outreach programme and publicity.

The importance of partnership working is recognised in the Review as essential for the delivery of road safety objectives, and this is to be facilitated by setting up a new national Road Safety Delivery Board.

## **Lessons to be taken from the analytical approach adopted for the 2010 targets**

A greater level of disaggregation by severity is needed with a focus on understanding the reasons for the poor performance on fatalities relative to serious



injuries. Better understanding of under-reporting is essential in order to establish whether the fatality trend is a more reliable indicator of overall safety than the much more favourable serious injury trend. The forecasting methodology focuses on long-term trends, but the lesson from the change in the fatality trend is that it is vital to look carefully at emerging trends and to consider what would happen if they were a real turning point not a temporary blip.

The bottom-up approach has served well in terms of a strong evidence base, but it does have a tendency to perpetuate past trends rather than to consider a downward shift in trend, and is implicitly conservative. This is despite the level of optimism in the 2010 forecasts due to assumptions about policy implementation and success. For the future it would be appropriate to consider a top-down approach as well. What would need to be done to deliver particular levels of casualty reduction? Where are the large numbers of casualties that must be targeted in order to achieve a step change in safety over the next 10–15 years?

On this basis likely priorities are:

- young (male) drivers – 41% of dead drivers are aged 16–29;
- A(NBU) roads – about a third of all deaths;
- drink-drive – 18% of deaths;
- driver behaviour – increases in single-vehicle accidents, vehicles leaving the carriageway, overturning – all speed related? Speed contributed to a third of fatal crashes;
- seat-belt wearing – 34% of fatalities in the Nottingham study were not belted, especially in the rear seats where only 11% of males at night were belted (Clarke *et al.*, 2007);
- multiplicative risk factors – youth/inexperience, alcohol, speed, lack of seat belts; and
- head and chest injury treatment – nearly 50% of fatalities have head/neck injury (Ward *et al.*, 2007).

## The Safe System Approach

Many countries are facing up to similar road safety problems and realising that a fundamental shift is needed in the approach to road safety policy if casualty reduction is to be afforded the priority it deserves. In no other area of activity (apart from some sporting activities) is the level of risk that is currently attached to road use tolerated. This realisation of the intolerability of road use leading to death and serious injury has led Sweden to adopt Vision Zero and the Netherlands to adopt their Sustainable Safety agenda. The need for a new approach to road safety is the underlying theme of the *World Report on Road Traffic Injury Prevention* that was produced by the World Health Organisation and the World Bank in 2004 (Peden *et al.*, 2004). It is also the subject of the Organization for Economic Cooperation and

Development (OECD) report *Towards Zero: Ambitious Road safety Targets and the Safe System Approach* (OECD, 2008).

Vision Zero and Sustainable Safety are two examples of a Safe System strategy that is increasingly being recognised in other countries as necessary to further improve safety outcomes. These approaches have a number of distinctive characteristics. They:

- aim to reduce all fatalities and serious trauma arising from road crashes;
- recognise that, prevention efforts notwithstanding, road users will remain fallible and crashes will occur;
- stress that those involved in the design of the system need to accept responsibility for ensuring that no deaths or serious injuries occur as a result of using the road transport system, and those that use the system need to accept responsibility for complying with the rules and constraints of the system;
- aim to develop a transport system better able to accommodate human error by reducing crash energy through managing the interaction of all components of the transport system, but particularly through improved management of the road infrastructure, travel speed and vehicles;
- rely upon comprehensive management structures incorporating all key government agencies and other organisations which have a role in determining the safe functioning of the transport system; and
- align safety management decisions with broader transport and planning decisions that meet wider economic goals and human and environmental health goals.

To be successful, the Safe System Approach requires a change in societal values and the recognition that, while transport infrastructure is essential for economic growth, economic development cannot come at the cost of death and serious injury. This means that safety must be accepted as the responsibility of system designers, and that road users and communities must recognise the safety constraints of the system and demand safer products and services. Although the recognition that any level of serious trauma arising from the road transport system is unacceptable is a relatively new concept in road safety, it has long been accepted in other areas such as air transport and electricity distribution. These systems operate in a climate where failsafe methods are the norm in order to avoid mistakes being made and having disastrous consequences. The challenge of the Safe System approach in the context of achieving ambitious road safety targets is to apply a wide range of ethical, public health, responsibility and integration perspectives that are apparent in relatively closed industrial systems to the relatively open road transport system.

Traditionally, the road safety manager's task has been to identify the risks confronting road users, to develop and gain agreement (from government and elsewhere) to the best set of countermeasures, and to inform people about the decisions that have been made. The responsibility for the safety of the road transport system and the focus for road safety efforts has then been transferred to the individual road user who is expected to modify their behaviour accordingly. This

‘hard’ approach is built on rigorous analysis of the evidence and on the application and evaluation of known countermeasures, and has met with considerable success: consider, for example, the impact of legislation around the world targeting the non-use of seat belts, drink-driving and speed legislation.

The Safe System approach stresses that there are many other ‘system designers’ beyond the road and vehicle engineers, who impact on the use of the network and who also carry a major responsibility for developing safer, survivable outcomes. The full range of system designers stretches from road builders and the police to companies in commercial traffic: in brief, all actors that professionally influence the design and functionality of the road transport system. This entails a more difficult, ‘soft’ approach, requiring a new set of target groups. Change will be needed not just from government agencies but also from community leaders, commercial organisations, professional bodies, and user groups and lobbies.

A vision-led approach is required in order to generate the conditions for change, and better means of engaging and communicating with all parties need to be developed. Open debate on safety standards, voluntary agreements and incentives, as well as regulation and legislation, should be encouraged.

An important element of the Safe System approach is the interaction between the road environment and permissible travel speeds, as exemplified in the Netherlands’ Sustainable Safety approach. This identifies five key elements in the safe design and management of the road environment:

- functionality – the use of the road as through route, distributor or access road;
- homogeneity – reducing differences in speeds, travel direction, vehicle mass, and either segregating different user types or reducing speed;
- predictability – users can predict the characteristics of the road;
- forgiving – roadside features protect from serious injury when things go wrong; and
- status recognition – road users assess their competence and unfit road users are prevented from exposure to situations they cannot cope with.

A Safe System view of a safe road environment and its risk factors is not restricted to the safety of the physical road infrastructure in conjunction with permissible travel speeds, but includes the match with surrounding land-use. Similarly, the safety of different road users is determined not just by the safety of the different vehicles that are being used nearby but also by the road environment in which they are used. Risk factors are not restricted to particular user behaviours but include the individual and corporate travel decisions and route choices users make prior to using the road.

Road safety problems in a Safe System approach are treated by considering the interaction of the components of the transport system rather than by implementing individual countermeasures in relative isolation. This requires a coordinated response, and effective road safety strategies are dependent on establishing an

effective coordinating mechanism. This often takes the form of a grouping of government agencies that include the following functions:

- strategy/policy, analysis and monitoring;
- education, information and promotion;
- road funding and highway management;
- vehicle regulation and management;
- user licensing and enforcement; and
- injury treatment and rehabilitation.

Since the GB Strategy and Target were set in 2000 there has been a considerable advance in thinking in several countries about how a Safe System approach can make a difference to the level of achievement of casualty reductions. There is also more clarity about the difference between a 'Vision' and a numerical target. In 1997–2000, when the analysis for the 2010 target was carried out, the view was taken that a time-specific numerical target that was 'challenging but achievable' was required. The idea of Vision Zero was considered to be unachievable and therefore not a target that could be recommended. The resulting target was rightly seen as a focus for policy and for casualty reduction effort by both central and local government, and as such has served well.

Unlike the current GB approach, the Safe System approach, of which Vision Zero is an example, goes beyond a set target for a specific date to a longer time horizon and, more importantly, to a philosophy or vision of a safe road system that takes account of human frailty and has a goal of eliminating deaths and serious injuries. The result of this way of thinking is that the emphasis shifts from just focusing on the next target period to a more fundamental requirement to spread responsibility for road safety across all sectors and to be more ambitious in the level of achievement that is seen as necessary.

This is quite a fundamental shift and is not just semantics. If death and serious injury are to be considered as being as unacceptable on the roads as they are in, for example, air transport, real changes are necessary in the management of the transport and planning systems in order to give road safety greater priority. Fundamental to this approach is the requirement to focus on results, to set an agenda which has road safety as a core business of government and society, and which stresses the shared responsibility to support the necessary interventions.

The need to raise awareness among road users and communities of the level of risk and the desirability of interventions to reduce that risk is essential for the promotion of a Safe System approach. At the macro level, individuals desire safe roads, but there is a gap between their abstract desire and their acceptance that their behaviour is relevant and may need to change. This can be seen by the reaction to the safety camera programme. Opinion polls indicate broad endorsement, but actual behaviour on the roads tells a different story. Drivers when behind the wheel and making their speed choice simply do not accept that when they speed they create risk. The challenge for the future is to close that gap and to create a climate where road safety

measures are seen as supportive of drivers not an unnecessary and unfair constraint on their freedom.

## Management of road safety

One of the most important recommendations of the OECD (2008) report, which reinforces the recommendations in the World Report on Traffic Injury, is that there should be a lead agency at a high level that has the responsibility for coordination across government departments, local government and in partnership with commercial organisations and NGOs. For this to have real impact, high-level political support is vital, together with coordination between policy programmes and objectives, and shared acceptance of the priority of a road safety vision that is an integral part of all government activity. Sharing the vision of safe roads may be an easier concept for other sectors of government and society to endorse than the position in the years following 2000 of a target tied to public service agreements that only the Department for Transport was accountable for. The new cross-departmental targets are a step in the right direction.

This will require much more discussion and coordination and cooperation than has sometimes been the case in recent years. For instance, police objectives should be seen as an integral part of the delivery of a Safe System.

Once there is a clear lead and visible process of government to promote road safety as an overarching goal, it will be easier to persuade the media and the public that a fundamental shift is required if GB is to keep up with other countries that have already made that commitment.

Clear numerical and time-specific targets are still the building blocks to safer roads. The need for good research and analysis is endorsed by the OECD report. Consideration should also be given to sub-targets and to performance indicators that will provide a more comprehensive monitoring system in order to evaluate progress and behaviour.

The process now underway to produce the policy framework for the post-2010 period provides the opportunity for a thorough examination of the management of road safety in GB. This should include analysis of what is needed in the GB context to implement the Safe Systems approach.

Fundamental to success in the next planning period is the need to increase awareness of risk and demand for safety from all levels of society. Although consultation is an important part of the programme of work that is underway to develop the next road safety strategy, it tends to be confined to road safety interest groups and stakeholders. More needs to be done to involve the wider community of road users. For instance, the *Learning to Drive* consultation document (DSA, 2008) could be made available proactively in an easily understood format to parents and young people, instead of expecting that they will access the website. This would provide the opportunity both to inform them of the need for change and the reasons for the proposed action, and to allow their views to be heard.

The continuing work on monitoring the targets combined with the strong research programme means that there is already a considerable knowledge base on which to

build new targets and develop new casualty reduction measures. The focus on countermeasures for specific problems is still needed, but it should be in the context of a new vision and new management system.

There is a need for a high-level group across government departments, in order to place road safety firmly in a cross-cutting policy context. This has been recognised with the setting up of the Road Safety Delivery Board, but wider membership may be needed to ensure coordination and consultation with all the relevant players including local government, NGOs and other agencies, not just road safety and transport organisations. The synergies between road safety, transport and land-use planning, environmental, health and education policies need to be made explicit to take road safety into the mainstream of policy.

## Conclusions

In developing the post-2010 road safety strategy and targets, the following issues should be addressed:

- more consultation and discussion, not just with interest groups;
- a clear philosophy that death and serious injury on the roads is unacceptable;
- make roads ‘fit for purpose’, i.e. greater emphasis on protection from severe crash consequences;
- more and better targeted enforcement as a key priority;
- consider road safety within the wider transport, land-use planning and environmental policy agenda;
- clear statement that road safety is a political priority;
- cross-departmental responsibility and collaboration for the delivery of strategy and targets;
- create a new road safety policy and delivery mechanism that is well resourced and high profile – more co-ordination and co-operation; and
- more proactive ‘selling’ of road safety as a basic human right not a restriction on freedom, with the emphasis on positive opportunities and outcomes.

This is not a quick or easy fix, but the OECD report concludes that fundamental changes to the way that road safety policy is developed and managed can deliver the shift in achievement of casualty reduction that is possible, if the will is there to demand that no level of death and serious injury on the roads is acceptable. Numerical targets are still needed as stepping stones to this ultimate vision, but they must not act as limiters on the level of ambition.



# References

- Broughton, J., Allsop, R. E., Lynam, D. A. and McMahon, C. M. (2000) *The Numerical Context for Setting National Casualty Reduction Targets*. TRL Report No. 382. Crowthorne: Transport Research Laboratory.
- Broughton, J. and Buckle, G. (2005) *Monitoring Progress towards the 2010 Casualty Reduction Target*. TRL Report No. 643. Crowthorne: Transport Research Laboratory.
- Broughton, J. and Buckle, G. (2006) *Monitoring Progress towards the 2010 Casualty Reduction Target – 2004 data*. TRL Report No. 653. Crowthorne: Transport Research Laboratory.
- Broughton, J. and Buckle, G. (2007) *Monitoring Progress towards the 2010 Casualty Reduction Target – 2005 data*. TRL Report No. 663. Crowthorne: Transport Research Laboratory.
- Broughton, J. and Buckle, G. (2008) *Monitoring Progress towards the 2010 Casualty Reduction Target – 2006 data*. TRL Report No. 668. Crowthorne: Transport Research Laboratory.
- Clarke, D. D., Ward, P., Truman, W. and Bartle, C. (2007) *Fatal Vehicle-Occupant Collisions: An In-depth Study*. Road Safety Research Report No. 75. London: Department for Transport.
- Department of the Environment, Transport and the Regions (1997a). *Road Safety Strategy: Current Problems and Future Options*. London: HMSO.
- Department of the Environment, Transport and the Regions (1997b). *Road Safety: Towards Safer Roads*. London: HMSO.
- Department of the Environment, Transport and the Regions (1998) *A New Deal for Transport: Better for Everyone*. London: TSO.
- Department of the Environment, Transport and the Regions (2000) *New Directions in Speed Management – A Review of Policy*. London: DETR.
- Department of Transport (1987) *Road Safety: The Next Steps*. London: HMSO.
- Department of Transport (1996) *Targeting the Future*. London: HMSO.
- Department of Transport, Local Government and the Regions (2000) *Tomorrow's Roads: Safer for Everyone. The Government's Road Safety Strategy and Casualty Reduction Targets for 2010*. London: DETR.
- Department for Transport (2004) *Tomorrow's Roads: Safer for Everyone. The first three-year review*. London DfT.



Department for Transport (2007) *Tomorrow's Roads: Safer for Everyone. The second three-year review*. London DfT.

Driving Standards Agency (2008) *Learning to Drive: a consultation paper*. DSA: Nottingham.

Lines, C. J. and Woodgate, E. (2000) *Post 2000 Targets: Review of Possible Road Engineering Measures*. Published Article PA3409/98. Crowthorne: Transport Research Laboratory.

Lowne, R. W. (2000) *Post 2000 Targets: Review of Possible Vehicle Safety Measures*. Published Article PA3410/98. Crowthorne: Transport Research Laboratory.

Maycock, G. (2000) *Post 2000 targets: Review of Possible Road User Measures*. Published Article PA3411/98. Crowthorne: Transport Research Laboratory.

Organisation for Economic Co-operation and Development (OECD) (2008) *Towards Zero Ambitious Road Safety Targets and the Safe System Approach*. Paris: OECD.

Peden, M., Scurfield, R., Sleet, D., Mohan, D., Hyder, A. A., Jarawan, E. and Mathers, C. (eds) (2004) *World Report on Road Traffic Injury Prevention*. Geneva: World Health Organization.

Ward, H., Lyons, R., Christie, N., Thoreau, R. and Macy, S. (2007) *Fatal Injuries to Car Occupants: Analysis of Health and Population Data*. Road Safety Research Report No. 77. London: Department for Transport.

## Appendix 1

# Membership of the STAR group

## Department of the Environment, Transport and the Regions

Roger Peal (chair)

Kate McMahon

Marilyn Waldron

John Doyle

Roger Worth

Val Davies

Tony Allsworth

David Lynam (TRL)

## Local government

John Partridge

Wolverhampton MBC

David Harvey

Derbyshire CC

Vince Christie/Andy Elmer

Local Government Association

Alan Silver

COSLA

# Police

Chief Inspector Keith Bailey/Hugh Alford ACPO Traffic Committee

# Other government departments

Alan Brown	Scottish Office
Derek Fishwick	Welsh Office
David Walker	Department of the Environment, Northern Ireland

# Road safety experts

David Lynam	Transport Research Laboratory
Professor Richard Allsop	University College London
Robert Gifford	PACTS
Dave Rogers	RoSPA
Lynne Sloman	Transport 2000

## Appendix 2

# Members of the Numerical Targets Sub-group

Kate McMahon	DETR (chair)
Professor Richard Allsop	UCL
Jeremy Broughton	TRL
Val Davies	DETR
Frank Dixon	Scottish Office
Mike Garnam	Highways Agency
John Couch	Independent consultant

# 3

## *Foresight: Intelligent Infrastructure Futures – implications for road safety*

Brian Lawton, Jeremy Broughton and Ben Johnson  
Transport Research Laboratory  
Crowthorne House  
Nine Mile Ride  
Wokingham RG40 3GA

### Abstract

This study of the *Foresight: Intelligent Infrastructures Futures; The Scenarios – Towards 2055* report (Curry *et al.*, 2006) has been carried out as part of the preparations being made by the Department for Transport for the post-2010 casualty reduction strategy, including consideration of new targets for reducing the number of people killed or seriously injured (KSI) in road accidents by 2020 or 2030.

Each of the four Foresight scenarios is considered in terms of road safety and also modal split in 2025, 2040 and 2055, and then summarised. The deflections to current road safety trends and hence the potential for casualty reduction in each scenario is estimated.

The report concludes that the overall effect of these scenarios on casualty reduction would probably be relatively minor. One reason for this is that even 2030 is only half way to 2055, the final year of the Foresight Report, so the scope for divergence from current trends is limited even for the more extreme scenarios.

It is unfortunate that the Foresight Report failed to consider motorcycling explicitly because this mode of transport has a particular significance for casualty forecasts. The overall forecasts for 2030 appear to be at least as sensitive to the future growth in the volume of motorcycling as to those issues which have been addressed (at least qualitatively) in the Foresight Report.

# Introduction

*Foresight: Intelligent Infrastructure Futures; The Scenarios – Towards 2055* (Curry *et al.*, 2006; also referred to in this report as ‘the Foresight Report’) explored how science and technology could be applied to infrastructure over the next 50 years to produce robust, sustainable and safe transport. It identified alternative futures and various ‘drivers for change’, describing four different extreme scenarios of the future. People from a variety of backgrounds took part in workshops to build up these scenarios and to consider their implications. Two axes of uncertainty were focused on producing the four scenarios:

- whether or not we will develop low-environmental-impact transport systems; and
- whether or not people will accept intelligent infrastructure.

In all four scenarios, the effects of climate change and the impact that transport has on climate change is relevant. This is reflected in different ways and to a differing extent in each scenario.

As the report emphasises, ‘the future is unlikely to look like any of these individual scenarios and may well contain elements of all four’. The scenarios are identified by the following names:

- Perpetual Motion;
- Urban Colonies;
- Tribal Trading; and
- Good Intentions.

**Figure 1: The axes of uncertainty and the four scenarios defined by combinations of those axes**

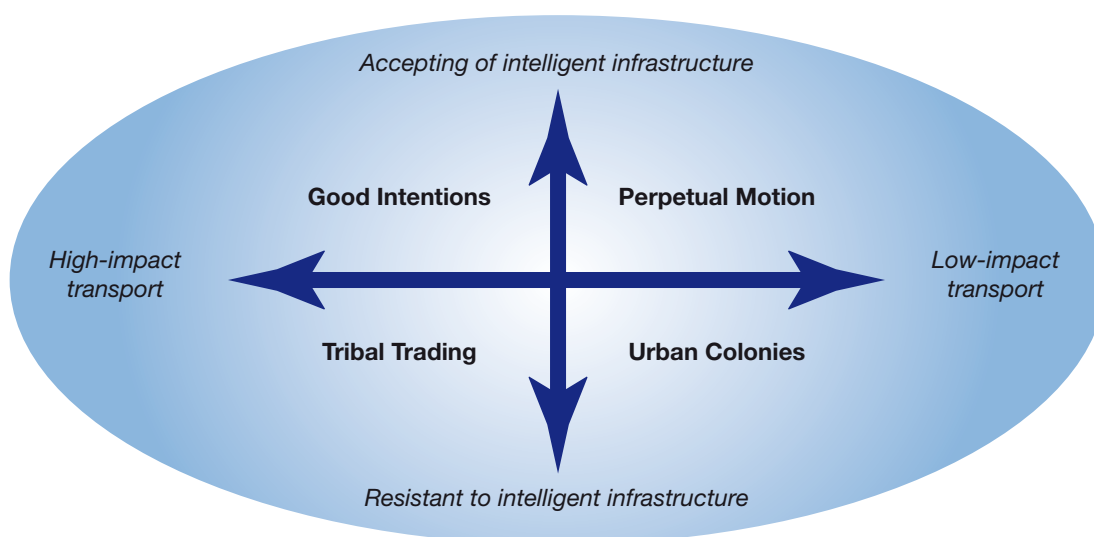


Figure 1, taken from the Foresight Report, identifies where each scenario lies conceptually in the two-dimensional space created by the two uncertainties.

The four scenarios are considered in full in the Foresight Report for two intermediate years 2025 and 2040 as well as the final year, 2055. The key issues that may affect road safety have been extracted from the report and are presented in four consecutive sections of this paper.

In these sections, the scenario is introduced with the overview from the Foresight Report. More detailed attributes are then quoted, indicated by italicised text. In addition, in year-specific sections of the Foresight Report, some critical issues are identified going forward; where these are quoted, they are introduced by the phrase ‘critical issue’.

The scenarios are then used in the final section to generate alternative sets of parameters for the casualty forecasting model. This model has been developed at the Transport Research Laboratory (TRL) and is being used to provide the numerical context for the post-2010 casualty reduction targets. This allows the sensitivity of the forecasts to the types of development described by the Foresight Report to be examined. The casualty forecasts are for 2020 and 2030, i.e. within the first half of the period considered by the Foresight team, and this limits the divergence from the ‘central’ forecasts even for the more extreme scenarios.

## Method

The first step in considering the road safety implications of each scenario was to draw out all of the relevant details described in the Foresight Report. These fall into two categories:

- those that might have a direct impact on the risk associated with any particular groups of road users; and
- those that might have an impact on the distribution of traffic by mode, since this will have an indirect impact on road safety.

For example, a reduction in the risk associated with cars may be offset, in casualty number terms, by an increase in the use of cars. These factors are reproduced for each scenario in the following sections and the impact that they will have is considered. The Foresight Report expresses the scenarios relative to a scenario that is not explicitly defined; this will be referred to as the ‘business as usual’ scenario.

The modes considered in this report, given the descriptions of each scenario and the presentation of traffic growth forecasts (detailed in a later section) are:

- cars;
- heavy goods vehicles (HGVs) and light commercial vehicles (LCVs);
- pedestrians and pedal cyclists; and
- buses.



Current Department for Transport forecasts to be presented suggest that the use of all of these modes will grow until at least 2025.

By their nature, the descriptions of the scenarios create ‘pictures’ of a possible future rather than providing specific forecasts of traffic growth. In order to translate each scenario into meaningful figures for traffic by mode, somewhat crude estimates have had to be made. The baseline is provided by the Department for Transport’s forecasts (Department for Transport, 2007a), which may be regarded as representing the ‘business as usual’ scenario. For example, if car use is expected to grow ‘less strongly’ in a particular scenario then the downward adjustment of the Department for Transport forecast will be ‘estimated’. There is usually very little basis for choosing a specific figure, which is the reason for describing the estimates as ‘somewhat crude’.

The Foresight Report describes each scenario both generally and at three points in time (2025, 2040 and 2055). The key aspects for travel patterns and risk by mode are described below at each of the three points in time. Only interpolated values for 2020 and 2030, however, will be used for the casualty forecasting.

The number of fatal and serious casualties among motorcyclists (riders and passengers of powered two-wheelers) is especially high, relative to motorcycle mileage, so casualty forecasts are especially sensitive to the future trend assumed for motorcycle use. Unfortunately, the Foresight Report does not mention motorcycles specifically whatsoever, and attempts to ‘interpret’ the report’s descriptions in terms of motorcycle use have proved highly speculative. Consequently, this key group is not presented in the same way as the other road user groups, but a general attempt is made to illustrate the sensitivity of the forecasts to assumptions about future levels of motorcycle use.

## Official traffic forecasts

Official forecasts for traffic growth in England were published in 2007 (Department for Transport, 2007a). The forecasts extend only to 2025, which is a relatively short time-frame when compared with the 50 years of the Foresight Report. The forecasts are summarised in Table 1.

Table 1: Predicted growths in traffic volume (vehicle-kilometres) from 2003 levels			
Year	Cars (%)	LCVs (%)	HGVs (%)
2010	11	17	4
2015	20	34	6
2025	27	67	12
Note, growth is relative to traffic volume in 2003.			

Forecasts for the volume of travel in England are also provided, and these are summarised in Table 2. Only the figures for walking and cycling will be used in the forecasting model.

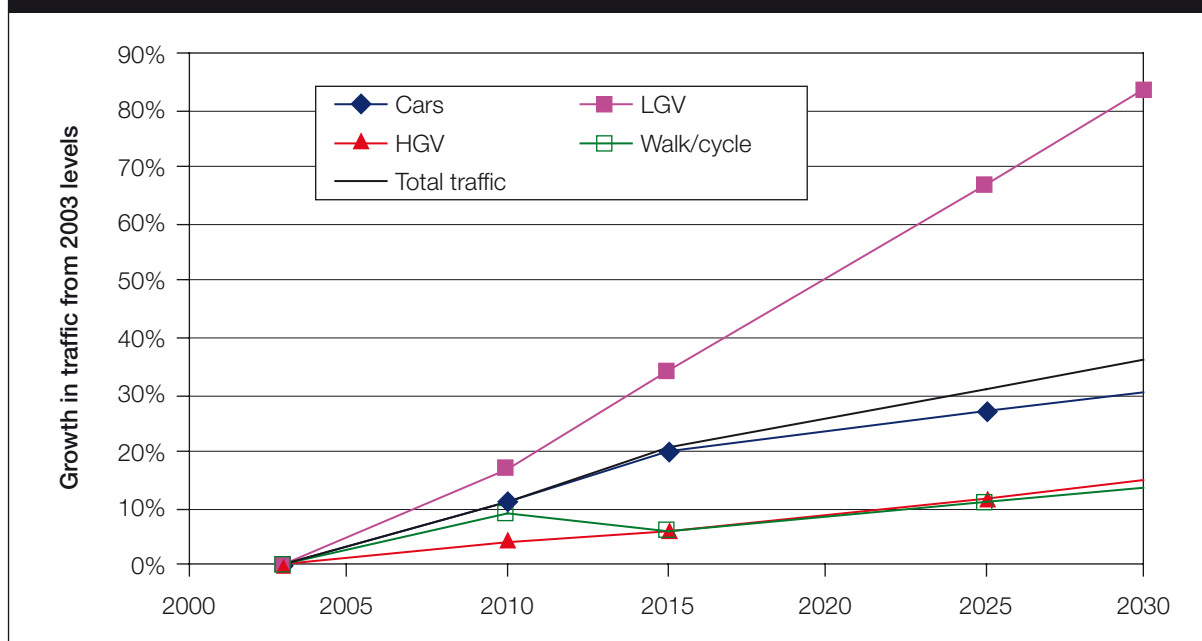
**Table 2: Predicted growths in distance travelled (person-kilometres) from 2003 levels**

Year	Cars (%)	Bus (%)	Walk/cycle (%)
2010	5	18	9
2015	11	17	6
2025	16	25	11

Note, growth is relative to volume of travel in 2003.

Neither set of forecasts is entirely suitable for predicting the growth in travel in Great Britain: they refer only to England and only extend as far as the earliest of the Foresight years – 2025. It is reasonable to make no correction for the first limitation in view of the preponderance within the British totals of road travel and accidents in England. The second limitation is more important, and no attempt will be made to extend numerical forecasts beyond 2030.

These data are shown in Figure 2, with forecasts for 2030 prepared by extrapolating the growth between 2015 and 2025. These will be used for the ‘business as usual’ scenario, and forecasts for the Foresight scenarios will be expressed as deviations from these forecasts.

**Figure 2: Official forecasts for growth from 2003 (Department for Transport, 2007a)**

## Casualty forecasting model

The model that was developed in the late 1990s to forecast the number of casualties in 2010 has been described before, most fully in TRL Report No. 382, *The Numerical Context for Setting National Casualty Reduction Targets* (Broughton *et al.*, 2000). In the TRL report, forecasts were made based on an approach consisting of:

- drink/driving, engineering and secondary safety measures (referred to as the DESS measures);

- the core programme, consisting of all current measures except those in the DESS group; and
- new measures, including measures which were innovative or a substantial expansion of existing measures.

A similar approach is currently being used to forecast the number of casualties in 2020 and 2030, and a later section will assess the sensitivity of the central forecasts (representing the ‘business as usual’ scenario) to these four scenarios. This section summarises the details from the scenarios that will be needed for this.

The road-user groups used for the casualty forecasts were:

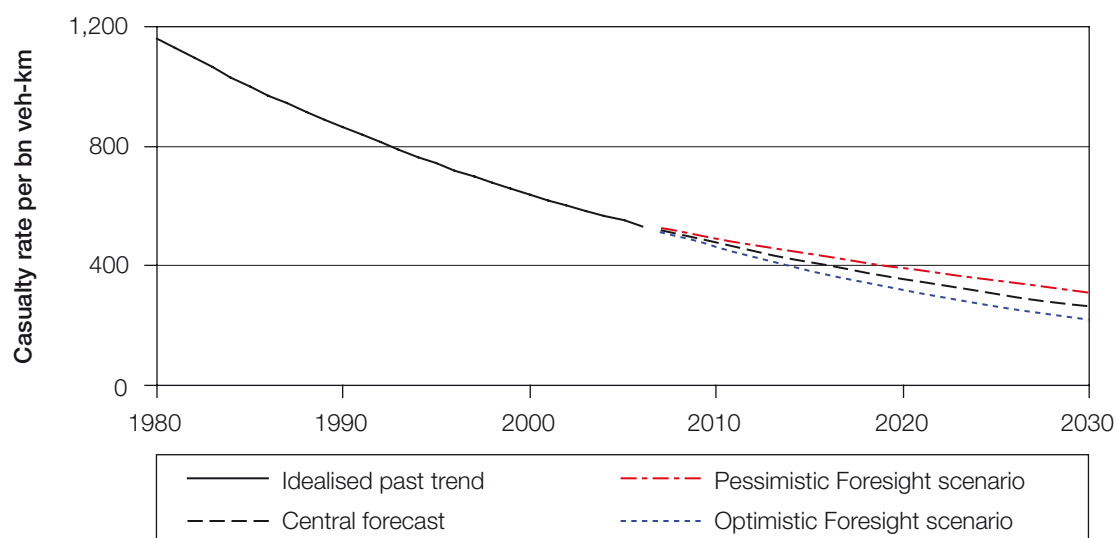
- car occupants;
- motorcyclists;
- pedestrians;
- pedal cyclists; and
- others.

To allow for uncertainty over the future level of road use by the various transport modes, a series of ‘transport scenarios’ was defined. The scenarios set out in the Foresight Report will be referred to as the ‘Foresight scenarios’ to avoid confusion. Each transport scenario consisted of forecasts for 2010 of the levels of traffic (all motor vehicles, cars, motorcycles) and of pedestrian and pedal cycle activity. The stages of the procedure for forecasting the consequences of a new road safety strategy for a specific transport scenario were:

- (a) estimate casualty rates in 2020/2030 to show what would be expected if there were no further DESS measures and if only the core road safety activities were undertaken at the current level;
- (b) prepare a Baseline casualty forecast using these estimated rates together with predictions of the volume of road travel in 2020/2030; and
- (c) apply the assumed effects of the measures in the new road safety strategy (including any further DESS measures) to the baseline forecast.

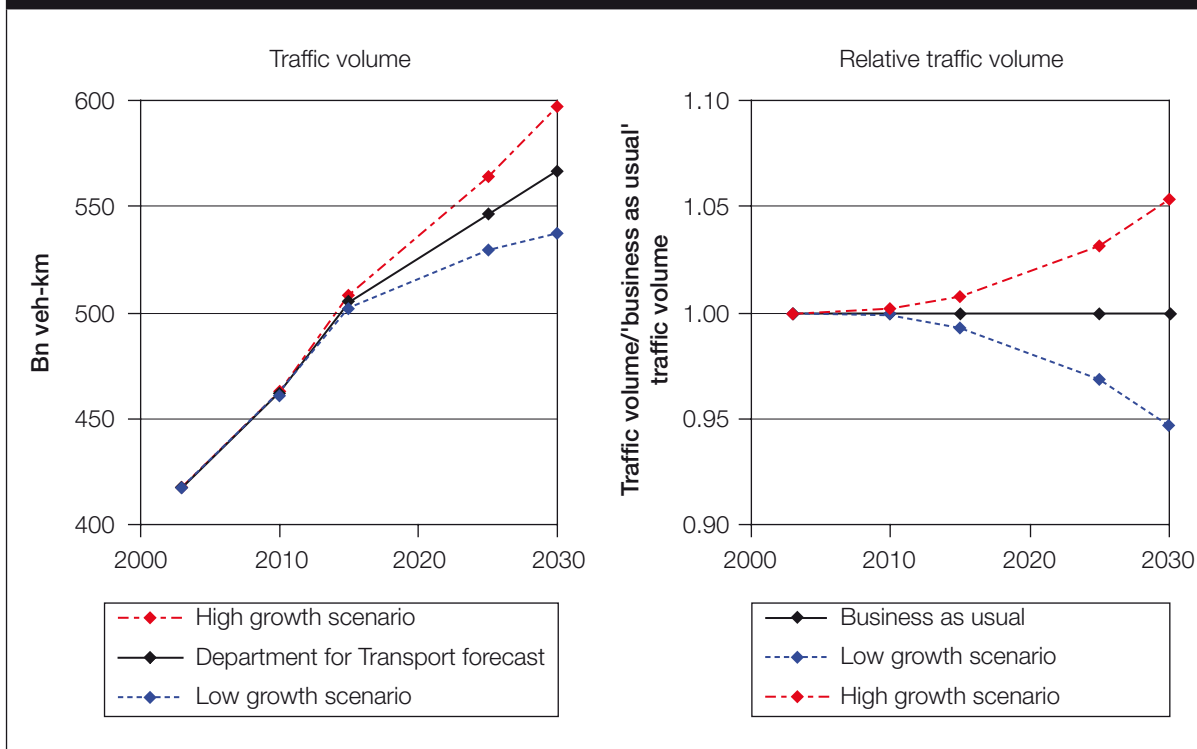
For (a), an assumption is needed about changes in the casualty rates until 2020/2030. The central assumption is that the rates will develop in future in the same way that they have in the recent past, and this has been used so far in the casualty forecasting. Historic rates are sourced from Road Casualties Great Britain 2006 (DfT, 2007b). An optimistic Foresight scenario (e.g. increasing willingness among drivers to comply with traffic laws) might suggest that the rates would fall rather faster, while a pessimistic scenario (e.g. increasing lawlessness) might suggest a slower fall. Figure 3 illustrates two possibilities, with the central forecast for the rate of reduction reduced by a quarter (pessimistic Foresight scenario) and increased by a quarter (optimistic Foresight scenario).

Figure 3: Possible modifications of casualty trends to reflect Foresight scenarios



For (b), Department for Transport forecasts will be adjusted as described earlier, although the Foresight report provides very little guidance about the precise adjustment. Figure 4 illustrates two possibilities, with traffic growth faster than the Department for Transport forecast (high growth scenario) and slower (low growth scenario). It is assumed that the divergence from the Department for Transport forecast will be gradual, and the example assumes a fifth, more or less, growth in 2030, with proportionately less divergence by 2020. The gradual divergence relative to the 'business as usual' scenario is also illustrated.

Figure 4: Possible modifications of traffic growth to reflect Foresight scenarios



The effects of likely new road safety measures (stage (c)) are being assessed in a separate exercise. It is possible, however, that the general public's willingness to accept new measures would be greater in some Foresight scenarios than in others. Indications of this will be noted, but it is too early to take account of them in the casualty forecasts.

As noted above, casualty forecasts for pedestrians and pedal cyclists are prepared separately. The Department for Transport forecasts and the Foresight Report, however, group these modes together, so parallel changes for the volume of walking and pedal cycling will be assumed.

## Perpetual Motion

The following overview of this scenario is quoted from the Foresight Report:

*'Perpetual Motion describes a society driven by constant information, consumption and competition. In this world, instant communication and continuing globalisation have fuelled growth: demand for travel remains strong.'*

*New, cleaner, fuel technologies are increasingly popular. Road use is causing less environmental damage, although the volume and speed of traffic remains high. Aviation still relies on carbon fuels and remains expensive. It is increasingly replaced by 'telepresencing' technology (for business) and rapid train systems (for travel).'*

## General description

The general attributes relating to road safety in this scenario are as follows:

- *Demand for travel remains strong.*
- *Road use causes less environmental damage, although the volume and speed of traffic remain high.*
- *Technology is applied without regard to the design of the physical environment or its waste footprint.*
- *High levels of (automated) safety systems.*
- *High levels of robustness – standardised, interoperable systems.*
- *Activity is concentrated in urban hubs, but older, higher earners tend to move to rural areas.*
- *Growing home working and telepresencing have not reduced levels of travel.*
- *The constant volume and speed of traffic create noise and stressful physical spaces.*

- *Modes are highly interconnected; travel systems are highly adaptive.*
- *On-board driver assistance is used to support and enhance decision making.*
- *Automated highway systems greatly increase traffic volume, speed and distance travelled.*
- *Short journeys dominated by light rail, taxibuses and car trains.*
- *Few opportunities for physical activity, including through walking and cycling.*
- *In-vehicle safety highly developed, but at the cost of increased danger for pedestrians and cyclists.*

Some of these descriptions suggest that the volume of motorised traffic will remain broadly in line with current forecasts, for example, ‘the volume and speed of traffic remain high’ and ‘home working and telepresencing have not reduced levels of travel’. However, that ‘on-board driver assistance is used to support and enhance decision making’ and that ‘automated highway systems greatly increases traffic volume, speed and distance travelled’ suggest that the volume of motorised traffic will increase over and above current forecasts.

The indications in this scenario are that there will be a reduction in the volume of vulnerable road users (pedal cyclists and pedestrians), possibly implying that this will not grow beyond today’s level.

The direct implications for road safety risk in this scenario are that there is an improvement for motorised vehicle occupants, for example, there are ‘high levels of (automated) safety systems’ and ‘in-vehicle safety [is] highly developed’. However, there appears to be a deterioration for non-motorised road users, for example, ‘technology is applied without regard to the design of the physical environment’, there are ‘few opportunities for ... walking and cycling’, and ‘increased danger for pedestrians and cyclists’.

## 2025

Road safety related attributes that are 2025 specific are as follows:

- *Ambient intelligence – intelligent and intuitive interfaces supported by computing and networking technology which is embedded in cars, roads and driver’s clothes – and artificial intelligence combine to provide on-board driver assistance. The result is a system that supports and enhances human decision making in the car.*
- *The in-car system communicates with the national array of sensors to provide real-time data on traffic and network performance. The information itself is useful to drivers, but the car operates most efficiently when it is given control and itself chooses how to respond to the data.*

- *Automated highway systems are now operating on major commuter routes, creating trains of automatically controlled cars that travel close together at high speed.*
- *Governments and local authorities worked with car manufacturers to integrate disparate vehicle management systems designed to even out traffic flows and reduce congestion.*
- *More people bought bigger cars and travelled further using the new systems.*
- *The Government for London and the south-east had started the transition in 2016 to a full fleet of guided buses across the region, financing it from the Congestion Charge.*
- *Hydrogen tablets – safe and easy to transport – are now used widely in public and commercial vehicles. Sales of domestic hydrogen cars are increasing.*
- *Car manufacturers invested heavily in a range of technologies that reduced the environmental impact of motor vehicles.*
- *More hybrid or hydrogen cars can be seen on the UK's roads, but they remain restricted to urban areas due to the infrastructure required to support them.*
- *Arguments continue about who should fund the refuelling stations in more rural parts of the country; everyone wants to see it done but no one seems prepared to put up the cash, as yet.*
- *A growing number of service workers are forced to work anti-social hours.*
- *A significant number of, mainly younger, people thrive on the buzz of living in the urban hubs; the more affluent move to the outskirts of towns or to rural areas.*
- *Some urban councils fear that town centres could be left with an unstable and polarised mix of residents: affluent urbanites and the disenfranchised.*
- *Some communities are implementing their own measures, putting in place community or street-level quiet zones, restricting vehicles to 10 mph and barring individuals who are not known to residents.*

Although the final point here might suggest a reduction in the amount of motorised traffic, the general picture for 2025 in this scenario is, if anything, of an increase in the volume of motorised traffic. For example, 'more people ... travelled further' and 'the more affluent move to the outskirts of towns or to rural areas', as well as the indirect effect on demand likely to come about due to the automation of some driving tasks.

The systems that automate some driving tasks are also likely to improve road safety for all road users, although it is probable that, on the rare occasions on which accidents do occur, the consequences will be more akin to those of a train accident than to those historically associated with a car accident.



One aspect of this scenario in 2025 that might result in a deterioration in road safety is that ‘more people bought bigger cars’, although it is likely that this would be more than offset by the other benefits.

## 2040

Specific 2040 road safety related attributes are as follows:

- *The agent-based software can alert parents when their children leave the school grounds and calculates the most cost-effective transport route for every journey.*
- *Long-distance guided vehicle systems have helped. Some travellers simply lock their car into the guided lane of a motorway and go to sleep while the vehicle takes them there. The system is now far safer than it was, and earlier problems about risk and liability were removed when the Treasury calculated that the cost of underwriting any liability was far less than the social and environmental benefits of doing so.*
- *More locally, public transport has mostly been replaced by the Swarm, a type of integrated mass taxi system. Local people-carrier vehicles are despatched into specific areas of a city, and are alerted to user locations and journey requests through their positionally enabled mobile phones. The network calculates the most efficient way of collecting and delivering multiple passengers, and allocates the fare. Security for the traveller is ensured because the identity and provenance of each passenger is known as soon as they make their journey request.*
- *Autonomous swarming networks of buses are being tested in several locations.*
- *The networks can process large amounts of information about traffic conditions and points of demand – the latter from tracking passengers’ mobile devices.*
- *The buses can modify their routes to speed up journey times and to collect passengers from pick-up zones, which are relatively large – rather than dedicated stops.*
- *Passengers can get on any bus that contacts them, rather than having to wait for a particular number.*
- *The biggest barrier to take-up is the reduced anonymity – the vehicles are closer to cars than buses in size and proximity between passengers is increased.*
- *Growing home working and telepresencing have not reduced levels of travel as much as some had hoped.*
- *Critical issue: the extent to which public transport can justify itself.*

By 2040, there will have been further advances in the automation of systems and thus their safety, and bus users in particular will have benefited in terms of personal security, for example. There are some indications of changes in bus use, though the

description does not make it entirely clear how bus use in 2040 will differ from that expected by current forecasts.

## 2055

Road safety related attributes that are 2055 specific are as follows:

- *Lots of private vehicular traffic, but low-emission vehicles are the norm.*
- *Fully guided vehicles allow you to dispense with a steering wheel altogether, allowing you to conduct video meetings and work while you are on the road.*
- *Flexible seating means that you can have face-to-face meetings while you are on the move, and frictionless technology ensures a smooth ride.*
- *The big picture is of a very busy city with lots of private car traffic. Everyone is always willing and able to travel using clean forms of energy.*
- *High-density cities and low-density suburbs.*
- *Routes include automatic car trains one can switch into.*
- *Demand for travel and transport has remained strong in this 'always on' world – transport is now well connected, semi-automated and (mostly) friction-free.*
- *Environmental curbs on car use are unnecessary, traffic management remains a critical problem.*
- *Motor manufacturers' success in developing hydrogen-fuelled vehicles has helped to meet the desire for more cars, but they are not cheap. However, cyclists and pedestrians continue to have a tough time – the volume and speed of traffic still means that many urban environments are not pleasant places to cycle or walk in. So-called 'intelligent vehicle management', in which motorists are required to switch over control of their vehicle to local guided transport systems, seem to make cars less predictable, not more so. At least in the old days a cyclist could catch a driver's eye to make sure they'd been seen. More broadly, transport use and benefit remains as polarised as it was at the end of the 20th century.*
- *People spend many hours juggling with the integrated travel system to find the easiest and cheapest way.*
- *Safety concerns around new technologies and increasingly fast travel were often raised in the 2010s and 2020s, fuelled by glitches in the system, but also by misuse. But trust in technology is the rule rather than the exception, largely because of the legacy of the 'online from birth' generation.*
- *Some urban centres are inhabited by the highly stressed and affluent, but also those outside mainstream society who survive by stealing.*
- *Distribution systems have become amazingly efficient.*

- *The intermodal transfer of packages have developed into a 'Parcel Internet', which claimed to have the routing pathway flexibility of the digital Internet.*

2055 sees an increase in motorised traffic in this scenario as 'the big picture is of a very busy city with lots of private car traffic', and 'the desire for new cars' has been met. There appear to be some indications of changes in the amount of walking and cycling, but it is not clear whether the net effect will be that there is more or less than current trends forecast.

In terms of safety itself, 'fully guided vehicles' and 'automatic car trains' suggest an improvement for motorised traffic. Although these may benefit vulnerable road users to some extent, the net effect for non-motorised traffic seems to be negative, with 'cars less predictable', for example, and cyclists and pedestrians no longer able 'to catch a driver's eye to make sure they'd been seen'.

## Key road safety impacts

- Motor vehicles dominate the roads more than ever, at the expense of pedestrians and cyclists.
- Speed and technology are the order of the day, yet have not reduced the volume of traffic.
- Although motor vehicle collisions are rare, those that happen are major and newsworthy.
- The rich travel further than ever, and at increasing speeds; the poor are even more cut-off from mainstream society than ever before.

## Urban Colonies

The following overview of this scenario is quoted from the Foresight Report:

*'In Urban Colonies, investment in technology primarily focuses on minimising environmental impacts. In this world, good environmental practice is at the heart of the UK's economic and social policies; sustainable buildings, distributed power generation and new urban planning policies have created compact, sustainable cities.*

*Transport is permitted only if green and clean – car use is still energy-expensive and is restricted. Public transport – electric and low-energy – is efficient and widely used.*

*Competitive cities have the IT infrastructure needed to link high-value knowledge businesses, but there is poor integration of IT supporting transport systems. Rural areas have become more isolated, effectively acting as food and bio-fuel sources for cities.*

*Consumption has fallen. Resource use is now a fundamental part of the tax system and disposable items are less popular.'*

## General description

The general attributes relating to road safety in this scenario are as follows:

- *New urban planning policies have created compact, sustainable cities.*
- *Transport is permitted only if green and clean – and car use (still energy-expensive) is restricted.*
- *Public transport – electric and low-energy – is efficient and widely used.*
- *Poor integration of IT supporting transport systems.*
- *Rural areas have become more isolated, effectively acting as food and bio-fuel sources for cities.*
- *Society integrated more at the local level.*
- *Safety benefits are limited and systems' resilience is uneven.*
- *Polices designed to reduce travel.*
- *High levels of safety in locally controlled systems. Interoperability issues.*
- *A number of the required changes can be implemented at a city level, without needing policy change at the national level.*
- *The scenario requires large-scale infrastructure change, which suggests that early intervention is required, coupled with relatively bold action.*
- *Planning regimes built on motorised access to in-town, edge of town, or out-of-town locations will be reversed.*
- *Requires a significant rebalancing away from national government and the private sector towards local and regional leaders.*
- *There has been a shift towards local production.*
- *Electric vehicles and biofuels are common.*
- *Transport systems are designed to be accessible for everyone.*
- *Integration of transport infrastructure is poor.*
- *People travel less.*
- *Walking and cycling have increased; public transport systems are based on light rail and electric vehicles.*

- *Prominence given to active travel modes has improved road safety and reduced transport deaths and injuries.*

As ‘new urban planning policies have created compact, sustainable cities’ and ‘public transport is efficient and widely used’ with transport systems ‘designed to be accessible for everyone’, there is a substantial increase in the use of buses. In addition, ‘walking and cycling have increased’ with ‘prominence given to active travel modes’. On the other hand ‘car use is restricted’ with ‘planning regimes built on motorised access [are] reversed’.

In terms of road safety, ‘rural areas have become more isolated’ with ‘high levels of safety in locally controlled systems’ and ‘reduced transport deaths and injuries’.

## 2025

Road safety related attributes that are 2025 specific are as follows:

- *At the end of the first decade of the 21st century, the Government had realised that it was necessary actively to encourage people to travel less; and that this in turn required public policy intervention to help households and individuals to change their lifestyles, and businesses to change their expectations*
- *Even before nationwide road pricing was introduced in 2015, charges and tax penalties were imposed on motorists’ benefits such as ‘free’ parking. The initial outcry was damped when the Government ran an expensive advertising campaign on the back of research which showed convincingly that the revenues from road taxes and fuel duty represented only about half of the cost of driving in the UK, especially once health costs were taken into account.*
- *The move to a new transport technology tends to be slow because new vehicles need new infrastructure (for example, different types of fuel infrastructure).*
- *Manufacturers are reluctant to market vehicles without infrastructure in place. But infrastructure development needs demand to justify the investment.*
- *This can create a market failure and public intervention is required to close the circle.*
- *Changes in infrastructure have had a significant part to play as cities have invested in public transport and cycle paths, and more people are getting out of their cars as the overall image of public transport improves. Transport innovation came at the local level rather than the national: local agencies were simply more responsive to innovation.*
- *It was a local authority that was the first to replace its city centre bus fleet with hybrid electric/NPG buses, and install the fuel infrastructure needed to do so – and opened up that infrastructure to private motorists with similarly powered vehicles.*
- *Not all public transport innovations were successful. Within outlying urban areas more flexible and demand-responsive public vehicles evolved as a hybrid*

*between buses and taxis. Although early results had shown a significant reduction of congestion, pilot testing of fully automated hybrid vehicles halted when newspapers reported that in trials a car had hit a pedestrian. The unions welcomed the re-introduction of drivers, and their warnings about over-reliance on autonomous systems struck a general chord. Plans for dual-mode long-distance commuting systems using hybrid vehicles linking larger conurbations were shelved indefinitely.*

- *Failure to integrate the intelligence of the infrastructure does mean that the individual components are less vulnerable to knock-on effects, making systems more robust than they would otherwise be.*
- *Government has a continual push to make it safer and easier to access jobs, shopping, leisure facilities and services by public transport, walking and cycling. Society embraced this new world where people do not travel as extensively.*
- *Cities are more compact, widening the range of local opportunities and activities that are accessible without using the car.*
- *Places designed around the car, where it was difficult to increase density, found it hard to adapt their existing transport infrastructure, which increased costs for local people. While market towns found themselves rejuvenated, rural areas became more isolated.*
- *Critical issue: policy objective to improve access for all and to change travel and mobility-related behaviour.*

As ‘cities have invested in public transport and cycle paths’ and ‘Government has a continual push to make it safer and easier to access jobs, shopping, leisure facilities and services by public transport, walking and cycling’, 2025 will have increased and safer bus use and more, safer, pedestrians and cyclists in this scenario.

## 2040

Specific 2040 road safety related attributes are as follows:

- *Critical issue: sustainable long-distance transport systems.*

## 2055

Road safety related attributes that are 2055 specific are as follows:

- *The decline in private automobile use has led to the pedestrianisation of streets and a better quality of public life.*
- *Cycling and walking are an integral part of everyday life, and hydrogen-powered public transport systems are widely used by all.*
- *High-density green cities with a lot of locally produced goods and efficient public transport systems.*



- *Automated transit systems – a kind of sophisticated tram system – run around cities.*
- *Walkways are covered but with occasional openings to small squares planted with trees, benches and hot-drinks dispensers.*
- *Bicycle and pedicab tracks criss-cross the city.*
- *Upgraded intercity devices link some of the more flourishing urban centres together.*
- *Delays caused by poor road conditions where local groups resisted urban redesign policies and attempted to maintain the status quo.*
- *Really expensive fuel for transport and redevelopment of urban centres into more family-friendly living/working/shopping designs.*
- *People travel, but not as far, and often by foot or cycle.*
- *Vehicles need to be controlled to ensure equity between drivers and vulnerable road users, to reduce noise, and to encourage community cohesion. One policy test is whether children can play on the streets in residential areas.*
- *Although intelligent infrastructure is widely deployed, it is not integrated.*
- *Large slow-moving ‘road trains’ are a common sight in their own guided tracks in motorway lanes, controlled by their own information network as they leave their ports for their inland destination. Transport is poorly integrated, with different systems controlled by different organisations. Freight, perhaps, was lucky that it was valuable enough to justify the infrastructure investment; for individual drivers, the mass traffic management systems which were widely predicted in the late 20th century were too unreliable to work, and were abandoned after a succession of mass pile-ups.*

‘Cycling and walking are an integral part of life’ in 2055, although there is some question as to the level of bus use: although there are ‘efficient public transport systems’, ‘transport is poorly integrated’. ‘The decline in private automobile use has led to the pedestrianisation of streets and a better quality of public life’ with the likely result that walking and cycling are substantially safer in 2055. There are also some indications that bus use will be somewhat safer in this scenario.

## Key road safety impacts

- The historical problems associated with cars are falling away, and only partially replaced by those associated with buses and other forms of public transport.
- Distinctions between busy urban areas and vacant rural areas are greater than ever.
- Local government is far more active, with national government unnecessary in the main.



- Localism means that everyone travels far less and within their own communities for the majority of their travel, with a positive effect on road safety.

## Tribal Trading

The following overview of this scenario is quoted from the Foresight Report:

*‘Tribal Trading describes a world that has been through a sharp and savage energy shock. The world has stabilised, but only after a global recession has left millions unemployed. The global economic system is severely damaged and infrastructure is falling into disrepair.*

*Long-distance travel is a luxury that few can afford and, for most people, the world has shrunk to their own community. Cities have declined and local food production and services have increased. Canals and sea-going vessels carry freight: the rail network is worthwhile only for high-value long-distance cargoes and trips. There are still some cars, but local transport is typically by bike and by horse.*

*There are local conflicts over resources: lawlessness and mistrust are high. The state does what it can – but its power has been eroded.’*

## General description

The general attributes relating to road safety in this scenario are as follows:

- *Infrastructure is falling into disrepair.*
- *Long-distance travel is a luxury that few can afford.*
- *Cities have declined and local food production and services have increased.*
- *There are still some cars, but local transport is typically by bus and by horse.*
- *The state does what it can – but its power has been eroded.*
- *Intelligent infrastructure is not on the agenda.*
- *Legacy infrastructure is patched and patched again.*
- *Limited travel and alternative forms of transport reduce emissions.*
- *Unsafe, insecure world. Infrastructure degrading.*
- *Local solutions to local needs and no co-ordinated effort.*
- *Empty cities and clustered, compact rural housing.*

- *Work is – inevitably – closer to home.*
- *Cross (regional) border travel incurs a tariff – a major source of income.*
- *Some regions are able to run limited public transportation systems.*
- *Local transport is mainly by human power or by horse.*

‘There are still some cars’ and ‘work is closer to home’, so a picture is painted of a reduction in car use compared with current forecasts. ‘Local transport is mainly by human power or by horse’, suggesting a substantial increase in the amount of walking and cycling compared with current expectations. Although these changes in modal split would be expected to improve road safety, there is deterioration due to other factors: ‘infrastructure is falling into disrepair’, ‘the state’s power has been eroded’ and there is ‘no co-ordinated effort’.

## 2025

Road safety related attributes that are 2025 specific are as follows:

- *With energy shortages and repair costs have come higher prices and unemployment.*
- *The UK Government has adapted the existing congestion charging technology simply to prevent travel where necessary, at least where power cuts allow.*
- *The RFID-based travel cards ensure that people are credited for taking passengers (a form of state-sponsored hitch hiking), even if they are also compelled to do this by law.*
- *Health outcomes are declining, and the ageing population is suffering in an age where healthcare is more likely to be provided to someone with longer-term prospects, and who can pay.*
- *Local food production is on the up; even if production is sparse, it makes work for people who would otherwise be workless.*
- *Armed gangs roam the roads and the army and police do little other than containment, unless officers are shot at. They are spread too thin. Gated communities are no longer just for the more affluent.*

In 2025, ‘the UK Government has adapted the existing congestion charging technology simply to prevent travel where necessary’, and ‘people are credited for taking passengers’. ‘Armed gangs roam the roads and the army and police do little other than containment’, suggesting a substantial reduction in the personal safety of all public road users.

## 2040

Specific 2040 road safety related attributes are as follows:

- *Borders are important for reasons of security and revenue; tariffs on transport are one of the most reliable ways of raising taxes. The power of the state has eroded, because it can no longer guarantee security or stability. Instead, the world has fragmented into smaller communities, often delineated by natural landmarks, and barriers, and by local resources.*
- *Transport is slow: energy efficiency matters far more than speed.*
- *Some cars still function, although most have had to be rebuilt after their electronics failed; some have been adapted to steam. Local transport, typically, is the preserve of the bike (sometimes electric-aided) and the horse.*
- *Distance matters, but less than it might.*
- *Many of the business parks and trading estates that populated the edges of towns have become 'new communities', which offer land and shelter. Their location, close to the big roads that are still there, means that they are meeting points and resting places for travellers.*

'Energy efficiency matters far more than speed', meaning that motorised vehicle usage will be reduced substantially compared with current forecasts. Walking and cycling will exceed current forecasts for 2040 since 'local transport, typically, is the preserve of the bike and the horse'. The picture for road safety itself is mixed: although 'the power of the state has eroded' and 'transport is slow', suggesting some improvement.

## 2055

Road safety related attributes that are 2055 specific are as follows:

- *If people travel as much as they ever did, they do it more slowly; they don't travel so far. Work is closer to home; indeed, in some places, living patterns have reverted to the pre-industrial, with the home and workplace being the same.*
- *The various options of car, train, even bus were increasingly disjointed and run by intensely rival business families with degenerating co-ordination between them.*
- *Vehicles for local use combine human power with electricity, for those who desire such luxury; the fastest vehicles on the road are steam-powered; there are precious few but they are well suited to the wide, if battered roads that remain.*

'[People] don't travel so far' and 'work is closer to home', so there will be a reduction in the amount of motorised traffic in 2055 compared with current forecasts. An increase in cycling and walking is expected once again given that 'vehicles for local use combine human power with electricity, for those who desire such luxury'.

## Key road safety impacts

- Lawlessness is the order of the day; the state has far more to be concerned with than road safety.
- Few people are brave and rich enough to venture out of their local community.
- Road infrastructure is continually stagnating.
- Buses, horses and the odd steam-powered vehicle are the main means by which people travel.

## Good Intentions

The following overview of this scenario is quoted from the Foresight Report:

*‘Good Intentions describes a world in which the need to reduce carbon emissions constrains personal mobility. A tough national surveillance system ensures that people travel only if they have sufficient carbon “points”. Intelligent cars monitor and report on the environmental cost of journeys. In-car systems adjust speed to minimise emissions. Traffic volumes have fallen and mass transportation is used more widely. Businesses have adopted energy-efficient practices: they use sophisticated wireless identification and tracking systems to optimise logistics and distribution. Some rural areas pool community carbon credits for local transport provision but many are struggling.*

*There are concerns that the world has not yet done enough to respond to the human activity which has caused the environmental damage. Airlines continue to exploit loopholes in the carbon enforcement framework. The market has failed to provide a realistic alternative energy source.’*

## General description

The general attributes relating to road safety in this scenario are as follows:

- *Personal mobility is constrained.*
- *A tough national surveillance system ensures that people travel only if they have sufficient carbon ‘points’.*
- *Intelligent cars monitor and report on the environmental cost of journeys.*
- *In-car systems adjust speed to minimise emissions.*
- *Traffic volumes have fallen and mass transport is used more widely.*
- *Some rural areas are able to pool community carbon credits for local transport provision but many are struggling.*

- *Over time, technology systems become essential to deliver efficiency and allow use of individual CO<sub>2</sub> allowances.*
- *Slowly, the importance of designing the urban environment for less travel and efficient use of resources achieves sufficient importance.*
- *Continued economic growth.*
- *High levels of safety though some concerns due to ageing infrastructure.*
- *Patchy investment achieves interoperability.*
- *Personal mobility is constrained.*
- *Intelligent cars monitor and report on the environmental cost of journeys; and in-car systems adjust speeds automatically to minimise emissions.*
- *Traffic volumes have fallen and mass transportation is used more widely.*
- *Businesses use highly sophisticated wireless identification and tracking systems to optimise logistics and distribution.*
- *The initial failure to curb mobility rights of the individual leads to 20 years with little significant change, before the scenario evolves towards implementation of technology as control – intelligent infrastructure systems used to police the consequences of the individualist society.*
- *A critical issue is the length of the delay before control systems are implemented effectively.*
- *The individual's belief in their right to mobility was considered an enduring one, which would require significant sticks – rather than carrots – to shift.*
- *Research indicates that individuals on lower incomes generally travel less, suggesting that they would be well placed to trade their surplus carbon entitlements.*
- *GDP growth continues despite less travel.*
- *Governments collaborate on policies to reduce the global impact of travel.*
- *Unrestricted personal mobility is a distant memory.*
- *Biofuel buses are popular.*
- *In-car technology shows economic and environmental costs of travel. Road use is charged on a pay as you drive basis.*
- *Real time management systems direct vehicles via the lowest impact route.*
- *Reduced vehicle speeds, coupled with technology, have led to lower levels of traffic injuries.*

This scenario foresees a substantial reduction in the volume of motorised traffic compared with current forecasts: ‘people travel only if they have sufficient carbon “points”’, ‘traffic volumes have fallen’ and ‘personal mobility is constrained’. Road safety will increase for all road users in this scenario: there are ‘high levels of safety’ and ‘intelligent cars’; ‘reduced vehicle speeds, coupled with technology, have led to lower levels of traffic injuries’.

## 2025

Road safety related attributes that are 2025 specific are as follows:

- *The first large-scale dynamic traffic flow management system pilot was initially hailed as a success but quickly ran into technical problems. Insufficient resilience caused system failure and complete gridlock in Birmingham on more than one occasion.*
- *Vehicles fitted with electronic vehicle identification chips calculate and assign premiums based on actual vehicle use. The driver’s monthly bill is calculated according to their driving data – distance travelled, premium toll roads chosen and emission level.*
- *The tax disc system has been abolished.*
- *West Midlands pilot – speeding travel times, smoothing flows on the network and reducing accident rates by up to 30%.*
- *It is still too early to tell how effective dynamic traffic flow management will be.*
- *Data control flows in real time.*
- *Road traffic management system gathers and transmits data in real time about traffic flow, optimal journey times and route choices.*
- *Drivers can choose to let the in-car navigation system select the optimal route – and can customise the algorithm for timing, pricing and speed.*
- *The car manufacturers, still suffering from global over-capacity and low profits, protest loudly that they need a long-term strategic commitment from the Government, or even fiscal incentives, to help overcome the continuing technology and financial problems associated with the widespread introduction of fuel-efficient vehicles.*
- *Critical issue: interoperability and inefficiency in traffic flow management*
- *Critical issue: continued resistance and citizen protest to protect ‘right to mobility’.*
- *Critical issue: Government commitment to fuel-efficient vehicles.*

An increase in motorised traffic might be expected by 2025: the ‘West Midlands pilot speeding travel times, smoothing flows on the network’ and a ‘road traffic

management system gathers and transmits data in real time about traffic flow, optimal journey times and route choices'. The West Midlands pilot also indicates the potential for accident rate reductions; though there is little to indicate that road safety benefits will have occurred by 2025.

## 2040

Specific 2040 road safety related attributes are as follows:

- *Two-car families are in decline, bicycle sales continue to soar, home working is increasing.*
- *Many local authorities have responded with extensive carbon-free infrastructure development programmes. Biodiesel buses have been a particular success.*
- *Pooling of community carbon credits for local transport provision, such as school buses.*
- *Food transport accounted for 12% of total emissions from the road network.*
- *New in-car technology is having an impact too – two dials on every dashboard tell the driver both the environmental cost of each journey and the true economic cost. In addition, sensors in a vehicle can send a distress signal to the police if the vehicle is involved in a crash while travelling at over 25 mph.*
- *Widespread use of biodiesel by the bus network requires the fuelling infrastructure to be in place.*
- *A growing number of commuters are willing to suffer long bus journeys during the week in order to spend their carbon entitlements at the weekends.*
- *London and Paris have led the way for further reducing speed limits in cities – and have threatened to impose legislation if car manufacturers do not commit to building ISAs into all models. Increasingly, cars are restricted to 15 mph in residential zones and 25 mph on the outskirts of towns and villages, and the technology is integrated with the national digital speed map. Vehicles download the latest version of the speed map as part of their daily software update and automatically limit their speed when entering or exiting different zones.*
- *Critical issue: policy commitment to long-term infrastructure planning.*

By 2040, 'biodiesel buses have been a particular success' and 'a growing number of commuters are willing to suffer long bus journeys during the week'. Road safety risks will also have reduced as a result of 'reducing speed limits in cities' where 'cars are restricted to 15 mph in residential zones and 25 mph on the outskirts of towns and villages'. There are further safety benefits post-crash in that 'sensors in a vehicle can send a distress signal to the police if the vehicle is involved in a crash while travelling at over 25 mph'.



## 2055

Road safety related attributes that are 2055 specific are as follows:

- *Traffic volumes have shrunk hugely.*
- *Implementation of reducing travel demand based on satellite surveillance which can monitor every car on the road.*
- *Youth culture hacks carbon control circuits and races. A rather different part of youth culture is 'stealth bombing' which includes racing along deserted motorways in the small hours.*
- *New emissions standards with tax relief brackets.*
- *Will the roads continue to clog up and frustrate the potential savings? Investment in satellite navigation and priority pass electronics for the main routes would help.*
- *Will the investment cost of meeting new standards for the benefit of all actually pay off? The cost risk of going on with old fleets was greater.*
- *Consumers getting more picky about the total environmental impact of the goods they buy.*
- *Increasing pressures for policies to clean up the impact of exponential traffic growth.*

'Traffic volumes have shrunk hugely', presumably due, at least in part, to the 'implementation of reducing travel demand based on satellite surveillance which can monitor every car on the road'. 'Stealth bombing' suggests a direct reduction in road safety in 'pockets', but there are no clear indications of changes in road safety at this point.

## Key road safety impacts

- Intelligent cars adjust speeds and improve traffic flow.
- Reluctantly, people travel less; the journeys they do make are of high economic value.
- Urban environments continue to be designed to reduce travel.
- Significant time-lags between decisions to implement systems to manage individuals' travel and when they become operational.

# Comparisons with current forecasts

Casualty forecasts for 2020 and 2030 have been prepared by TRL, applying the methodology originally described by Broughton *et al.* (2000). These central forecasts represent, in essence, the ‘business as usual’ scenario, and this section will examine whether the forecasts might vary appreciably under any of the Foresight scenarios.

With this aim, the exact forecasts are less important than their sensitivity to the changes set out in the Foresight Report. To introduce these casualty forecasts briefly, they assume that:

- current road safety measures will continue, so that recent casualty trends can be extrapolated to 2030, but there will be no major new measures;
- the effects of improved car secondary safety represented by the latest cars will spread through the fleet as earlier cars are replaced, but there will be little further improvement; and
- road travel will grow as predicted in the latest forecasts (Department for Transport, 2007a).

The central forecasts are presented in Table 3, expressed relative to the number of casualties in 2006, and they will form the baseline for the sensitivity analysis. The Foresight Report does not mention motorcycling, so these forecasts assume that the volume of motorcycling in 2020 and 2030 will be equal to the volume in 2006. Similarly, it will be assumed that the changes described in the Foresight Report will not affect motorcycle safety, so the motorcyclist casualty forecasts for the ‘business as usual’ scenario will be used to evaluate each Foresight scenario. The sensitivity of the overall casualty forecasts to assumptions about the volume of motorcycling will be examined in a later section.

**Table 3: Forecast casualty reductions from 2006, ‘business as usual’**

		Car occupants (%)	Motorcyclists (%)	Pedal cyclists (%)	Pedestrians (%)	Others (%)	All road users (%)
Killed	2020	32	21	11	45	17	31
	2030	43	34	24	68	32	45
KSI	2020	50	33	43	52	45	46
	2030	69	49	65	74	67	66

The next step is to choose the adjustments to the parameters of the forecasting model that represent changes in exposure (corresponding to Figure 4). The qualitative changes in exposure that have been presented for the four scenarios in later sections are summarised in Table 4.

**Table 4: Changes in Foresight scenarios, compared with the 'business as usual' scenario**

	Traffic growth			
	Cars	HGV/LCV	Bus	Walk/cycle
Perpetual Motion	Faster	Faster	Faster	Slower
Urban Colonies	Slower	No change	Faster	Faster
Tribal Trading	Slower	No change	No change	Faster
Good Intentions	Slower	No change	No change	No change
	Risk reduction			
	Cars	HGV/LCV	Bus	Walk/cycle
Perpetual Motion	Faster	Faster	Faster	Slower
Urban Colonies	Faster	Faster	Faster	Faster
Tribal Trading	Slower	Slower	Slower	Slower
Good Intentions	Faster	Faster	Faster	Faster

Table 5 shows the traffic growth figures, based on Department for Transport data, but rebased to 2006 and interpolating/extrapolating to 2020 and 2030. It also includes adjustment factors for the four scenarios. As explained earlier, the Foresight Report provides no guidance about the precise adjustments, so these figures should be considered to be indicative. Different values could equally well have been chosen, but these are intended to provide a substantial test of the sensitivity of the casualty forecasts. Past data suggest that changes of 10% in forecasts of traffic growth are at the limit of what is credible. The data for the national volume of walking and cycling are weaker, so larger adjustments are made for two scenarios.

**Table 5: Traffic growth, 2006 to 2020 and 2030**

	Department for Transport forecast (baseline)		Adjustments for Foresight scenarios (2030)			
	2020 (%)	2030 (%)	Perpetual Motion (%)	Urban Colonies (%)	Tribal Trading (%)	Good Intentions (%)
Distance travelled by:						
Cars	21	28	10	-10	-10	-10
All motor vehicles	22	32	10	-8	-8	-8
Pedestrians/pedal cyclists	9	14	-10	20	20	0

To allow for the gradual divergence from the Department for Transport forecast illustrated in Figure 4, the modifications applied for 2020 are two-fifths of the factors shown for 2030. For example, more car traffic is expected under the Perpetual Motion scenario: the car traffic growth assumed for 2030 is  $1.10 \times 28\% = 30.8\%$ , and  $1.04 \times 21\% = 21.8\%$  for 2020. The figures shown for all motor vehicles are the weighted sum of changes for cars, buses and HGV/LCVs. The latter are not shown, but all adjustments are -10% (slower), 0% (no change) or 10% (faster), as previously.

The final step to prepare the forecasting model is to choose parameters for the change in risk (corresponding to Figure 3). The upper part of Table 6 shows the rate changes (per cent per annum) used for the central casualty forecasts, based on recent trends. The lower part shows the adjustments applied for the four scenarios. The direction of the adjustments (i.e. increase or decrease) is based on the observations in the previous sections, but there is no information in the Foresight Report to indicate the scale of the adjustment. For the same reason, the adjustment factors used are the same for both fatalities and KSI (killed and seriously injured). Most of the rate changes are positive, as the rates are declining, so multiplication by a factor greater than one implies a more rapid decline in future, i.e. more rapid casualty reduction. Car occupants killed are the exception; here, the model has been adjusted so that the same direction is retained, i.e. a factor greater than one implies a less rapid rate increase in future.

**Table 6: Forecast rate changes and adjustments for Foresight scenarios**

		Car occupants	Motorcyclists	Pedal cyclists	Pedestrians	Others
Central forecast (baseline)	Killed	−0.9%	1.3%	2.5%	5.1%	2.3%
	KSI	3.1%	2.3%	5.5%	6.0%	5.1%
Adjustments for Foresight scenarios						
Perpetual Motion		1.10		0.90	0.90	1.10
Urban Colonies		1.10		1.10	1.10	1.10
Tribal Trading		0.90		0.90	0.90	0.90
Good Intentions		1.10		1.10	1.10	1.10

Table 7 compares the overall killed and KSI forecasts in the four Foresight scenarios with the ‘business as usual’ forecasts. Even by 2030, with what are intended to be appreciable changes to the model’s parameters, the overall effect on the total number killed is between a 2.4% increase and a 4.9% decrease. The effects are smaller for KSI, between a 1.3% increase and a 1.5% decrease.

**Table 7: Change in casualty forecasts associated with Foresight scenarios**

	Killed		KSI	
	2020 (%)	2030 (%)	2020 (%)	2030 (%)
Perpetual Motion	1.2	2.2	0.4	1.3
Urban Colonies	−2.6	−4.5	−0.3	−0.9
Tribal Trading	2.0	2.4	−0.3	−0.9
Good Intentions	−2.7	−4.9	−0.5	−1.5

Table 8 presents the impact that these percentage differences have on the casualty numbers in the four Foresight scenarios.

The effects on individual road-user groups are somewhat greater. Figure 5 illustrates the extreme case, the forecast for killed in 2030.

**Table 8: Casualty forecasts associated with Foresight scenarios**

	Killed		KSI	
	2020	2030	2020	2030
'Business as usual'	2,190	1,739	17,207	10,937
Perpetual Motion	2,217	1,777	17,283	11,079
Urban Colonies	2,133	1,661	17,154	10,841
Tribal Trading	2,233	1,780	17,153	10,840
Good Intentions	2,130	1,654	17,124	10,778

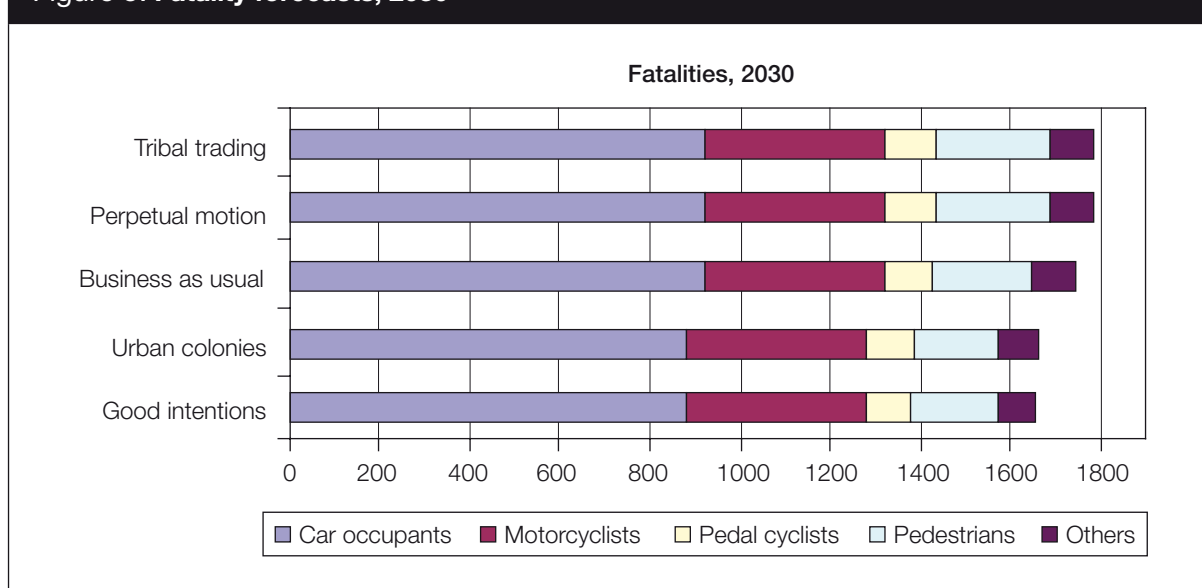
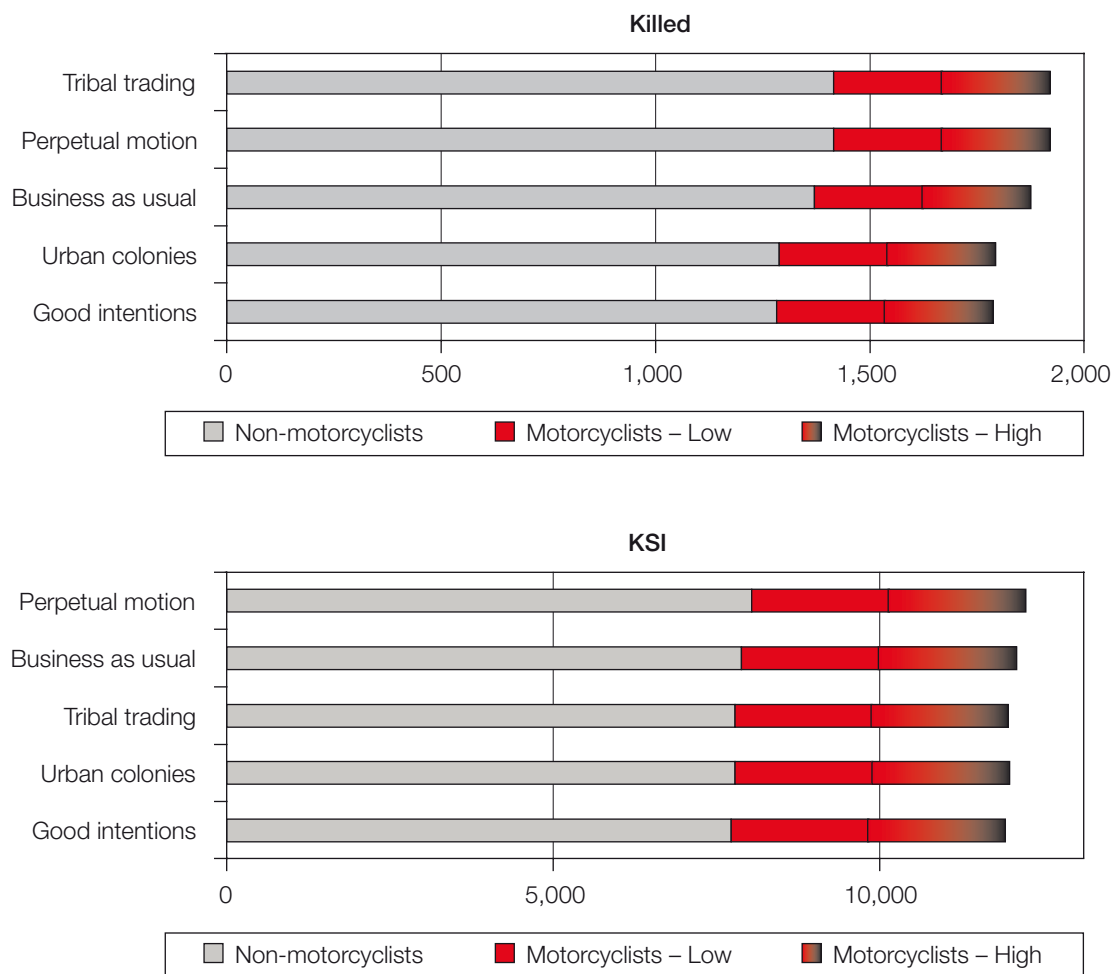
**Figure 5: Fatality forecasts, 2030**

Figure 5 suggests that the overall effect if one of the Foresight scenarios were to be realised would probably be relatively minor. One reason for this appears to be that even 2030 is only half way to 2055, the final year of the Foresight report, so the scope for diverging from recent trends is limited even for the more extreme scenarios.

## Motorcycling

The Foresight Report does not mention motorcycling whatsoever, so these forecasts have assumed that the volume of motorcycling in 2020 and 2030 under each scenario will be equal to the volume in 2006. In order to illustrate the sensitivity of the 2030 forecasts to this assumption, Figure 6 has been prepared with two alternative assumptions about the volume of motorcycling:

- the low assumption – there will be 25% less motorcycling in 2030 than in 2006; and
- the high assumption – there will be 50% more motorcycling in 2030 than in 2006.

**Figure 6: Sensitivity of casualty forecasts to motorcycling assumptions, 2030**

The grey bars in Figure 6 represent the sums of the forecasts for the non-motorcycle modes, so the right-hand bars with graduated shading indicate the range of overall casualty forecasts corresponding to the spectrum of assumptions about motorcycling between 25% reduction and 50% growth.

These results can be used to test any specific assumption about the growth of motorcycling. For example, if one felt that Tribal Trading would lead to rather less motorcycling in 2030 than in 2006, then the overall fatality forecast would be around 1,700, while if Good Intentions were to lead to about 50% more, then the overall fatality forecast would be around 1,850. Thus, motorcycling assumptions that vary by Foresight scenario can reverse the ranking shown when a single assumption is applied with each scenario.

## Conclusions

This report has summarised the elements in the Foresight Report that outline how road safety and the use of the roads may develop over the next 50 years. In the Foresight Report, four scenarios were described with reference to a central scenario.

This central scenario, which was not described explicitly, assumed current patterns evolve in line with recent developments. The Foresight Report described considerable differences from this central scenario, but unfortunately there was no attempt to quantify these divergences from the 'business as usual' scenario. Also, it failed to mention motorcycling, a minority mode of transport that is associated with high risks.

Using the road safety related aspects of the Foresight Report, this report has then attempted to assess the sensitivity of casualty forecasts for 2020 and 2030 to the alternative types of development represented by these scenarios. This has involved choosing various numerical values to represent each scenario, so different results would inevitably have been achieved if different values had been chosen. It appears that even if trends are altered as envisaged by the Foresight Report, the overall effect on casualties would probably be relatively minor. One likely reason is that even 2030 is only half way to 2055, the final year of the Foresight Report, so the scope for divergence is limited even for the more extreme scenarios.

The sensitivity of these forecasts to alternative assumptions about future growth in motorcycling has been demonstrated. The overall forecasts for 2030 appear to be at least as sensitive to this issue as to those which have been addressed (at least qualitatively) in the Foresight Report.

## References

Broughton, J., Allsop, R. E., Lynam, D. A. and McMahon, C. M. (2000) *The Numerical Context for Setting National Casualty Reduction Targets*. TRL Report No. 382. Wokingham: Transport Research Laboratory.

Curry, A., Hodgson, T., Kelnar, R. and Wilson, A. (2006) *Foresight: Intelligent Infrastructure Futures; The Scenarios – Towards 2055*. London: The Office of Science and Technology, the Department for Trade and Industry. [www.foresight.gov.uk/Intelligent%20Infrastructure%20Systems/the\\_scenarios\\_2055.pdf](http://www.foresight.gov.uk/Intelligent%20Infrastructure%20Systems/the_scenarios_2055.pdf) (accessed on 11 October 2007).

Department for Transport (2007a) *Road Transport Forecasts for England 2007. Results from the Department for Transport's National Transport Model*. London: The Department for Transport. [www.dft.gov.uk/pgr/economics/ntm/071023\\_AnnualForecast07.pdf](http://www.dft.gov.uk/pgr/economics/ntm/071023_AnnualForecast07.pdf) (accessed on 11 October 2007).

Department for Transport (2007b) *Road Casualties Great Britain 2006*. London: The Stationery Office. [www.dft.gov.uk/162259/162469/221412/221549/227755/rcgb2006v1.pdf](http://www.dft.gov.uk/162259/162469/221412/221549/227755/rcgb2006v1.pdf) (accessed on 11 October 2007).



## 4

# Truck drivers' compliance with road laws, regulations and researchers

David Crundall, Damian Poulter, Peter Bibby,  
David D. Clarke and Peter Chapman  
Accident Research Unit  
School of Psychology  
University of Nottingham  
Nottingham NG7 2RD

## Abstract

Truck drivers are less likely to be involved in a traffic collision than the average driver, but when they are the fatality rate is double that found with cars. Research should therefore be directed towards an understanding of why these truckers might crash. There are two particular types of behaviour that may influence the crash liability of drivers: their compliance with road laws and the Highway Code, such as paying due care and attention (avoiding distraction) or driving within the speed limit; and their compliance with Government regulations for truck drivers (as set down by the Vehicle and Operator Services Agency (VOSA)), including pre-start vehicle checks and avoiding overloading. This paper reports an overview of a questionnaire study that attempted to assess how truck drivers' self-reported attitudes and behaviours related to crash liability in regard to compliance on the road, and compliance with VOSA regulations. We found that in response to non-specific questions (following the structure of the Theory of Planned Behaviour) drivers believed that, while their own attitudes were the greatest determinant of how they drive, their compliance with VOSA regulations was strongly influenced by their level of perceived behavioural control. When they were asked more specific questions (relating to particular topics such as speeding or overloading etc.), the items that tended to discriminate between high- and low-risk drivers were predominantly related to perceived behavioural control for both on-road behaviour and compliance with VOSA regulations. These findings need to be viewed with caution, however, due to a third compliance issue: compliance (or lack of) with the researchers. Truck drivers were distrustful of our study, and many responded negatively. Accordingly, the response rate was much lower than anticipated. The findings are discussed in regard to understanding truck drivers' crash liability and ways in which future research can better engage with the truck-driving community.

# Introduction

The current study concentrates on factors relating to the crash liability of a subgroup of occupational drivers, namely drivers of large goods vehicles (LGVs), defined as goods vehicles with a gross weight over 3,500 kg. As a group, truck drivers are distinguishable from other road users for reasons beyond vehicle type. For example, the annual mileage per individual far exceeds that for car-driving populations. Greater exposure might suggest that road traffic crash involvement would be greater for truck drivers than non-commercial drivers, but when mileage is taken into account truck drivers (who have 42 crashes per 100 million kilometres travelled) are involved in fewer crashes than non-commercial drivers (71 crashes per 100 million kilometres) in the UK in 2005 (Department for Transport, 2006). However, despite lower crash involvement than other vehicle types, trucks are more likely to be involved in a crash that results in a fatality due to the weight and relative size of the vehicle compared with other road users, as well as increased length of stopping distances (Campbell, 1991; Chang and Mannering, 1999; Huang *et al.*, 2005; Clarke *et al.*, 2005; Björnstig *et al.*, 2008). The fatal crash rate for LGVs is 1.8 per 100 million vehicle kilometres, which is double the fatal crash rate of cars (0.9 per 100 million vehicle kilometres) (Department for Transport, 2006). In addition, injury severity is worse if a crash involves a truck (Chang and Mannering, 1999).

In a recent report to the Department for Transport undertaken by the University of Nottingham, Clarke *et al.* (2005) analysed over 2,000 crash reports involving a range of work-related vehicles. LGV drivers scored highest among occupational drivers for 'blameworthiness' in their crash involvement (a ratio of '**to blame**' and '**partly to blame**' crashes compared with '**not to blame**' crashes), with the causal factors of fatigue and vehicle defects most prevalent in truck crashes (Clarke *et al.*, 2005). Clarke *et al.* also found that trucks were the most likely vehicle group to be involved in crashes where people were killed or seriously injured, again largely attributable to the larger mass of trucks relative to other vehicles.

It appears that LGV driving shares some of the risks faced by other road users, but has its own characteristics and risks that require specific attention. The Vehicle and Operator Services Agency (VOSA) intend to address the issue of risk among the LGV driving community by developing a method by which they can identify LGV drivers at risk of crash involvement or non-compliance with regulations. Such a method will enable VOSA to target high-risk drivers more effectively based on key demographic and psychological factors associated with driving and non-compliance behaviour. This report will serve as a preliminary investigation into the risk factors and driving behaviour of truck drivers from a psychological perspective.

## LGV crash causation

VOSA acknowledge the two main contributors to LGV crashes as non-compliance with vehicle and driver safety protocols (compliance with regulations), and inappropriate driving behaviour on the road (compliance with road laws and the Highway Code). We suggest that both non-compliance and inappropriate driver responses are influenced by **driver violations** and **driver errors**. These two underlying factors have been consistently identified in many studies through the use

of the Driver Behaviour Questionnaire (DBQ; e.g. Parker *et al.*, 1995; Parker *et al.*, 1998; Chapman *et al.*, 2001). **Violations** refer to intentional non-compliance with traffic laws and the Highway Code (e.g. speeding, tailgating, etc.), while **errors** refer to self-reported mistakes that may inadvertently lead to drivers breaking the rules of the road, or may increase the chance of an accident.

The influence of **errors** and **violations** upon **non-compliance** and **driver responses** gives rise to four potential categories of causal factors that could lead to a crash:

1. Violations leading to non-compliance – potential causes include drivers disregarding safety protocols such as failing to observe required breaks, and interference with vehicle safety systems such as the speed limiter.
2. Violations influencing driver responses – these can include active violations such as tailgating, undertaking and speeding, and passive violations such as internally-motivated distractions such as talking on a mobile telephone or eating while driving.
3. Errors leading to non-compliance – though crashes resulting from these are quite rare (Clarke *et al.*, 2005), they can still be devastating. These include forgetting to make checks on the vehicle or loads, or incorrectly calculating load weight.
4. Errors that influence driver responses – these include failures in observation, external distractions, choosing the wrong lane at a junction, and misjudging the speed of other vehicles.

These factors do not necessarily act independently, and are likely to interact. For instance, an inadequately maintained braking system may only be identified after a period of speeding tests the brakes to their limit. Any profiler that attempts to identify the risk of LGV drivers needs to consider all four categories of potential causes, and their interplay. The current research aims to assist in the design and development of such a psychometric profiler that will assess all four categories of causes.

## Risk factors

In order to design a profiler that would capture the truck-driving experience, the existing scientific literature was reviewed in order to identify critical factors related to crash involvement for truck drivers. Furthermore, preliminary consultation with participating truck operators, driver trainers and truck drivers was conducted in order to identify salient issues and behaviours encountered in day-to-day truck driving. Ten error and violation factors were identified as pertinent issues in truck driving. Six are concerned with driver behaviour and four address non-compliance with road traffic regulations for trucks (see Table 1).

While most of these have clear links to traffic collisions, it should be noted that 'driving culture' is more of a collective term referring to the underlying ethos surrounding drivers. This particular factor includes items that ask whether money is their motivator for driving, whether they have the belief that all truck drivers will be involved in an accident at some point, and whether they feel that truck drivers discuss safety issues. It should also be noted that there is a clear distinction between

the risk factors of taking breaks and fatigue. While the latter refers to the likelihood of falling asleep at the wheel over long distances or early or late shifts, the former refers more to the ability to stick within guidelines regarding breaks that may have a short-term impact on attention.

**Table 1: A list of 10 risk factors and associated references**

	Risk factor	Related references
On-road behaviour	Speeding	e.g. Hakkanen and Summala, 2001; Aarts and van Schagen, 2006
	In-cab distraction	e.g. Hanowski <i>et al.</i> , 2005; Blanco <i>et al.</i> , 2006
	Poor observation	e.g. Hakkanen and Summala, 2001; Clarke <i>et al.</i> , 2005
	Close-following	e.g. Fuller, 1981
	Intimidation	e.g. Walton, 1999
Compliance with VOSA regulations	Driving culture	
	Taking breaks	Hakkanen and Summala, 2001; Arnold <i>et al.</i> , 1997
	Pre-start checks	Clarke <i>et al.</i> , 2005;
	Overloading	Clarke <i>et al.</i> , 2005, VOSA, 2009
	Fatigue	Morrow and Crum, 2004

Six questions were devised for each of these 10 risk factors: three **error** items and three **violation** items. Within each of these three items, one question assessed an individual's attitude towards the behaviour (will it lead to good outcomes?), one question assessed subjective norms (their beliefs about the attitudes of peers and other socially-relevant people), and one question assessed perceived behavioural control (that is, the degree to which an individual believes they can personally influence that behaviour). These three types of question are taken from the Theory of Planned Behaviour (TPB; Ajzen, 1985; 1988), which is a social psychological model that has been put forward to explain behaviour via intentions (or lack of intentions). The key three components that feed into intentions are: attitudes, subjective norms and perceived behavioural control, which provides the basis for the current items.

In addition to the 60 risk factor questions (10 risk factors  $\times$  (errors and violations)  $\times$  three components of the TPB), 10 general questions were added that looked at all five levels of the TPB (attitudes, subjective norms, perceived behavioural control, intentions and self-reported behaviour) for both on-road behaviour and compliance with regulations (both expressed in general terms rather than specific to risk factors).

It was predicted that different patterns of response might be found for on-road driving compared with compliance with the LGV regulations.

# Methodology

## Profiler development

Prior to the main postal profiler being compiled, a 70-item pilot profiler was distributed to 100 LGV drivers. Each item consisted of a statement that drivers could agree or disagree with. They marked their level of agreement on a seven-point scale. The left of the scale indicated strong disagreement and the right of the scale indicated strong agreement. A total of 50 truck drivers (response rate = 50%) sent their completed profiler back via a free postal service. Face validity was achieved through consultation with participating truck operators, driver trainers and truck drivers themselves. Informal analysis was conducted exploring mean scores and standard deviations for each item, as well as bivariate correlations between items. For items where mean scores were at one end of the scale, and with a standard deviation below 1.5, items were rephrased in order to try and increase response variance. Feedback from drivers did not reveal any confusing or incomprehensible items or terminology, and thus it was decided to proceed with the existing 70-items for the main profiler, with only minor changes to 23 items.

Demographic information was collected from respondents, including age, gender, annual mileage, LGV driving experience (the number of years since obtaining their licence), licence endorsements, shift details, and vehicle defect reporting. With regard to the data on experience (LGV licence years) and exposure (annual LGV mileage), minor adjustments were required. For the length of time drivers had held an LGV licence, 20 participants reported holding an LGV licence or car licence for longer than legally possible. In these cases it was assumed that it was a calculation error by the respondent. The length of time an LGV or car licence had been held was adjusted to match the number of years from the legal license age (18 years and 17 years respectively) to their current age.

With regard to crash involvement, truck drivers had to complete a section detailing both truck and car crashes they had been involved in during the past two years, and near-crashes they had been involved in during the previous two weeks when in a truck and in a car. For crashes, drivers were also asked to briefly describe the most recent crash they had been involved in when driving a truck, as well as rating the extent of the crash on a three-point scale of severity ('minor damage only', 'major crash/minor injury', 'person seriously injured or killed'), and the degree of their culpability on a three-point scale ('not to blame', 'partly to blame', 'totally to blame'). For near-crashes, drivers were asked to briefly describe the most recent near-crash they had experienced when driving a truck, as well as rating the extent of the near-crash on a three-point scale of severity ('little danger of crash', 'moderate danger of crash', 'serious danger of crash'), and the degree of their culpability on a three-point scale ('not to blame', 'partly to blame', 'totally to blame').

In relation to personal experiences of truck driving, participants were also asked to rate the extent to which they found truck driving enjoyable and the extent to which they found truck driving stressful on a scale from '1' ('never') to '7' ('all the time'), as well as how often they felt tired when driving for work and how often they changed their work shift patterns on a scale from '1' ('never') to '7' ('all the time'). Finally, drivers were asked a short set of questions relating to their general health,

including whether they were smokers or non-smokers, how many personal injury claims they had made in the last five years, and how much they drank per week. Alcohol intake was calculated by asking the number of pints of beer, glasses of wine and single measures of spirits they drank a week, which were converted post-hoc by the researchers into a single score reflecting the total number of units consumed per week, according to the official alcohol guidelines set out by the Department of Health (2006).

The main profiler consisted of two sets of questions pseudo-randomly mixed together. The first set of questions were 10 TPB items, five relating to general conformity to LGV regulations and a second set of five questions relating to general road laws when driving an LGV. As previously mentioned, there were six statements in each of the 10 categories: two for the TPB factor of attitudes, two for subjective norms and two for perceived behavioural control, with one of each statement relating to an error and one relating to a violation. See Table 2 for a matrix of the number of items by category.

**Table 2: The number of profiler items broken down across TPB categories and behavioural precursors to crashes**

	Violations		Errors	
	Non-compliance	Driver behaviour	Non-compliance	Driver behaviour
Attitudes	4	6	4	6
Subjective norms	4	6	4	6
Perceived behavioural control	4	6	4	6

## Procedure

Three truck operators were approached by VOSA to take part in the research, and all three initially agreed to distribute 1,000 profilers to LGV drivers within their company. The operators consisted of a waste management company ( $n = 1,000$ ), a dairy foods company ( $n = 1,000$ ), and a fleet management and logistics company ( $n = 483$ ; this was a revised distribution target decided by the operator), and, as such, covered a range of LGV driving experiences. Profilers were sent to a representative of each truck operator and were then administered by hand to a random sample of truck drivers by company trainers. Drivers were instructed to complete the profiler and return it in a postage-paid envelope provided by the research team. The instructions in the profiler assured drivers that their responses were anonymous, that their identity would be protected according to British Psychological Society ethical guidelines, and it was emphasised that their individual data would not be shared with any other party in order to encourage drivers to answer honestly about their truck-driving experiences rather than reporting what they think they ought to say.

In order to try and increase the response rate, drivers were also given an opportunity to enter a prize draw to win £250 as an incentive to take part in the survey by writing their name and address on a separate competition slip. Upon return of the freepost envelope, profilers and competition slips were separated by a third party so that



individual drivers could not be identified by the researchers. As a further inducement, drivers were informed that it had been agreed with all three operators that they could complete the profilers on company time.

## Participants

A total of 2,943 profilers were distributed across a variety of outlets. A total of 232 drivers (225 males, 4 females, 3 missing) returned profilers, making the overall return rate 7.88%. In addition to the profilers that were sent to drivers from the three truck operators who agreed to participate in the study and distribute profilers to their fleet of drivers, the University of Nottingham attempted to boost responses by distributing 460 additional profilers at a range of outlets frequented by LGV drivers, including truck-stop cafes ( $n = 5$ ), LGV service stations ( $n = 4$ ) and lay-by cafes ( $n = 1$ ). Finally, an online version of the profiler was made available for one week and advertised through web sites frequented by truck drivers.

The mean age of the respondents was 46.8 years ( $SD = 9.4$  years), with annual truck mileage of 49,524 miles ( $SD = 39,092$  miles). Drivers had an average of 20 years' ( $SD = 11.6$  years) experience driving trucks. A total of 33.9% of truck drivers reported having a crash in the last two years, with 36.2% reporting more than a couple of near-crashes in the previous two weeks. A total of 87.7% reported at least one vehicle defect on their truck in the last month, with 40.8% reporting 0–2 defects and 25.4% reporting six or more defects.

## Data analysis

The initial intention was to perform an exploratory factor analysis and relate the results to both objective and subjective indicators of performance (points on licence, accidents). Unfortunately, the low response rate and failure to obtain objective data from the partner operators required a different approach.

The new analyses comprised the following:

1. Path analysis of the TPB factors which was conducted separately for driver behaviour and non-compliance in order to determine the key factors that predict intentions and behaviours regarding obeying all road traffic laws and ensuring one's LGV complies with all regulations. Specifically this includes investigation of the direct and indirect effects of attitudes, subjective norms, perceived behavioural control, and intention on both driving behaviour and on non-compliance behaviour.
2. Comparison of higher- versus lower-risk drivers on self-reported behaviour (LGV crashes and LGV near-crashes) and non-compliance (vehicle defect reporting) criteria. For the crash criterion, responses from crash-free drivers were compared with responses from drivers involved in an LGV crash in the previous two years. For the near-crash criterion, responses from drivers experiencing a low frequency of near-crashes (0–2) in the previous two weeks were compared with responses from drivers experiencing a higher frequency of near-crashes (3+). For the non-compliance criterion, no objective data on non-compliance were available, therefore we substituted self-reported frequency of



reported vehicle defects in the previous month. The top quarter of drivers reporting vehicle defects (six or more defects in the last month) were compared with the bottom quarter of drivers reporting vehicle defects (less than three defects in the last month), in order to identify any distinguishing variables. Individual *t*-tests were run for all dependent variables, including all demographic variables, all 60 profiler items and all 10 TPB items.

3. Correlation of demographic variables with key items arising from the analysis of higher- versus lower-risk drivers in terms of self-reported behaviour (LGV crashes and LGV near-crashes) and non-compliance (vehicle defect reporting) in order to assist in identifying characteristics of risky drivers.

## Measures of driver behaviour and compliance

For the two behavioural measures (crash and near-crash involvement) and the non-compliance measure (vehicle defects reported), the original intention had been to validate the reliability of self-report data through comparison with objective data from driver records held by operators. Unfortunately these data were not available, and instead only self-report data were used in the analysis. The behavioural measures of self-reported crash involvement and near-crash involvement were used in the analysis. Owing to the relatively infrequent occurrence of crashes at an individual driver-level, near-crash frequency was also included as it has been commonly used as a surrogate for crash involvement (e.g. Morrow and Crum, 2004; Chapman and Underwood, 2000). For example, previous research has demonstrated that risk factors such as driving while fatigued can account for significant variance (~40%) in the frequency of near-crashes (Morrow and Crum, 2004). The non-compliance measure used was self-reported number of vehicle defects reported in the previous month. While there is considerable evidence from the driving literature to suggest that self-report data can be as reliable as objective data (e.g. Elliott *et al.*, 2007; Haglund and Åberg, 2000), caution is required when interpreting the following results due to a lack of verification with objective behavioural and non-compliance data.

## Results and discussion

Although the response rate was disappointing, the analyses were extensive and can only be briefly summarised here. For detailed understanding of the path analyses on the general TPB items, please refer to Poulter *et al.* (2008):

- With regard to the general questions relating to the TPB model, the path analysis revealed that law-abiding on-road behaviour in trucks was related more to attitudes and subjective norms than perceived behavioural control. If drivers think it is important to follow driving laws, and perceive that other drivers also believe it is important to follow driving laws, and also intend to follow the law in future, then they were more likely to report being law abiding.

- For compliance with truck regulations, however, perceived behavioural control had the largest direct effect. Compliance was found to depend on whether drivers can actually comply with laws, or believe they can actually comply, rather than what they think about compliance.
- The differing results of the path analyses for on-road driving behaviour and regulation-compliance behaviour suggest that any future interventions that may be targeted at improving either on-road behaviour or compliance with regulations would require different approaches.
- Interventions designed to improve driver behaviour might incorporate efforts to change truck drivers' attitudes towards driving laws, as well as challenging their perceptions of how other truck drivers view law-abiding behaviour.
- Interventions designed to improve compliance rates might target individual operators with poor compliance histories in order to ensure that their drivers actually have the capability and resources to comply with regulations.
- A second analysis was conducted on demographic variables and truck drivers' agreement with statements on errors and violations for on-road behaviour and regulation-compliance behaviour by comparing lower-risk truck drivers (no crash history, low near-crash experience, high vehicle defect reporting) with higher-risk truck drivers (crash-involved, high near-crash experience, low vehicle defect reporting).
- Older drivers were less likely to have been involved in a crash than younger drivers, and reported feeling less stressed and less tired than younger drivers while driving.
- Drivers who had more near-crashes in their LGV also experienced near-crashes that were more serious, as well as experiencing a greater number of actual crashes in their LGV.
- Drivers reporting more serious near-crashes in their LGV also attributed less personal blame for the near-crashes and less blame for actual crashes that they were involved in.
- Drivers reporting a greater number of vehicle defects on their LGV reported more than twice as many LGV crashes in the previous two years, and made more personal injury claims in the previous five years.
- While it appears that the general TPB questions regarding on-road behaviour suggested that driver attitudes were the main predictor of intentions and thus behaviour, it appears that when the items contain concrete examples (in the form of the risk factors), it is the perceived behavioural control items that tend to discriminate between high- and low-risk drivers.
- This suggests that, while drivers might consider themselves to be the masters of their own destiny in abstract driving terms, when they are cued to recall specific instances, it appears that high-risk drivers identify a lack of control over their behaviour due to external factors.

While the low response rate to the profiler precluded a full analysis and understanding of LGV drivers' crash liability, the results have identified certain patterns that are worthy of further study. However, any future research must face the up-hill struggle of engaging with LGV drivers. When it became apparent that the drivers employed by our partner operators were not providing the required response rate, we distributed the profilers to opportunity samples of LGV drivers, and provided an online version which was advertised on various truck web-forums. While we merely received a reduced response from our operators, the responses we received from our own efforts also included a lot of negative feedback. Drivers were distrustful of the profiler, and predicted that the results would either be used to further penalise their profession or would appear in the national press denouncing 'dangerous' truck drivers. At the heart of the profiler was a desire by VOSA to better target their efforts in reducing LGV crashes. While this is a laudable aim in itself, it would also have the benefit of reducing the number of trucks that are stopped at check points, allowing the majority of compliant drivers to continue unimpeded. However, the defensive nature of the truck-driver community, as witnessed by the researchers, needs to be understood as a research topic in its own right. This group appear to feel marginalised and demonised, and research should address ways of tackling this apparently widespread isolationism. It is possible that the upcoming introduction of the Professional Certificate of Competence may have an impact on this collective defensive attitude, though equally it could just as easily fall victim of it.

## References

- Aarts, L., and van Schagen, I., (2006) Driving speed and the risk of road crashes: a review. *Accident Analysis and Prevention*, 38, 215–224
- Ajzen, I. (1985) From intentions to actions: a theory of planned behavior. In J. Kuhl and J. Beckmann (eds), *Action Control: From Cognition to Behavior*. Berlin: Springer-Verlag. pp. 11–38.
- Ajzen, I. (1988) *Attitudes, Personality, and Behavior*. Milton Keynes: Open University Press.
- Arnold, P. K., Hartley, L. R., Corry, A., Hochstadt, D., Penna, F. and Feyer, A. M. (1997) Hours of work, and perceptions of fatigue among truck drivers. *Accident Analysis and Prevention*, 29(4), 471–477.
- Björnstig, U., Björnstig, J. and Eriksson, A. (2008) Passenger car collision fatalities – with special emphasis on collisions with heavy vehicles. *Accident Analysis and Prevention*, 40(1), 158–166.
- Blanco, M., Biever, W. J., Gallagher, J. P. and Dingus, T. A. (2006) The impact of secondary task cognitive processing demand on driving performance. *Accident Analysis and Prevention*, 38, 895–906.
- Campbell, K. (1991) Fatal accident involvement rates by driver age for large trucks. *Accident Analysis and Prevention*, 23(4), 287–295.

- Chang, L-Y. and Mannering, F. (1999) Analysis of injury severity and vehicle occupancy in truck- and non-truck-involved accidents. *Accident Analysis and Prevention*, 31, 579–592.
- Chapman, P., Roberts, K. and Underwood, G. (2001) A study of the accidents and behaviours of company car drivers. In *Behavioural Research in Road Safety: Tenth Seminar*. London: Department of the Environment, Transport and the Regions.
- Chapman, P. and Underwood, G. (2000) Forgetting near-accidents: the role of severity, culpability and experience in the poor recall of dangerous driving situations. *Applied Cognitive Psychology*, 14, 31–44.
- Clarke, D. D., Ward, P., Bartle, C. and Truman, W. (2005) *An In-depth Study of Work-related Road Traffic Accidents*. Road Safety Research Report No. 58. London: Department for Transport.
- Department for Transport (2006) *Focus on Freight*. London: The Stationery Office.
- Department of Health (2006). How much is too much: Drinking and you. [www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH\\_4139672](http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4139672), accessed on 29 October 2006.
- Elliott, M. A., Armitage, C. J. and Baughan, C. J. (2007) Using the theory of planned behaviour to predict observed driving behaviour. *British Journal of Social Psychology*, 46, 69–90.
- Fuller, R. G. C. (1981) Determinants of time headway adopted by truck drivers. *Ergonomics*, 24, 463–474.
- Haglund, M. and Åberg, L. (2000) Speed choice in relation to speed limit and influences from other drivers. *Transportation Research Part F*, 3, 39–51.
- Hakkanen, H. and Summala, H. (2001) Fatal traffic accidents among trailer truck drivers and accident causes as viewed by other truck drivers. *Accident Analysis and Prevention*, 33, 187–196.
- Hanowski, R. J., Perez, M. A. and Dingus, T. A. (2005) Driver distraction in long-haul truck drivers. *Transportation Research Part F*, 8, 441–458.
- Huang, Y.-H., Roetting, M., McDevitt, J. R., Melton, D. and Smith, G. S. (2005) Feedback by technology: attitudes and opinions of truck drivers. *Transportation Research Part F*, 8, 277–297.
- Morrow, P.C. and Crum, M. R. (2004) Antecedents of fatigue, close calls, and crashes among commercial motor-vehicle drivers. *Journal of Safety Research*, 35, 59–69.
- Parker, D., Lajunen, T. and Stradling, S. G. (1998) Attitudinal predictors of interpersonally aggressive violations on the road. *Transportation Research Part F*, 1, 11–24.

- Parker, D., Reason, J. T., Manstead, A. R. S. and Stradling, S. G. (1995) Driving errors, driving violations and accident involvement. *Ergonomics*, 38(5), 1036–1048.
- Poulter, D. R., Chapman, P., Bibby, P. A., Clarke, D. D. and Crundall, D. (2008) An application of the Theory of Planned Behaviour to truck driving behaviour and compliance with regulations. *Accident Analysis and Prevention*, 40(6), 2058–2064.
- Walton, D. (1999) Examining the self-enhancement bias: professional truck drivers' perceptions of speed, safety, skill and consideration. *Transportation Research Part F*, 2, 91–113.
- VOSA (2009). Vehicle safety: the dangers of overloading. [www.vosa.gov.uk/vosacorp/repository/Vehicle%20Safety%20-%20The%20Dangers%20of%20Overloading.pdf#xml=http://www.vosa.gov.uk/SCRIPTS/teaxis.exe/webinator/search/xml.txt?query=load&pr=CORP&order=r&cq=&id=4a28ac446](http://www.vosa.gov.uk/vosacorp/repository/Vehicle%20Safety%20-%20The%20Dangers%20of%20Overloading.pdf#xml=http://www.vosa.gov.uk/SCRIPTS/teaxis.exe/webinator/search/xml.txt?query=load&pr=CORP&order=r&cq=&id=4a28ac446), accessed on 5 June 2009.

# 5

## A poor way to die: social deprivation and road traffic fatalities

David D. Clarke, Pat Ward, Wendy Truman and Craig Bartle  
School of Psychology  
University of Nottingham  
Nottingham NG7 2RD

### Abstract

A sample of 893 fatal vehicle occupant cases was considered, from 10 UK police forces, from the years 1994–2005 inclusive. Each case was summarised on a database that included the main objective features (such as time and place), a summary narrative, a sketch plan and a list of explanatory factors. Each case was then assigned an Index of Multiple Deprivation (IMD) score based on the postcode/address of the primary fatality, and these scores were separated into IMD quintiles.

The main findings were that driving at excessive speed, driver intoxication, driver/passenger failure to wear seat-belts, and unlicensed/uninsured driving were most prevalent in fatal collisions in the most deprived IMD quintiles. Young drivers (under 24 years) form high proportions of fatal casualties across all IMD quintiles. Older drivers and passenger fatalities are more concentrated in the least deprived IMD quintiles.

### Introduction

Research has indicated that social deprivation is associated with increased injury and fatality levels in road traffic collisions. In an international review, Petridou and Tursz (2001) commented that ‘existing data indicate that socio-economic disparities are predictors of both injury morbidity and mortality as well as the long-term outcome of an injury’. Abdalla *et al.* (1997), in an analysis of a database created by merging road casualty information and census data in Scotland, noted that ‘... in general it was found that the casualty rates amongst residents from areas classified as relatively deprived were significantly higher than those from relatively affluent areas’. Similarly, Chichester *et al.* (1998), in a study that analysed hospital accident

and emergency (A&E) admissions and investigated associations between road traffic accidents (RTAs) and socio-economic status, reported ‘... findings [that] strongly suggest a positive trend between RTA activity and deprivation ... for gender, victim role, purpose of journey and age’. Chichester *et al.* (1998) recommended ‘further research between RTAs and deprivation’. In a comprehensive study of trends in fatal car-occupant collisions (Department for Transport, 2007), it was noted that ‘there is some evidence, among men aged 20–64 ... that the risk of death increases with disadvantage’.

Regarding unlicensed drivers, in particular, research published by the Department for Transport (2003; 2007) showed that ‘crashes were significantly more severe when an unlicensed driver was involved’, and that ‘there is also evidence that young men from more disadvantaged backgrounds are **less** likely than their more affluent peers to have a full driving licence and are **more** likely to be driving unlicensed and/or uninsured. While the link to fatalities is not proven, there is evidence which suggests that accidents of unlicensed drivers are more frequent and more severe.’

## Method

A sample of 893 fatal vehicle occupant cases was considered, from 10 UK police forces, from the years 1994–2005 inclusive. Each case was summarised on a database that included the main objective features (such as time and place), a summary narrative, a sketch plan and a list of explanatory factors. Each case was then assigned an Index of Multiple Deprivation (IMD) score based on the postcode/address of the primary fatality, and these scores were separated into IMD quintiles.

## How an Index of Multiple Deprivation is defined

Super Output Areas (SOAs) are small areas of the country specifically devised to improve the reporting and comparison of local statistics. Within England and Wales there is a Lower Layer (minimum population 1,000) and a Middle Layer (minimum population 5,000). Unlike electoral wards, these SOA layers are of consistent size across the country and are not subjected to regular boundary change. The IMD 2004 uses over 30,000 Lower Layer Super Output Areas (LSOAs) to determine a measure of how deprived an area is, based on income, employment, health deprivation, education, skills, training and geographical access to services. Each LSOA area in England and Wales is then given a ranked score from 1 (most deprived) to 32,482 (least deprived).

## Index of Multiple Deprivation quintiles in the Nottingham fatal accident database

Levels of deprivation associated with accidents in the dataset were assessed using the IMD. Scores were assigned on the basis of postcode data, or the first line of the address, for fatalities in a truncated data file. This work was carried out with the kind help of researchers at University College London (UCL). The IMD scores generated



by this process were then added to the correct full fatal case files available at the University of Nottingham. (This rather elaborate process was used in order to comply with the requirements of the Data Protection Act.)

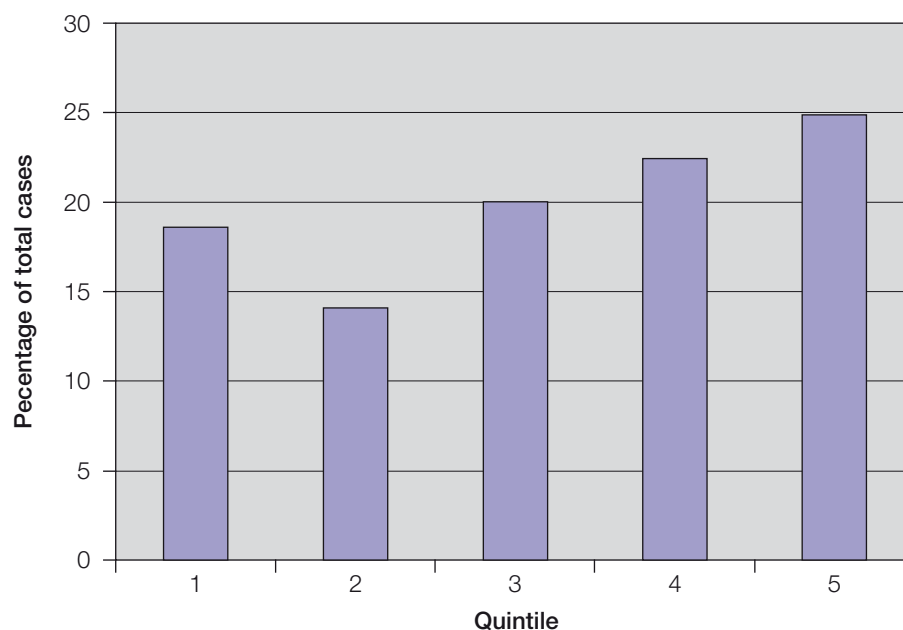
There were 893 case records that could be matched with IMD scores (approximately 75% of the Nottingham fatal accident database). These were cases where the postcode or first address line of an in-car fatality had been assigned an individual IMD score by researchers at UCL. Where IMD scores were available, case records were coded to IMD quintile scores, i.e. 1 (most deprived) to 5 (least deprived).

## Results

### Overall distribution of the sample

Figure 1 shows the distribution of fatal car occupant collisions in the sample by IMD quintile expressed as a percentage of the sample ( $n = 893$ ).

Figure 1: Proportion of cases in each IMD quintile ( $n = 893$ )



It can be seen in Figure 1 that fatal car-occupant cases peak in the least deprived quintile (five – nearly a quarter of total cases).

### Deprivation, fatality and speed

Speeding accidents were examined, and divided into separate types, based predominantly on levels of risk-taking by drivers:

- **Type 1:** deliberate risk-taking involving speed in excess of the limit.

- **Type 2:** deliberate risk-taking involving driving too fast for the road conditions, for example cornering deliberately fast.
- **Type 3:** ignorance of speed, for example failing to realise that wet road conditions increase the likelihood of skidding.
- **Type 4:** misjudgement of the correct speed for the conditions, for example misjudging the sharpness of a bend.

Judgements were made by individual researchers, using all the available data. Primary sources included, for example, witness statements from surviving passengers concerning the vehicle speed/driver behaviour, or accident reconstruction reports using critical speed marks left by a car to calculate a likely velocity range at the point of control-loss (usually compiled by a specially trained police traffic officer).

These four types of speed accident were examined in relation to the IMD associated with the driver. Figure 2 shows the overall contribution of all types of speed to fatal accidents by driver IMD quintile.

Figure 2: **Speed – all speed-related accidents (proportion of each quintile)**

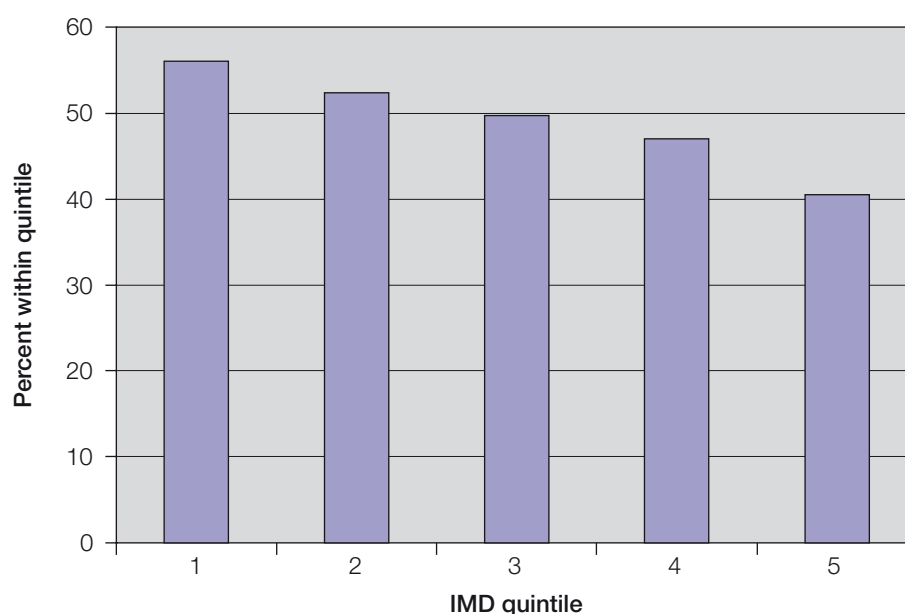
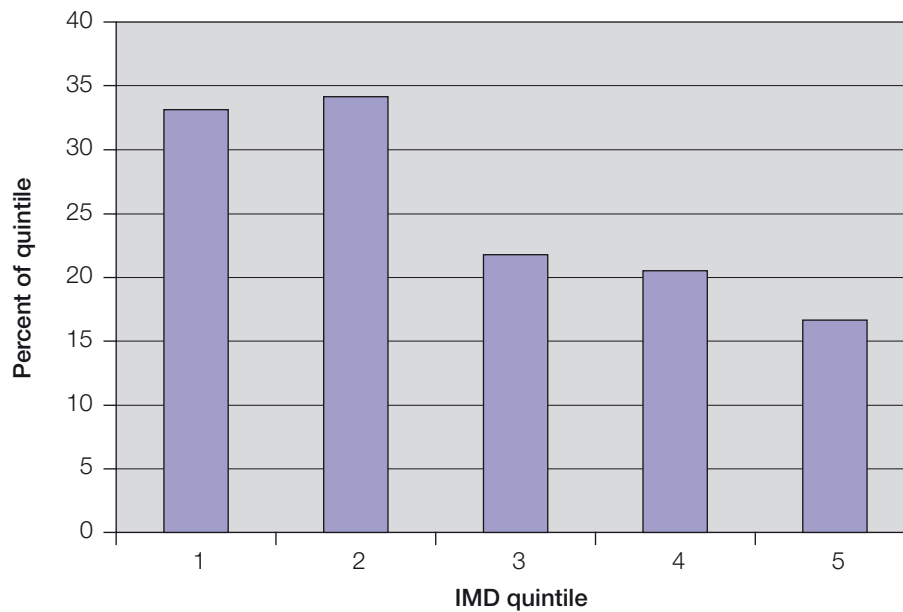


Figure 3 shows a similar distribution in the type 1 speed accidents – deliberate risk-taking involving speed in excess of the limit.

However, the distribution of type 2 speed accidents (deliberate risk-taking involving driving too fast for road conditions, for example cornering deliberately fast), was different, showing a flatter distribution of percentages in each quintile.

Unfortunately, it was not possible to obtain meaningful results relating to type 3 and 4 speeding accidents, as frequencies (and resulting percentages) were very low. The majority of speed-related fatal cases involved the two risk-taking kinds of speeding.

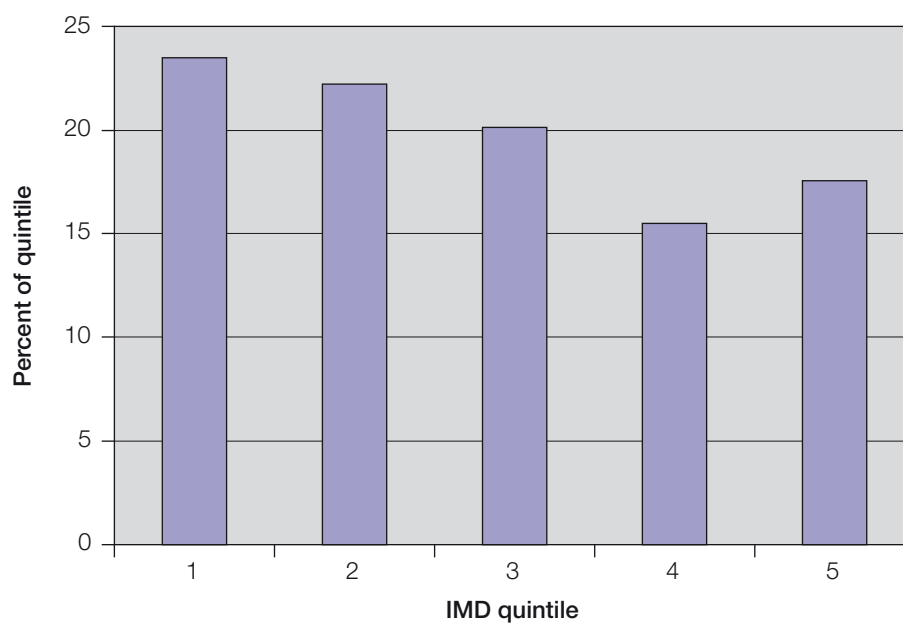
Figure 3: **Risk** – deliberate risk-taking involving speed in excess of the limit (proportion of each quintile)



## Deprivation, fatality and impaired driving

Figure 4 shows the level of drink/drugged driving in the sample by IMD quintile, expressed as within-quintile percentages.

Figure 4: **Impairment** – cases involving impaired driving (proportion of each quintile)

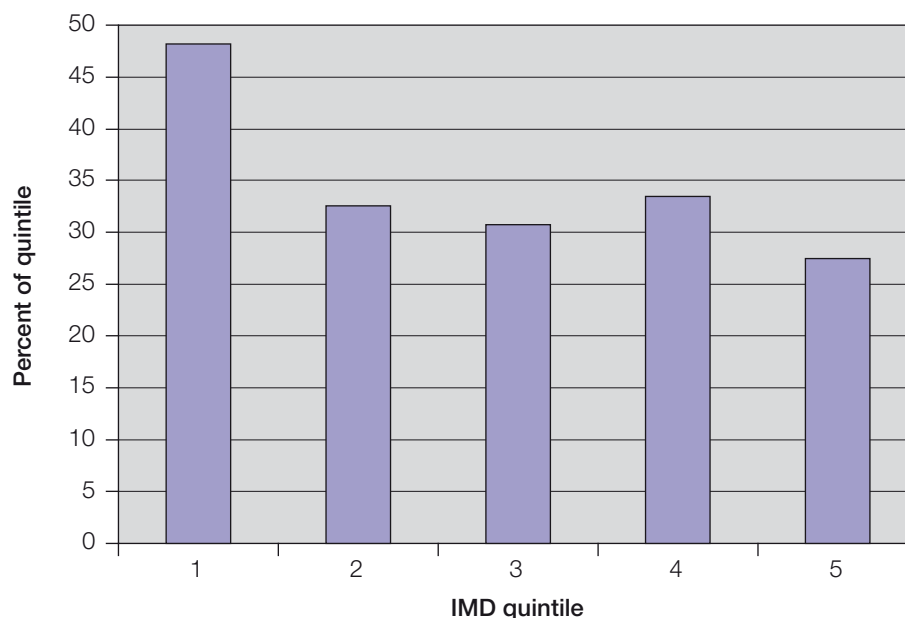


It can be seen that the two most deprived IMD quintiles have over one in five of their fatal accidents including alcohol or drugs as a contributory factor.

## Deprivation, fatality and seat-belt wearing

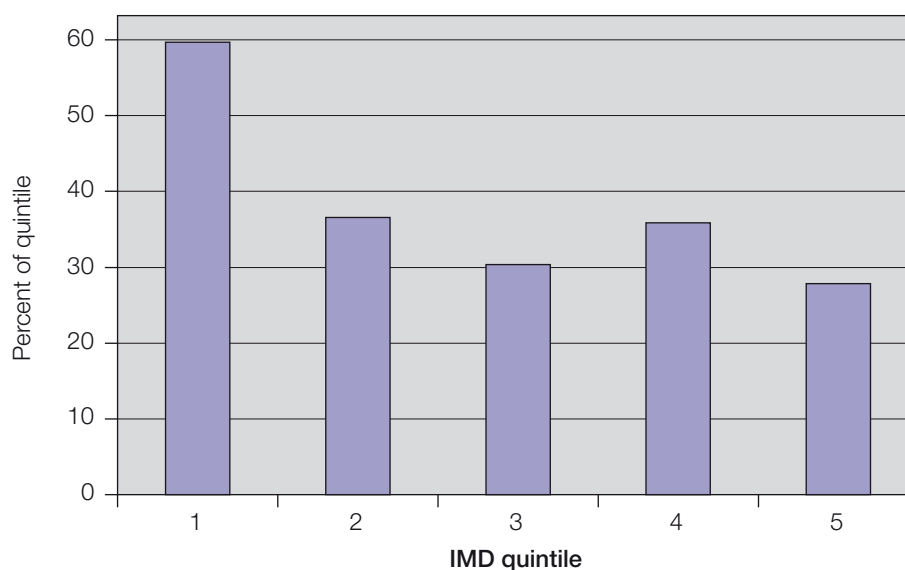
Figure 5 shows the percentage of fatalities not wearing seat belts (both driver and passenger fatalities) by IMD quintile.

Figure 5: **Seat belts – fatalities not wearing seat belts (proportion of each quintile)**



It can be seen that the most deprived IMD quintile (1) has nearly twice the percentage of non-seat-belt wearing fatalities compared with the least deprived quintile (5). If passenger fatalities are considered alone, the difference in percentage distribution becomes even more stark, as shown in Figure 6.

Figure 6: **Passengers and seat belts – passenger fatalities not wearing seat belts (proportion of each quintile)**



## Deprivation, fatality and driving licence violations

Eight per cent of the IMD sample cases involved a driver without a full driving licence (either through having no licence at all, driving illegally on a provisional licence, or driving while already disqualified). Two-thirds of these cases were single-vehicle accidents, approximately twice the proportion observed in the sample as a whole. Factors such as excess alcohol and drugs, and excess speed were found to be common in this group. Figure 7 gives a breakdown by violation type.

Figure 7: **Licensing** – unlicensed, provisionally licensed and disqualified drivers

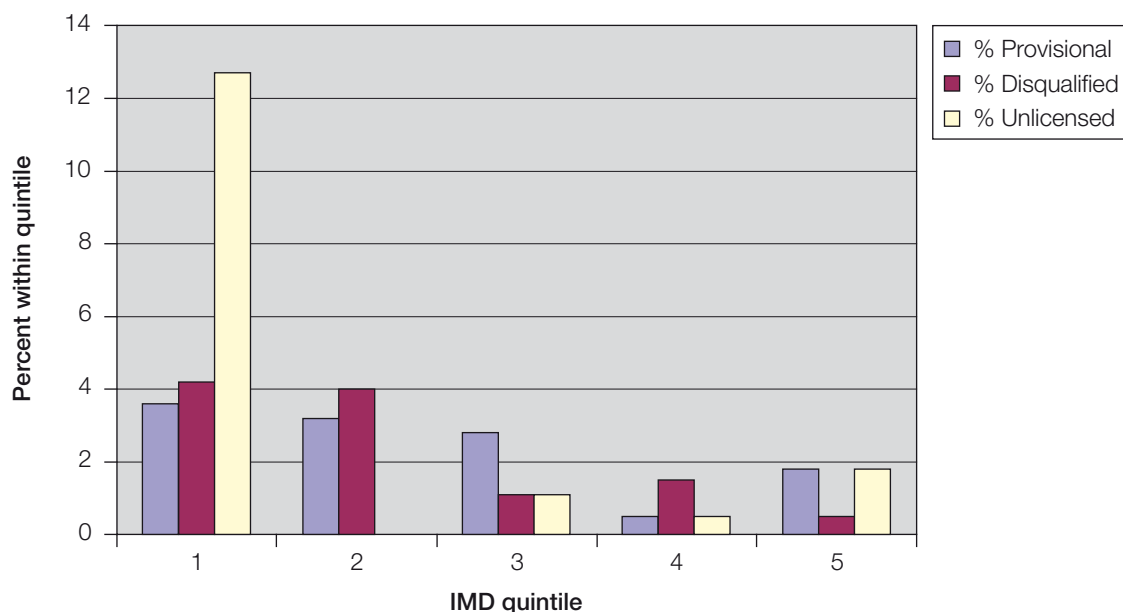


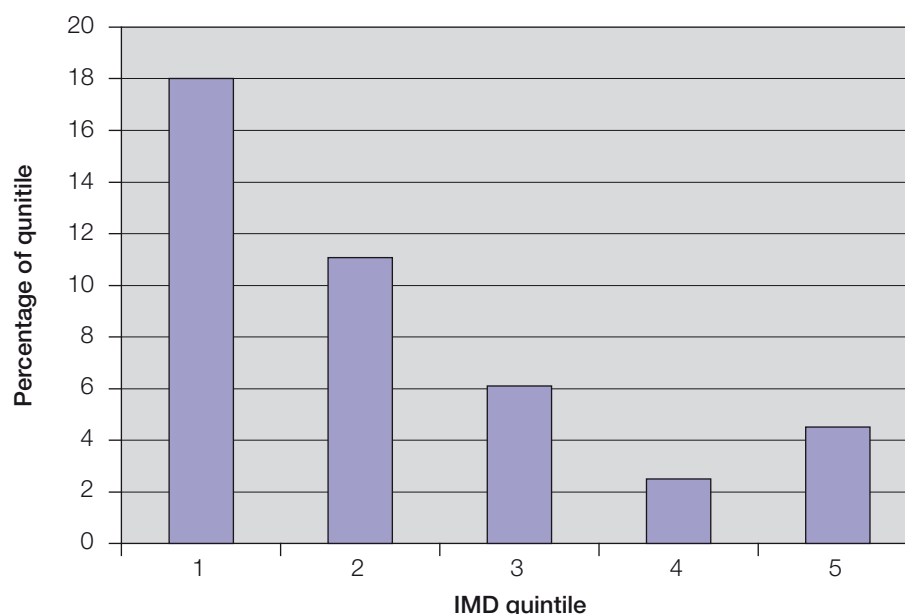
Figure 7 clearly shows that fatalities involving driving licence violations are especially prevalent in the lowest IMD quintile (1), and the most common violation within this quintile is driving without any kind of licence.

## Deprivation, fatality and insurance violations

Approximately 7% of all cases involved a driver without mandatory third-party insurance. This is probably an underestimate, as this information was not always recorded if the police could convict the offender for another serious offence; there was also considerable ‘overlap’ with the group of ‘no-licence’ offenders detailed above. Figure 8 shows clear differences in uninsured driving across IMD quintiles.

It can be seen in Figure 8 that the most deprived quintile (1) has over three times the recorded rate of insurance violations in fatal collisions as the least deprived quintile (5).

Figure 8: **Uninsured driving – fatalities involving uninsured driving (proportion of each quintile)**



## Deprivation and passenger fatalities

Of the 893 available cases, 284 (approximately 32% of the IMD sample) involved the death of one or more passengers in a vehicle. There were also 110 cases (approximately 12% of the IMD sample) involving more than one fatality (multiple fatalities were defined as those with two or more fatalities, driver fatalities included). Figure 9 shows the percentage of multiple fatalities (including the driver) within each IMD quintile, expressed as a percentage of all passenger fatality cases for that quintile.

Figure 9: **Multiple fatalities – number of fatalities (proportion of each quintile)**

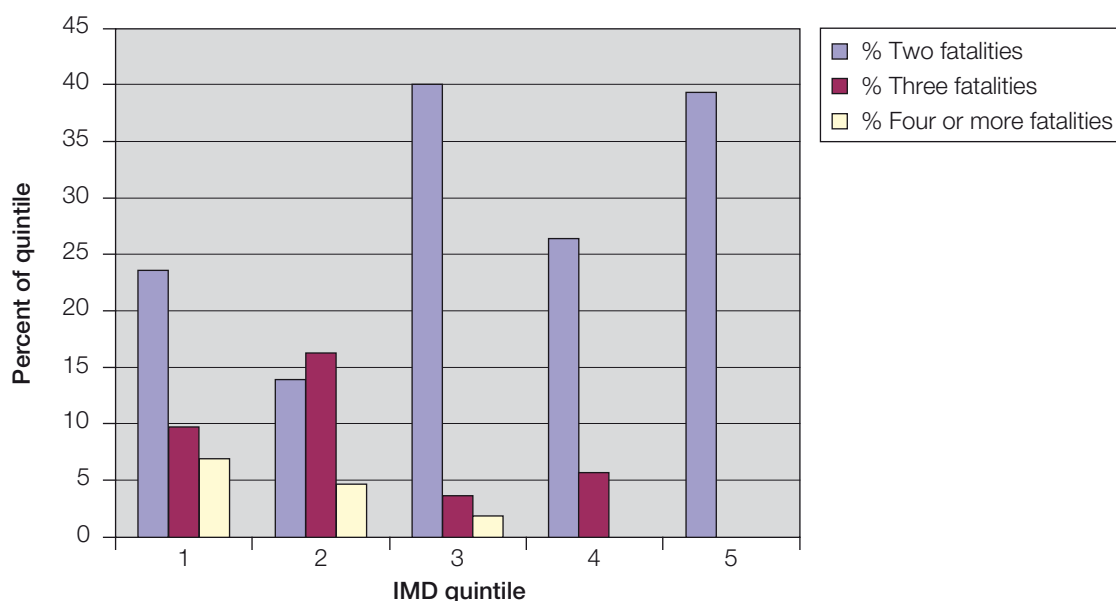
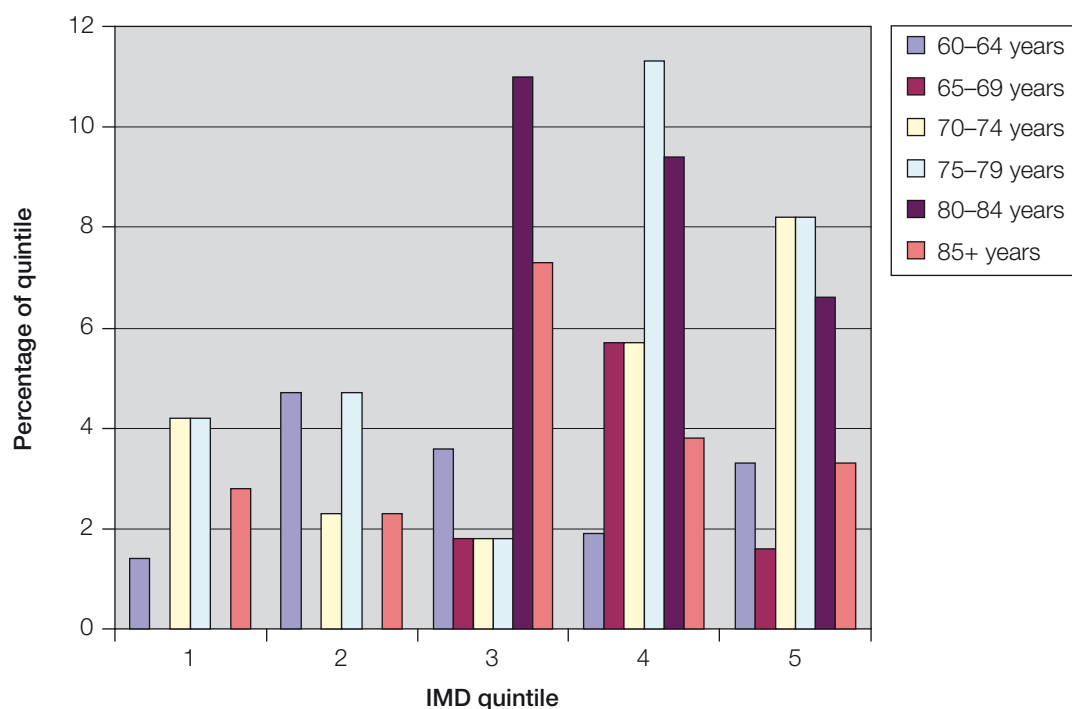


Figure 9 shows that, while fatal cases involving two persons seem more prevalent in the higher IMD quintiles, fatalities involving three or more persons seem to be concentrated in the lower deprivation quintiles.

## Deprivation and elderly passenger fatality

Approximately 8% of the IMD sample involved the fatality of a passenger aged 60 years or over. Figure 10 shows the percentage of passenger fatalities in various age bandings over 60 years by IMD quintile.

Figure 10: **Older passengers** – passenger fatalities aged 60+ (proportion of each quintile)



It can be seen in Figure 10 that passenger fatalities aged over 80 years are concentrated in the top three IMD quintiles.

## Deprivation and ‘unsurvivable’ crashes

The Transport Research Laboratory (TRL) has defined ‘unsurvivable’ accidents as ‘collisions or roll-overs that would be expected to result in fatal injuries to correctly restrained occupants of a passenger car’ (e.g. in Broughton and Walter, 2007).

Approximately 50% of the IMD sample comprised cases where one or more vehicle occupants were either declared dead at the scene, or who died in transit to hospital. A further 4% of cases died within one to four hours of reaching hospital. Figure 11 shows the percentage of cases in each quintile considered as ‘unsurvivable’ (using the first definition above).



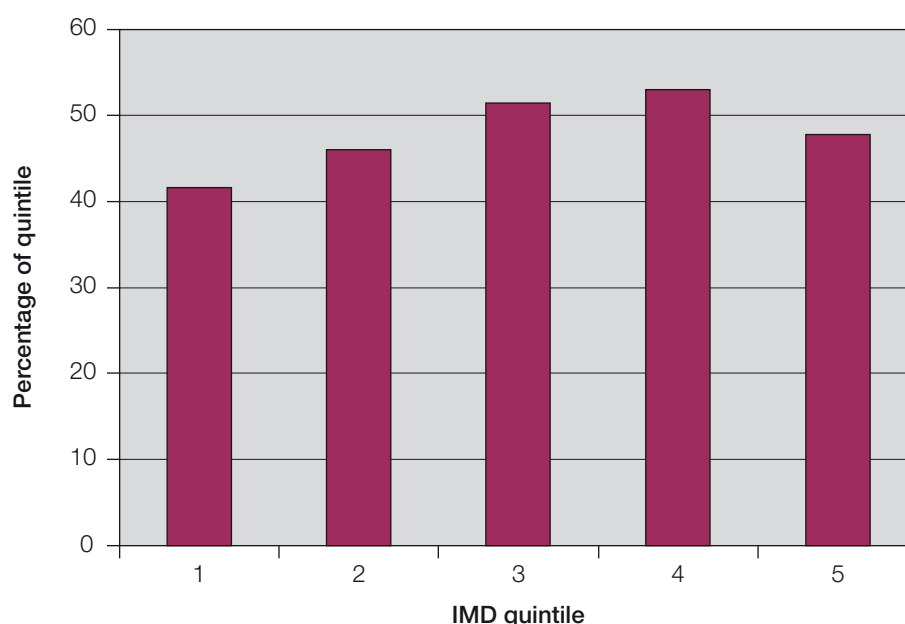
Figure 11: **'Unsurvivable' cases** – dead at the scene/on arrival (proportion of each quintile)

Figure 11 shows that the proportion of 'unsurvivable' crashes seems to increase in the higher IMD quintiles.

## Discussion

In approximately 25% of total cases, fatal car-occupant cases peak in the least deprived quintile (5). This is perhaps surprising as, for many indices of risky driving behaviour, lower IMD scores are associated with higher observed percentages of total cases involving such factors. This was found to be the case in speed-related fatal collisions, and particularly those involving deliberate risk-taking involving speed in excess of the speed limit. Drivers and passengers involved in fatal accidents in lower quintiles were also more likely to be not wearing a seat belt, more likely to be under the influence of alcohol, more likely to be travelling while unlicensed and uninsured, and more likely to be in multiple-fatality collisions. There was also limited evidence (not reported here) that fatalities in the lowest two quintiles were more likely to occur late at night or in the early hours of the morning.

Further analysis of the data has shown some reasons for the apparent anomaly, however. When both driver and passenger fatalities are examined by age, it can be shown that all quintiles contain high proportions of younger drivers/passengers, particularly in the 16–19-year-old age range. However, older driver and passenger fatalities are found proportionally more often in the higher, least deprived quintiles. The percentage of driver fatalities aged between 60–74 years and over 75 years generally increases across IMD quintiles; furthermore passenger fatalities aged over 80 years were concentrated in the top three quintiles.

It would seem, therefore, that the top quintiles in the sample are 'doubly loaded', i.e. have the same high proportion of younger, risk-taking drivers as cases in other

quintiles **and** a higher proportion of older fatal casualties, when compared with lower IMD quintiles. Other research, for example Maycock (1997), has estimated that ‘half of the increased fatality risk of drivers aged 75 years or more, compared to drivers aged 30 years, might be due to the enhanced susceptibility of the older drivers to be killed in the accidents in which they are involved, rather than to their higher accident rates’. When the percentage of cases in each quintile considered as ‘unsurvivable’ were examined, there was some evidence that the proportion of such accidents increased across IMD quintiles, and perhaps it is the higher proportions of older driver and passenger fatalities found in the higher quintiles that may offer one explanation for this finding.

In many other respects, the IMD sample can be regarded as an entirely representative sample of cases from the main fatal accident database held at Nottingham University. Previously published research on this database (Clarke *et al.*, 2007) showed that there were two main problem areas: the first, and apparently greater one, concerned the behaviours engaged in by younger drivers and their passengers, of all IMD classes, who took the most risks and travelled at the highest speeds. Such young drivers in fatal accidents are ‘violators’, as described, for example, in the work of Reason *et al.* (1990) and Åberg and Rimmö (1998). The second, somewhat smaller problem area in the previous research, concerned misjudgements and mistakes made by elderly drivers that lead to fatalities. Older drivers have appeared both to be more likely to be involved in fatal ‘right of way’ collisions (Clarke *et al.*, 2007) and they were also more likely to appear in the higher IMD quintiles in this study. Such older drivers are more prone to the errors (as opposed to violations) described by Reason *et al.* (1990).

## Conclusions

The results from this study suggest that campaigns/enforcement focusing on the areas of speeding, driver intoxication, seat-belt use and unlicensed/uninsured driving (although important across the board) should perhaps be focused additionally on communities in IMD quintiles 1–2. Researchers such as Begg and Langley (2000) have shown that there is a link between such areas of risk-taking, i.e. that drivers who failed to wear a seat belt were more likely to drive at speed and/or while intoxicated. This suggests that it is general driver attitudes regarding risks to themselves and others that are the problem, rather than attitudes towards discrete risk-taking behaviours considered in isolation. Similar links regarding networks or patterns of aberrant behaviour have been found in other studies: Broughton (1999) established a link between unlicensed driving and other types of car crime, for example. Such observations have led authors such as Corbett (2003) to argue that the emphasis in enforcement should be put on ‘intelligence-led offender targeting and intelligence gathering’ in police vehicle-stop scenarios.

It would seem that, in the case of fatal accidents at least, certain groups of drivers cannot be told often enough of the dangers to which they can expose themselves and their passengers, and perhaps that additional measures focused on particularly disadvantaged groups need to be added to the provision of safety information.

# Acknowledgements

The authors of this paper would like to acknowledge the contribution of researchers at University College London (Dr Roselle Thoreau and Dr Heather Ward), whose work in assigning IMD codes to postcodes/address information made the work possible.

# References

- Abdalla, I. M., Raeside R., Barker D. and McGuigan D. R. (1997) An investigation into the relationships between area social characteristics and road accident casualties. *Accident Analysis and Prevention*, 29(5), 583–593.
- Åberg, L. and Rimmö, P. A. (1998) Dimensions of aberrant driver behaviour. *Ergonomics*, 41(1), 39–56.
- Begg, D. J. and Langlely, J. D. (2000) Seat-belt use and related behaviors among young adults. *Journal of Safety Research*, 31(4), 211–220.
- Broughton, J. (1999) *Analysis of driver licence records from DVLA*. TRL Report No. TRL403. Crowthorne, Berkshire: TRL Limited.
- Broughton, J. and Walter, L. (2007) *Trends in Fatal Car Accidents: Analysis of CCIS Data*. TRL Report No. PPR 172. Crowthorne: TRL Limited.
- Chichester, B. M., Gregan, J. A., Anderson D. P. and Kerr, J. M. (1998) Associations between road traffic accidents and socio-economic deprivation on Scotland's west coast. *Scottish Medical Journal*, 43(5), 135–138.
- Clarke, D. D., Ward, P. J., Truman, W. A. and Bartle, C. (2007) *Fatal Vehicle-occupant Collisions: An In-depth Study*. Road Safety Research Report No. 75. London: Department for Transport.
- Corbett, C. (2003) *Car Crime*. (Crime and Society Series.) Uffculme, Devon: Willan Publishing.
- Department for Transport (2003) *Research into Unlicensed Driving: Final Report*. Road Safety Research Report No. 48. London: Department for Transport.
- Department for Transport (2006) *Road Casualties Great Britain: 2006 – Annual Report*. [www.dft.gov.uk/pgr/statistics/datatablespublications/accidents/casualtiesgbar/roadcasualtiesgreatbritain2006](http://www.dft.gov.uk/pgr/statistics/datatablespublications/accidents/casualtiesgbar/roadcasualtiesgreatbritain2006) (accessed on 1 November 2007).
- Department for Transport (2007) *Trends in Fatal Car-occupant Accidents*. Road Safety Research Report No. 76. London: Department for Transport.

Maycock, G. (1997) *The Safety of Older Car-drivers in the European Union*. Brussels: European Road Safety Federation, ERSF; Basingstoke: AA Foundation for Road Safety Research.

Petridou, E and Tursz, A. (2001) Socio-economic differentials in injury risk. *International Journal of Injury Control and Safety Promotion*, 8(3), 139–142.

Reason, J., Manstead, A., Stradling, S., Baxter, J. and Campbell, K. (1990) Errors and violations on the roads: a real distinction? *Ergonomics*, 33(10–11), 1315–1332.

## 6

# Ethnicity and injury risk in deprived areas: why a social marketing approach is needed

Nicola Christie,<sup>1</sup> Richard. H. Kimberlee,<sup>2</sup> Ronan Lyons,<sup>3</sup> Elizabeth Towner<sup>2</sup> and Heather Ward<sup>4</sup>

<sup>1</sup> Postgraduate Medical School  
University of Surrey  
Guildford GU2 7WG

<sup>2</sup> University of the West of England  
Bristol BS16 1QY

<sup>3</sup> Centre for Health Information, Research and Evaluation (CHIRAL)  
School of Medicine  
Swansea University  
Swansea SA2 8PP

<sup>4</sup> University College London  
London WC1E 6BT

## Abstract

The study objective was to gain an insight into the relationship between ethnicity and road safety behaviour among adults living in deprived areas. The method involved a questionnaire-based face-to-face interview survey among residents from deprived areas. The survey was conducted in five districts that represent the poorest 15% of districts in England and Wales, which also have high road traffic collision rates. Participants were community residents aged 16 or over living in deprived areas. The results suggest that Black and Minority Ethnic (BME) participants in deprived areas are significantly more likely to report being involved in a collision as a car occupant, have more access to a car in their household and less likely to report that they ‘always’ wear a seat belt in the back of a car compared with the majority population. Particular groups, notably Asian British, report relatively high collision rates, are more likely to have access to a car in their household and are least likely to report always wearing a seat belt. It was concluded that more needs to be done to understand the reasons that underpin these observed differences between ethnic groups. The data suggest that the dichotomy between that majority and BME groups obscures important differences in risk between BME groups. A segmented approach is required to target interventions at those most at risk. In order to do this we need to understand more about the types of car occupant collision involving BME groups and more about the factors that influence safety behaviour for these groups.

# Introduction

Road traffic collisions (RTCs) cause 1.2 million deaths per year globally, affecting several million family members, a toll likely to double by 2010 (Lord Robertson, 2006). In the UK, over 3,000 people are killed on the roads (Department for Transport, 2006). The most disadvantaged in society are the most likely to be injured or killed in a road traffic collision and therefore it is a major cause of health inequality (Christie and Ward, 2007; Ward *et al.*, 2007a; Ward *et al.* 2007b). There is a strong link between ethnicity, deprivation and injury per se. The over-representation of Asian ethnic groups is apparent for all types of unintentional injury. Mortality ratios for people under the age of 15 years and over the age of 65 years are greater in migrants from the Indian sub-continent than those born in England and Wales (Balarajan, 1995). There is a small, but growing, body of evidence on the link between socio-economic status, ethnicity and road traffic injury. Black and Minority Ethnic (BME) children are at increased risk of road traffic injury as pedestrians (Christie, 1995; Thomson *et al.*, 2001). However, one of the most difficult problems in understanding the high pedestrian injury risk of BME children is to differentiate the effects of socio-economic status and ethnicity because many BME residents tend to be the most deprived in society (Thomson *et al.*, 2001). To add to this complexity, people from BME groups tend to cluster in specific areas, which are often areas of multiple disadvantage (Owen, 1992, 1994) Place, as well as individual disadvantage, may therefore adversely affect health (Macintyre *et al.*, 1993; Sloggett and Joshi, 1994).

While there is some evidence concerning the relationship between socio-economic status, ethnicity and road traffic injury risk for children, little is known about how this varies among adults. This lack of evidence is partially attributable to the fact that neither socio-economic status nor ethnicity is coded on national injury surveillance databases in the UK. While there is no national data collected on the casualty's ethnic origin, London is unique in the UK because ethnic origin is recorded on police casualty data. Steinbach *et al.* (2008) looked at the relationship between deprivation and ethnicity for London. Ethnicity was coded broadly as 'White', 'Black' and 'Asian'. Casualty rates per head per population were the highest in the Black groups and lower in Asian groups compared with the White group. In order to examine the effect of deprivation, the risk of pedestrian injury was calculated per decile of area-based deprivation following research by Edwards *et al.* (2008), which showed a link between deprivation and road traffic injury in London. White children in the most deprived areas were 2.5 times at risk of injury compared with White children in the least deprived deciles. For Asian children, the injury rates for the most deprived were four times higher than the least deprived, but for Black children there was no relationship between deprivation and risk. Importantly, these relationships were found for children and adults. Therefore, deprivation did not account for all of the variation in injury rates between ethnic groups. Exposure may account for these differences, but little is known about whether there are differences in exposure patterns between ethnic groups.

This study was commissioned to support and evaluate the Neighbourhood Road Safety Initiative (NRSI) 2004–07 ([www.nrsi.org.uk](http://www.nrsi.org.uk)) which was set up to support the UK Government road safety target to 'reduce the number of people killed or seriously injured by 40 per cent and the number of children killed or seriously

injured by 50 per cent, by 2010 compared with the average for 1994–98, tackling the significantly higher incidence in disadvantaged communities’ (DETR, 2000).

Fifteen local authorities were involved in the NRSI, identified on the basis of casualty rates and deprived status, and they were invited to bid for funding by the Department for Transport. Many of these districts had very high proportions of people from BME backgrounds. While the key focus was reducing child pedestrian risk, districts were asked to consider the risks faced by all members of the community, irrespective of age and road use. Taking into account evidence on causal links and how best to target inequalities, districts were encouraged to adopt a holistic approach to casualty reduction. This approach advocates treating the root cause rather than the symptom by including a variety of solutions, such as engineering, education, enforcement and health promotion activities, and working together with a range of local stakeholders to share experience and expertise. The aim of this research was to provide information on road traffic injury risk, road safety behaviour and travel patterns for different population groups living in deprived areas. The survey included questions on road traffic collision involvement and seat-belt use, and full demographic characteristics of the participants.

## Method

The survey was conducted by a fieldwork company and, because of cost, was carried out in only five of the 15 districts participating in the NRSI. Interviews were conducted in 2005–07. Each district was divided into 20 sampling points, with 40 interviews to be conducted in each. Quota controls were applied proportionately to each sample point of 40 interviews based on neighbourhood data on wards in terms of gender, age and ethnicity. A questionnaire-based face-to face interview was carried out with a household member that fitted the quota. Interviews were spread geographically over the sampling area. Eight hundred people were sampled in each district, and therefore 4,000 interviews were completed. Refusal rates were not collected.

The community surveys sought information about adults’ travel patterns, their safety behaviour, and their views about factors affecting their quality of life in the neighbourhood, such as traffic nuisance, facilities for young people, anti-social behaviour, and accessibility of services and green spaces. People were allowed to define their own ethnic group from a possible 17 groups derived from the 2001 Census codes.

## Results

Between 2005 and 2007, 4,102 people were interviewed in districts ranked as the 15% most deprived in England and Wales. Of the sample, 26% were aged 16–29, 28% were aged 30–44, 19% were aged 45–59, 22% were aged 60–79, 4% were aged 80 or over, and 26% were from a BME group.



For the purposes of this analysis, the White UK group was operationally defined as the majority population and all other ethnic groups were defined as the BME group. Of the BME group, the largest single group were Asian Pakistani, presenting 12% of the total sample and just under half (48%) of the total BME group (see Table 1).

**Table 1: Self-reported ethnic group of participants sampled in the 15% most deprived districts in England and Wales with high road traffic casualties**

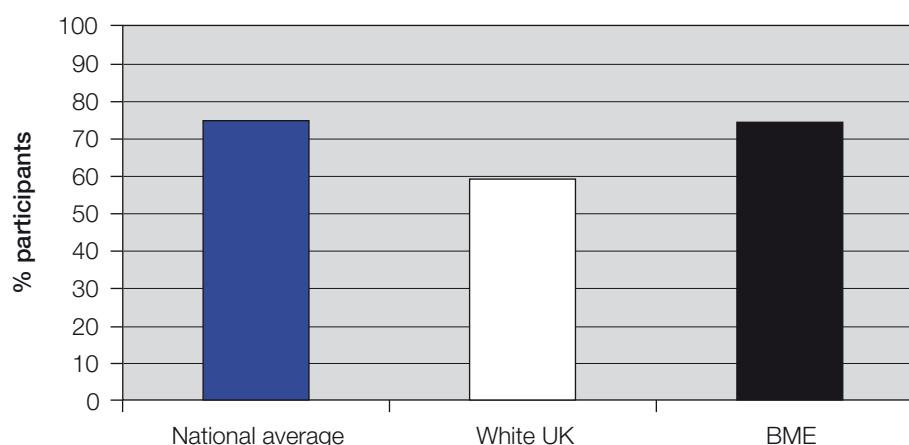
	Number in sample	Proportion in sample
White UK	3,038	74.1
White European	29	0.7
White Irish	18	0.4
White Other	8	0.2
Black British	9	0.2
Black Caribbean	11	0.3
Black African	15	0.4
Black Asian	17	0.4
Black Other	3	0.1
Mixed Origin	24	0.6
Asian Bangladeshi	83	2.0
Asian Chinese or South East Asian	12	0.3
Asian Indian	147	3.6
Asian British	132	3.2
Asian Pakistani	513	12.5
Asian Other	16	0.4
Other Group	27	0.6
Total	4,102	100.0

Of the total sample, 5% (203) of the participants reported that they had been involved in a road collision in the last year, and of these 54% were male and 46% female and there was no significant difference between the majority population and the BME group in the proportions of males and females reporting that they had been involved in a road traffic collision in the last year ( $\chi^2 = 1.4$ ,  $n = 203$ ,  $df = 1$ ,  $p = 0.226$ ). Of those who reported being involved in a road traffic collision, 36.5% were aged 16–29, 36.5% were aged 30–44, 17% were aged 45–59, 9% were aged 60–79, and 1% were aged 80 or over. There was no significant difference in the age distribution of these participants between the majority population and the BME group ( $\chi^2 = 8.5$ ,  $n = 203$ ,  $df = 4$ ,  $p = 0.074$ ). Most reported being involved in a traffic collision as a driver (91%) or passenger (9%); no one reported being involved as a pedestrian. Over a third (35%) said they went to hospital as a result of the collision and, of these, around a fifth (19%) stayed in hospital for one or more nights. Around half (51%) of those who reported having a collision said that they had visited their local doctor. Most participants reported that their collisions had occurred in the local area (61%), that is, an area which is within a 10–15-minute walk or 5–10-minute car journey from their home.

The BME group were significantly more likely to report that they had been involved in a road collision in the last year compared with the majority population: 7% (79) versus 4% (124) ( $\chi^2 = 18.6$ ,  $n = 4,102$ ,  $df 1$ ,  $p = 0.001$ ). Participants from BME groups were significantly more likely to report being injured as a driver than a passenger compared with the majority group (96% versus 87%) ( $\chi^2 = 4.7$ ,  $n = 203$ ,  $df 1$ ,  $p = 0.030$ ). There was no significant difference between population groups in the proportions reporting that they went to hospital after the collision ( $\chi^2 = 0.005$ ,  $n = 203$ ,  $df 1$ ,  $p = 0.942$ ), but significantly more of the BME group said that they had visited their local doctor (62% versus 44%) ( $\chi^2 = 6$ ,  $n = 203$ ,  $df 1$ ,  $p = 0.014$ ). For those who went to hospital there was no difference ( $\chi^2 = 0.38$ ,  $n = 70$ ,  $df 1$ ,  $p = 0.534$ ) between the majority and the BME group in the number who said they had stayed in hospital for one or more nights.

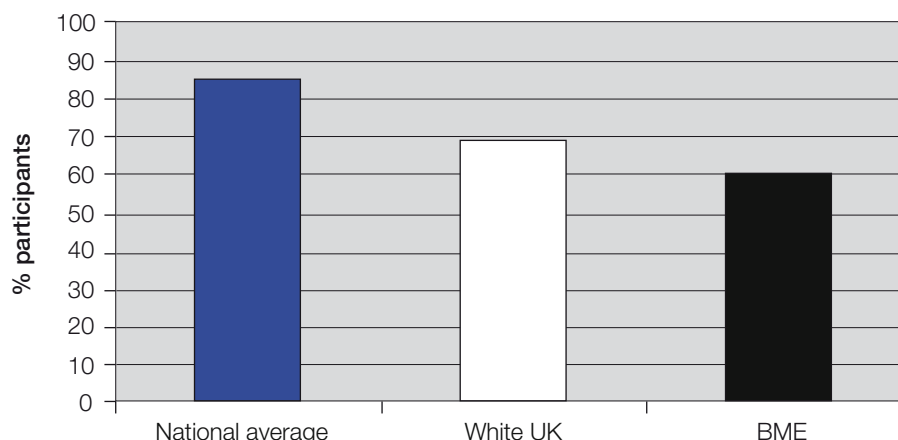
The significantly higher reported collision rate among car occupants from the BME group may be related to exposure. Participants from the BME group were significantly more likely to report having access to a car compared with their counterparts in the majority group ( $\chi^2 = 77.6$ ,  $n = 4,103$ ,  $df 1$ ,  $p = 0.001$ ) (see Figure 1).

**Figure 1: Participants living in low socio-economic areas – per cent reporting that they had access to a car by ethnic group compared with the national average**



The exposure to risk as car occupants may also be greater for the BME group compared with the majority group. Although there was no significant difference ( $\chi^2 = 0.43$ ,  $n = 4,103$ ,  $df 1$ ,  $p = 0.511$ ) between groups reporting that they always wore a seat belt in the front of the car at 89% (though this was still 5% lower than the national average of 94%, reported in government-funded observational studies of seat-belt wearing, see Broughton and Buckle (2007)), the BME group was significantly ( $\chi^2 = 24.2$ ,  $n = 4,103$ ,  $df 1$ ,  $p = 0.001$ ) less likely to report always wearing a seat belt in the back of a car compared with the majority population (see Figure 2).

**Figure 2: Participants living in low socio-economic areas – per cent reporting that they ‘always’ wear a seat belt in the back of a car by ethnic group compared with the national average**



While the numbers in some BME groups are small, the data indicate variations in reported risk, with Asian British most likely to report being involved in a road traffic collision (see Table 2).

**Table 2: Self-reported road traffic collisions in the last year by ethnic group**

Self-reported ethnic group	Number who reported being involved in a road traffic collision in the last year	Per cent of ethnic group	Number in ethnic group
White UK	124	4	3,037
White European	1	3	29
White Irish	0	0	18
White Other	1	13	8
Black Caribbean	0	0	11
Black African	1	7	15
Black Asian	2	12	17
Black Other	0	0	3
Mixed Origin	1	4	24
Asian Bangladeshi	4	5	83
Asian Chinese or South East Asian	0	0	12
Asian Indian	13	9	147
Asian British	25	19	132
Asian Pakistani	29	6	513
Asian Other	1	6	16
Other Group	1	4	27
<b>Total</b>	<b>203</b>	<b>5</b>	<b>4,102</b>

This is likely to be related to the fact that they report one of the highest levels of access to a car in their household (see Table 3).

**Table 3: Self-reported access to a car in the household by ethnic group**

Self-reported ethnic group	Number in sample	Per cent of ethnic group	Total in sample
White UK	1,781	59	3,038
White European	15	52	29
White Irish	6	33	18
White Other	6	75	8
Black British	4	44	9
Black Caribbean	7	64	11
Black African	8	53	15
Black Asian	12	71	17
Black Other	3	100	3
Mixed Origin	12	50	24
Asian Bangladeshi	55	66	83
Asian Chinese or South East Asian	6	50	12
Asian Indian	120	82	147
Asian British	111	84	132
Asian Pakistani	401	78	513
Asian Other	7	44	16
Other Group	12	44	27
<b>Total</b>	<b>2,566</b>	<b>63</b>	<b>4,102</b>

It is also a concern that reported seat-belt wearing for this group is particularly low (see Table 4).

**Table 4: Self-reported seat-belt wearing in the back of a car by ethnic group**

Self-reported ethnic group	Number who reported 'always' wearing a seat belt in the back of a car	Per cent of ethnic group	Number in ethnic group
White UK	2,080	68	3,038
White European	17	59	29
White Irish	13	72	18
White Other	6	75	8
Black British	5	56	9
Black Caribbean	6	55	11
Black African	9	60	15
Black Asian	12	71	17
Black Other	2	67	3
Mixed Origin	18	75	24
Asian Bangladeshi	57	69	83
Asian Chinese or South East Asian	7	58	12
Asian Indian	87	59	147
Asian British	68	52	132
Asian Pakistani	310	60	513
Asian Other	14	88	16
Other Group	9	33	27
<b>Total</b>	<b>2,720</b>	<b>66</b>	<b>4,102</b>

# Discussion

The main findings are that BME participants in deprived areas are significantly more likely to report being involved in a collision as a car occupant compared with the majority population. This may be related to exposure because ethnic BME participants were significantly more likely to have access to a car in their household at levels similar to the national average. In addition, while there was no significant difference, the proportions that said they always wore seat belts in the front of the car in BME groups were significantly less likely to report that they ‘always’ wear a seat belt in the back of a car. While the numbers per BME group become quite small for some ethnic groups, the data suggest that particular groups, notably Asian British, report relatively high collision rates, are more likely to have access to a car in their household and are least likely to report ‘always’ wearing a seat belt. It is a concern that the level of reported restraint use is relatively low among BME groups generally. With growing car ownership, interventions aimed at increasing restraint use can offer one of the most effective injury control mechanisms for car occupants of all ages, as commented by the Organization for Economic Co-operation and Development (OECD) in 1997: ‘... the decision to wear a seat belt, if available, is the most important single action that can be taken by a vehicle occupant to minimize the risk of personal injury in a road collision’ (OECD, 1997). High seat-belt wearing rates are a characteristic of the top performing OECD countries for traffic safety and lower seat-belt wearing is often identified as problem for deprived and BME groups by these countries (Christie *et al.*, 2004). Differences in seat-belt wearing between ethnic groups have also been noted in other countries, with lower use among BME groups being used to explain their relatively high risk of injury (Briggs *et al.*, 2005).

A weakness of the study is that it relies on self-reported behaviour and little is known whether or not socially desirable answers have been made. In addition, because there are 17 ethnic groups in the sample, the number of participants becomes very small for some BME groups which limit the extent to which findings can be generalised. The data were collected as part of a wider survey of road safety risk and quality of life, and detailed information on the situational factors involved in the collisions was not collected. No information was collected on how much they travelled by car.

A strength of this paper is that it collected information about ethnicity and road traffic collisions and road safety behaviour from a large number of participants in deprived areas as part of a wider survey of road safety, exposure to risk and quality of life. Data on ethnicity and socio-economic status are not collected in routine injury surveillance databases, and to our knowledge this is the first survey of its kind in the UK. This information is extremely important for informing the development of programmes aimed at reducing risk among disadvantaged groups. Self-report data allow behaviour to be directly and accurately linked to ethnicity. The data provided information from a wide range of BME groups and these data indicate considerable variations between them that would otherwise be unknown.

Inequalities in road traffic injury risk have, in the past, focused on pedestrian injury among children. Recent analyses of fatalities among car occupants suggest that the socio-economic gradients are also evident (Ward *et al.*, 2007a, 2007b). Our research suggests that factors related to ethnicity may contribute to the increased risk of road

traffic injury among deprived groups. More needs to be done to understand the reasons that underpin the observed differences between ethnic groups in terms of road safety, as it is quite clear that the dichotomy between the majority and BME groups obscures important differences between BME groups themselves.

More attention needs to be given to inequalities in risk between different BME groups as car occupants. We need to know more about car use and attitudes to safety among different ethnic groups.

A segmented social marketing approach (Smith, 2006) may be required to target interventions at those most at risk. In order to do this we need to understand more about the types of car occupant collisions involving BME groups and more about the factors that influence safety behaviour for these groups. Further research is required to understand the belief systems and lifestyle patterns underpinning safety behaviour alongside factors such as access and ownership of cars, socio-economic status and educational level.

Intervention programmes may need to consider the most appropriate way to raise awareness of road traffic safety among different ethnic groups. Practitioners will need to consult with community leaders and outreach workers to explore the best ways to involve disadvantaged communities in ways to reduce road traffic injuries. A promising example of this type of approach can be seen in the partnership between Blackburn with Darwen local authority and mosque leaders to address the injury risk of young pedestrians on journeys to and from the mosque. More needs to be done to disseminate the value of this type of approach in understanding risks and, by working alongside communities, in finding ways to reduce these risks. However, what is clear is that BME groups want to be engaged in the solutions and not 'demonised' as a road-user group (Steinbach *et al.*, 2008).

## Conclusions

In deprived areas BME groups report a higher rate of road traffic collisions as car occupants and a lower restraint use compared with the majority of the population. The higher reported traffic collision rate among BME groups may be related to a higher exposure rate as car occupant's compared with the majority group. Dichotomising population in terms of a White UK majority versus BME groups in the analysis of road safety behaviour obscures important differences between ethnic groups. A segmented approach is needed in order to identify those most at risk, to understand more about the impact of socio-cultural factors on collision rates and to then design appropriate intervention measures.

## Acknowledgement

The authors would like to acknowledge the Department for Transport as the funding body for the research.

# References

Balarajan, R. (1995) Ethnicity and variations in the nation's health. *Health Trends*, 27(4), 114–119.

Blackburn with Darwin Borough Council (2007) *Mosque Marshalling Scheme*. [www.injuryobservatory.net/documents/MrGrahamCampbell.ppt](http://www.injuryobservatory.net/documents/MrGrahamCampbell.ppt)

Briggs, N. C., Levine, R. S., Haliburton, W. P., Schlundt, D. G., Goldzweig, I. and Warren, R. C. (2005). The Fatality Analysis Reporting System as a tool for investigating racial and ethnic determinants of motor vehicle crash fatalities. *Accident Analysis and Prevention*, 37, 641–649.

Broughton, J. and Buckle, G. (2007) *Mobile Phone Use and Seat Belt Wearing Rates in London*. Crowthorne: TRL Limited..

Christie, N. and Ward, H. (2007) The Neighbourhood Road Safety Initiative: evaluation of the UK Government's response to high road traffic injury risk in deprived communities. *African Safety Promotion: A Journal of Injury and Violence Prevention*. 5, 2.

Christie, N. (1995). *The High Risk Child Pedestrian: Socio-economic and Environmental Factors in their Accidents*. Crowthorne: Transport Research Laboratory.

Christie, N., Towner, E., Cairns, S. and Ward, H. (2004) *Children's Road Traffic Safety: An International Survey of Policy and Practice*. Road Safety Report No. 47. London: Department for Transport.

Department for Transport (2006) *Think! Key facts and Research: Death and Injury on the Road*. [www.thinkroadsafety.gov.uk/statistics.htm](http://www.thinkroadsafety.gov.uk/statistics.htm)

Department of the Environment, Transport and the Regions (DETR) (2000) *Tomorrow's Roads: Safer for Everyone – The Government's Road Safety Strategy and Casualty Reduction Targets for 2010*. London: DETR. [www.dft.gov.uk/pgr/roadsafety/strategytargetsperformance/tomorrowsroadssaferforeveryone](http://www.dft.gov.uk/pgr/roadsafety/strategytargetsperformance/tomorrowsroadssaferforeveryone)

Edwards, P., Green, J., Roberts, I., Grundy, C. and Lachowycz, K. (2008) *Deprivation and Road Safety in London: A Report to the London Road Safety Unit*. London: London School of Hygiene and Tropical Medicine. [www.tfl.gov.uk/assets/downloads/deprivation-and-road-safety.pdf](http://www.tfl.gov.uk/assets/downloads/deprivation-and-road-safety.pdf)

Lord Robertson (2006) *Commission for Global Road Safety*. [www.fiafoundation.com/resources/documents/304796102\\_\\_robertson\\_commission\\_announcement\\_press\\_release.pdf#search=%22Commission%20for%20Global%20Road%20Safety%2C%202006%22](http://www.fiafoundation.com/resources/documents/304796102__robertson_commission_announcement_press_release.pdf#search=%22Commission%20for%20Global%20Road%20Safety%2C%202006%22)

Macintyre, S., Maciver, S. and Soomans, A. (1993) Area, class and health: should we be focusing on places or people? *Journal of Social Policy*, 22, 213–234.



Organization for Economic Co-operation and Development (OECD) (1997) *The Availability of Seat Belt Wearing Data in OECD Member Countries (1995) IRTAD Special Report*. Paris: OECD.

Owen, D. (1992) *Ethnic Minorities in Great Britain: Settlement Patterns, National Ethnic Minority Data Archive 1991. Census Statistical Paper No.1*. Warwick: University of Warwick, Centre for Research in Ethnic Relations.

Owen, D. (1994) Spatial variations in ethnic minority groups populations in Great Britain. *Population Trends*, 78, 23–33.

Sloggett, A. and Joshi, H. (1994) Higher mortality in deprived areas: community or personal disadvantage. *British Medical Journal*, 309, 1470–1474.

Smith, W. A. (2006) Young drivers. Social marketing: an overview of approach and effects. *Injury Prevention*, 12 (Supplement 1).

Steinbach, R. Edwards, P., Green, J. and Grundy, C. (2008) *Road Safety of London's Black and Asian Minority Ethnic Groups: A Report to the London Road Safety Unit*. London: London School of Hygiene and Tropical Medicine. [www.tfl.gov.uk/assets/downloads/road-safety-of-londons-black-asian-minority-ethnic-groups.pdf](http://www.tfl.gov.uk/assets/downloads/road-safety-of-londons-black-asian-minority-ethnic-groups.pdf)

Thomson, J. A., Tolmie, A. K. and Mamoon, T. P. (2001) *Road Accident Involvement of Children from Ethnic Minorities*. Road Safety Research Report No. 19. London: Department for Transport.

Ward, H., Christie, N., Lyons, R., Broughton, J., Clarke, D. and Ward, P. (2007a) *Trends in Fatal Car-occupant Accidents*. Research Safety Research Report No. 76. London: Department for Transport.

Ward, H., Lyons, R., Christie, N., Thoreau, R. and Macey, S. (2007b) *Fatal Injuries to Car Occupants: Analysis of Health and Population Data*. Road Safety Research Report No. 77. London: Department for Transport.

# 7

## A discussion-based module for learner driver training

Britta Lang  
Road Safety Behaviour and Attitudes Group  
Transport Research Laboratory  
Crowthorne RG40 3GA

### Introduction

The fact that newly-qualified drivers are over-represented in Great Britain's casualty statistics has remained unchanged over many years. Considerable efforts in the area of driver training have been, and are being, made to provide mechanisms for accelerating the learning experiences of newly-qualified drivers. While traditional driver-training programmes focussing on vehicle control skills have found to have no demonstrable safety benefits (Christie, 2001; Mayhew, Simpson, Williams and Ferguson, 1998), a growing body of current research (e.g. Hattaka *et al.*, 1999) indicates the need of also targeting higher-order cognitions and motivational orientations (e.g. driver attitudes) that determine **why people drive the way they drive** in order to successfully reduce newly-qualified drivers' accident liability. It is widely recognised that what is subsumed as 'attitudes' in lay (rather than psychological) terms is the product of a development process comprising early learning experiences as passengers and learning through observing the examples set by parents and, later, peers. This current thinking is reflected by the Department for Transport's second three-year review of the Government's road safety strategy (Department for Transport, 2007a), which states that **'We need a comprehensive package of reforms: education to influence attitudes long before people reach 17, a thorough training process and a reformed testing process which test that learners can drive safely, not just master how to control a car.'**

The Department for Transport commissioned the Transport Research Laboratory (TRL) to develop a facilitated discussion group that could be used as a training module for young learner drivers shortly before they take their test. The intervention will focus on participants' motives for driving, and their driving-related attitudes and beliefs. It is to address the wider context of young peoples' lifestyles, their self-perception and social environment in order to impact the way they drive.

Planning a pre-test intervention that addresses attitudes, motives and beliefs of learners is in line with the Driving Standard Agency's (DSA) intention to develop learner drivers' competence to the highest possible level before the driving test. This endeavour is supported by findings from qualitative research (Department for

Transport, 2007b) which suggests that young adults believe that, currently, the acquisition of the ‘real’ rules of the road happens after the test.

To inform the development of a proposal for a discussion group targeted at learner drivers, TRL:

- (a) conducted a literature review on pre-driver attitudes, motives and beliefs; and
- (b) facilitated a workshop with selected experts from the fields of psychology, education, policy making and road safety.

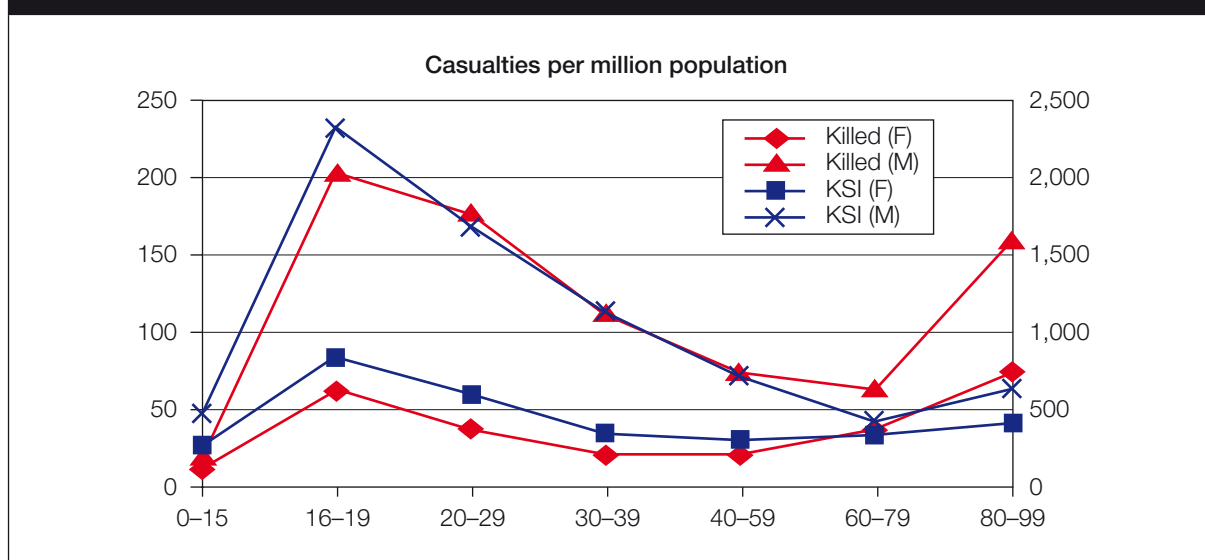
Findings from both sources were combined and are presented in this paper together with an outline of the intervention planned on the basis of these findings.

## Findings from the literature and an expert workshop

### Crash involvement of young drivers

Traffic crashes are the single greatest killer of 15–24-year-olds in the member countries of the Organization for Economic Co-operation and Development (OECD). In OECD countries, this age group represents about 27% of all drivers killed yet it only accounts for about 10% of the driver population (OECD, 2006). Findings for Great Britain are similar, where young drivers (17–21 years old) represent 10% of the population, but are involved in 20% of the crashes. Statistics show that newly-qualified drivers have an increased risk of being involved in a crash compared with older and more experienced drivers (Forsyth *et al.*, 1995; Wells *et al.*, 2008). As Figure 1 illustrates, the risk of being killed or seriously injured in a crash peaks in the late-teenage years, which is the age when most car drivers learn to drive (Broughton, personal communication, 15 January 2007).

Figure 1: UK casualty rates, by age and sex, 2002–04



The investigation of novice driver crashes (e.g. Maycock, 2002; Clarke *et al.*, 2002) shows that novice drivers are heavily over-represented in single-vehicle and loss-of-control crashes. Compared with older drivers, they have more crashes in the evenings and early mornings, which reflects the differences in the travel patterns of these drivers by time of day. In addition, factors such as alcohol, fatigue, speed and peer pressure contribute to young driver crashes during these periods of the day (Maycock, 2002). Worse crash outcomes are linked to the fact that young drivers, especially males, are less likely to wear seat belts (OECD, 2006).

The following behaviours have been found to increase novice drivers' crash risk:

- **Speeding** – speed and speeding are well-established contributors to crash risk. Research has shown that younger drivers (in particular, younger males) tend to drive faster and exceed legal speed limits more often than older drivers (e.g. Campbell and Stradling, 2003).
- **Tailgating** – shorter headways, corresponding to higher risk, have been found for young drivers, and their involvement in rear-end crashes is greater than for older drivers (Evans and Wasieleski, 1983).
- **Overtaking** – younger, inexperienced drivers tend to be less safe than older, more experienced drivers when overtaking. They are more likely to overtake on hill crests or bends, or when there is not a safe space in the on-coming traffic (Clarke *et al.*, 1998). Overtaking is often not taught or practised during pre-test lessons (Groeger and Clegg, 1994).
- **Driving when impaired** – it is well established that drink-driving is associated with increased rates of risky driving behaviour (e.g. speeding, close following, etc.) and with increased crash risk (Horwood and Ferguson, 1999). At the same time, young drivers are more susceptible to the effects of alcohol and drugs, i.e. younger drivers' fatal injury risk increases substantially faster than that of older people with each alcoholic drink consumed (Keall *et al.*, 2004). Compared with other substances, alcohol is by far the most frequently consumed. However, drugs are increasingly a factor in crashes; the number of crashes involving drivers who had taken illegal substances increased six-fold over a period of 10 years (Department for Transport, 2005). With the high prevalence of mixing alcohol and drugs, it is difficult to fully ascertain the impact of isolated drugs on crash risk (Turnbridge *et al.*, 2000).

Driver impairment may, furthermore, be the result of fatigue which is estimated to be prevalent in 10–30% of road crashes. Research suggests that young drivers are involved in more fatigue-related accidents than older drivers (Clarke *et al.*, 2002). As young drivers tend to drive late in the evening or early in the morning more often than older drivers, they are more exposed to situations where fatigue may occur.

- **Driving with passengers** – studies have shown that young drivers' crash risk is significantly increased by the presence of similarly aged passengers in the vehicle, particularly if both the driver and passengers are men (Preusser *et al.*, 1998). Williams (2000) found that the crash risk of teenage drivers was positively correlated to the number of passengers in the car.

- **Driving when distracted** – in-car technology (e.g. navigation systems, the radio, etc.) generally, and mobile phone more specifically, can be a source of distraction. Burns *et al.* (2002) demonstrated significantly increased reaction times to hazards in drivers using hands-free or hand-held mobile phones while driving. Hosking *et al.* (2006) found detrimental effects of sending and retrieving text messages from mobile phones in novice drivers.
- **Driving in potentially dangerous driving situations** – recent models of driving, for example the GDE matrix (Hattaka *et al.*, 1999), suggest that driving as an activity is embedded in and influenced by superior goals and lifestyle factors. When learning to drive, and subsequently as novice solo drivers, young adults are in the midst of a socialisation process by which they are freeing themselves from their parents' influence and making their own way in the world (Gegersen, 1997). This effort is expressed in youth culture and lifestyle, and, compared with older adults, young novice drivers are highly social and much more active, and increase their risk levels simply by virtue of their lifestyle and their higher exposure to driving situations that are particularly challenging (i.e. driving at night or with passengers in the car).

## Influences on the crash liability of novice drivers

The reasons for the poor driving performance of novice drivers are complex and typically a combination of circumstances will contribute to the specific risk encountered by novice drivers (OECD, 2006). An overview on contributing factors is provided in the following sections.

### EXPERIENCE

Longitudinal studies (e.g. Maycock and Forsyth, 1997; Wells *et al.*, 2008) demonstrate that the accident liability of novice drivers significantly decreases during and after the first year of solo driving and that this is dominated by the effects of increasing experience and is not simply the result of increasing age (maturation). This finding suggests that learning to drive takes time and needs extended practice in order to reach a sufficient competence level. Novice drivers have less spare capacity in all driving circumstances and, thus, sources of additional demand (e.g. the radio or use of a mobile phone, etc.) will compromise their performance and safety more than for experienced drivers. Furthermore, it has been shown that experienced drivers perceive potentially dangerous situations more quickly than inexperienced drivers (Quimby and Watts, 1981). Chapman *et al.* (2002) demonstrated that the eye movement patterns of novice drivers and experienced drivers differ, particularly in hazardous situations. Grayson and Sexton (2002) showed that experienced drivers have, on average, substantially higher scores on a hazard perception test than do inexperienced drivers (unless the latter are given special training).

## BIOLOGICAL FACTORS

Brain-imaging studies indicate that, beyond the age of 18, the human brain is still developing, particularly areas in the frontal lobe that deal with executive functions like planning, impulse control, reasoning and the integration of information (Sowell *et al.*, 1999; Giedd, 2004). These results suggest that it is harder for younger drivers to anticipate the consequences of their behaviour before choosing a course of action. Hormonal changes throughout puberty and in early adolescence, especially the increase in testosterone levels in young males, have been linked to sensation seeking (Bogaert and Fisher, 1995) and may explain why men are more prone to risky behaviour patterns than women.

## GENDER DIFFERENCES

Gender differences that are relevant to driving already exist at pre-driving age as well as after passing the driving test (e.g. Parker and Stradling, 2001; Waylen and McKenna, 2002). Male drivers tend to rate themselves as more skilled than females, tend to perceive driving as less risky and are more likely to respond to negative peer-pressure. They are also less likely to perceive the benefits of preventive safety, such as seat-belt use (Masten, 2004).

## PERSONALITY

Personality traits have been found to be weakly, but consistently, linked to crash involvement (Arthur *et al.*, 1991). The relationship between personality traits and the propensity to commit driving violations is strong (OECD, 2006). The association of the personality factors 'high Extraversion', 'low Conscientiousness' and 'low Agreeableness' have been found to be associated with higher crash involvements. Similarly, links between sensation seeking and risky lifestyles and crash involvement have been demonstrated.

## SOCIAL NORM/LIFESTYLE

The majority of novice drivers are young and thus in the middle of a coming-of-age process that includes freeing themselves from their parents' influence and progressively becoming more independent (OECD, 2006). Peer influence, youth culture and group identity increase in importance while parents' influence on young adults' behaviour diminishes. Research has shown that the presence of similarly aged passengers leads to increased risk levels in young drivers, particularly if both the driver and the passenger are men (Chen *et al.*, 2000; Preusser *et al.*, 1998).

# Attitudes, motives and beliefs in young drivers

Three problem-clusters that seem particularly important regarding the high crash liability of young novice drivers were identified in the review conducted for this project:



1. Motives for driving that are additional to the transport motive and that are influenced predominantly by lifestyle, social norms and personality. Such motives include time gains, thrill seeking, self-assertion/expressing one's identity, competing, and testing one's own and others' limits (Gregersen, 1997; Nääätänen and Summala, 1976);
2. Insufficient awareness of risk and task difficulty, and poor task calibration as a result of an overestimation of one's driving skills, control and capability, tolerance of higher risks, and underestimation of task difficulty and actual risks (Elander *et al.*, 1993; McKenna, 1993; Fuller 2005; Kuiken and Twisk, 2001).
3. Erroneous driving-related beliefs may be formed as a result of a lack of factual information and consequently a lack of knowledge. This is supported by the finding that most young drivers do not intentionally engage in high-risk behaviours, but are hampered by their lack of experience and their poor self-assessment (OECD, 2006). The targeted improvement of trainees' self-evaluation skills and, consequently, their insight into and knowledge of the factors that are likely to impact their driving has also been put forward within the European project GADGET (Guarding Automobile Drivers Through Guidance, Education and Technology) (Hattaka *et al.*, 1999), which explicitly included motivational and lifestyle factors in its taxonomy of the driving task.

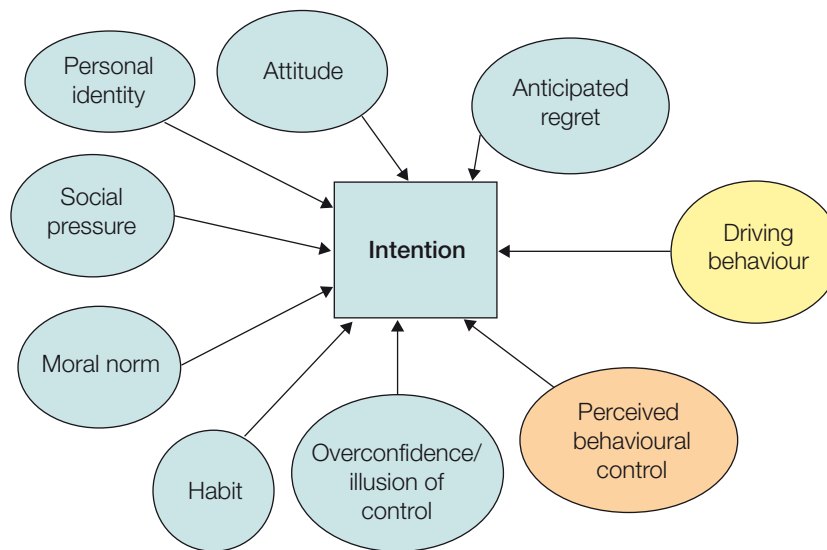
## The proposed discussion group module for learner drivers

### Theoretical background and planned content

The theoretical underpinning of the planned discussion group is the Theory of Planned Behaviour (Fishbein and Ajzen, 1975), which claims that actual behaviour is predicted by an individual's intention to perform that behaviour when he or she has the opportunity to do so. Intention to perform a behaviour can be determined by sampling attitudes, subjective norms and perceived behavioural control, all of which form a behavioural intention. Attitudes towards a behaviour are defined as evaluations of the positive or negative outcomes of performing the behaviour. Subjective norms are the perceived social pressures to perform the target behaviour. Perceived behavioural control is an individual's estimate of the ease or difficulty of performing the target behaviour. Perceived behavioural control may also directly predict behaviour. Figure 2 shows an extended model of the Theory of Planned Behaviour, which includes components particularly relevant to young learner drivers.

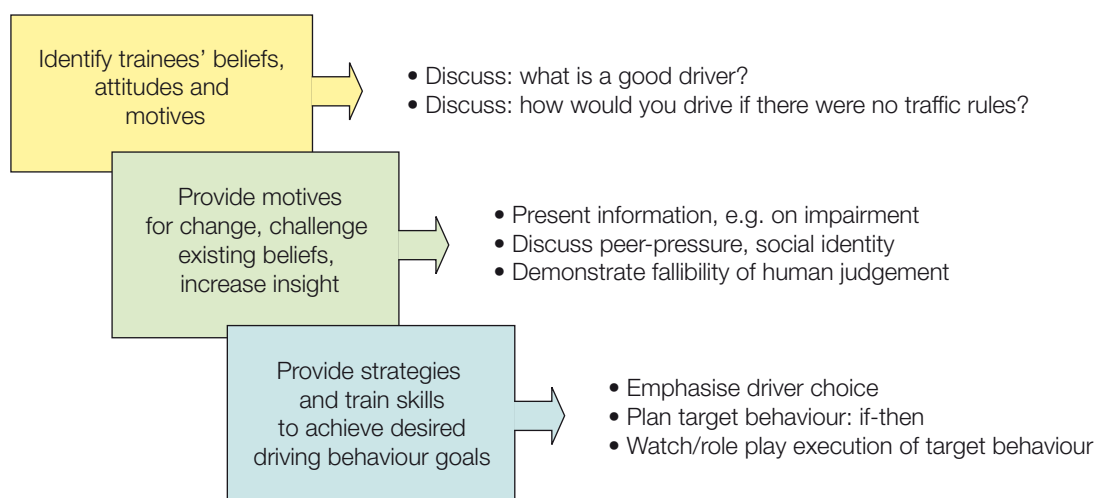


Figure 2: Approach to developing new behavioural implementation intentions



The discussion-based module will follow a three-step approach, which is illustrated in Figure 3. First, it will invite participants to consider what the motives, attitudes and beliefs are that currently guide their behavioural intentions in driving-related situations. It will subsequently identify alternative motives that may be important to the learners too (i.e. protecting children in traffic from harm), and will present information that may be required to correct erroneous beliefs (e.g. the belief that drugs do not really affect driving). Finally, it will help learners to develop behaviour plans (i.e. ‘if I am late, I will ring ahead rather than speeding’) and to practise the skills required to implement those behaviour plans.

Figure 3: Three-step procedure for the discussion group module



## **ADDITIONAL MOTIVES**

The discussion group will open with the question ‘what is a good driver?’. The facilitator will challenge the talent model of driving (i.e. the view that good driving is a matter of talent rather than practice). The discussion will cover how participants would drive if there were no limiting factors such as traffic signs and rules. This will allow participants to reflect on what motives, currently or in the future, will determine the way they drive. Increasing participants’ self-awareness for the motives that guide their driving behaviour and, ultimately, their safety will allow them to make better informed choices regarding their driving style and the costs that may be associated with these choices.

## **DRIVER CALIBRATION**

Drivers frequently overestimate their control over driving situations. The group will work to identify what factors (apart from one’s own skill) may affect driving (e.g. road conditions, the behaviour of other road users) and which are beyond a driver’s control. This will help create an understanding that driving at any point in time may be influenced by factors outside the driver’s control. Participants will be encouraged to include safety margins into their driving style that allow for other road users’ errors, thus taking control of their driving environment. The concept of the road transport system, with vehicle and road design providing protection as long as drivers keep within a ‘behavioural design envelope’ may be explored.

The insight that driver’s control of driving situations is limited could be developed by the analysis of accidents that are a chain of bad decisions made by different drivers. This will be illustrated by the formula:  $\text{accident} = \text{violation} + \text{error}$ . Additional exercises that demonstrate the participant’s own fallibility (i.e. inattention blindness as described by Simon and Chabris (1999)) will be carried out to demonstrate that their assessments of risk may sometimes be inaccurate and to reinforce the message that greater safety margins will protect themselves and others from harm.

## **DRIVER INSIGHT**

A scenario approach comparable to the scenario included in the Kirklees Enhanced Pass Plus training (Edwards, 2005) could be used to let group participants identify relevant factors that may affect their driving performance (i.e. impairment, distraction, journey planning).

The role of the passenger on driving performance will be discussed and participants could be encouraged through role play to develop a repertoire of strategies that could be used in situations where they, as passengers, feel put at risk by a driver or where passengers are encouraging a driver to take risks. Contrasts between what passengers are thinking about a display of risky driving and the impression that the driver thinks he or she is creating could be explored.

# Discussion

The development of a discussion-based module that targets the driving-related attitudes, beliefs and motives of young adults and the factors that may influence their driving reflects recent recommendations from the training literature to address the higher cognitive processes and motivational orientations which determine the way we drive. The proposed discussion group emphasises the participants' choice and responsibility as drivers and thus aims to intrinsically motivate them to drive in a safe way. Participants will be encouraged to reflect on the factors that may impact the way they are driving and to develop their self-evaluation skills to more accurately assess their capability as a driver in relation to the demands of specific driving situations. Furthermore, the discussion group will aim to equip participants with the skills to actually implement the target behaviour, once the transition to solo driving is made. To allow the learning from the discussion group to be implemented in the post-test driving context, close proximity between the intervention and solo driving is highly desirable as the newly-formed (good) intentions are likely to fade with an increasing gap between the training and implementation. To strengthen the learning experience, it would also be desirable to have at least one additional training session after passing the test. This would allow for the discussion of experiences made as novice drivers, to compare the pre-test expectations and intentions with the 'reality' of driving, and to refine strategies in dealing with problematic situations. However, a second training session post-test is fraught with logistical difficulties and so does not seem feasible at this point in time.

When developing an intervention targeted at learner drivers, their diversity in terms of confidence, knowledge and eloquence has to be considered and catered for. To ensure that a maximum number of learner drivers participate in, and benefit from, the intervention, the skills of the facilitator are of utmost importance. The facilitator must, on the one hand, allow the participants to draw their own conclusions from the discussion, but, at the same time, skilfully steer the process in such a way that safety-negative outcomes are avoided at all times. It is yet to be determined where facilitators with the necessary skills may be recruited from. While, for example, driving instructors may have the technical knowledge relating to the safe handling of the car in the traffic environment, they may not have the required skills in moderating the proposed discussion group. Road safety officers or teachers may be better equipped to deliver an effective intervention, but even so would need careful training to ensure that they were able to deliver the interventions in the planned way.

In the process of developing an intervention, the evaluation of its impact should also be considered. After establishing the discussion group content, four pilots of the discussion group will be carried out to ascertain its success with a diverse range of participants, in particular learner drivers from different socio-economic backgrounds, ethnicity, gender and educational attainment. Questionnaires based on the Theory of Planned Behaviour, will be administered before and after the discussion group to provide an indication of the interventions' short-term effectiveness in terms of attitudinal change and popularity. Once this immediate proof of concept and acceptance has been established, a comprehensive and scientifically designed longer-term evaluation of the intervention, including a comparison against a control group, will be required in order to establish whether it impacts actual driving behaviour and accident liability.

# References

- Arthur, W. A., Barrett, G. V. and Alexander, R. A. (1991) Prediction of vehicular accident involvement: a meta analysis. *Human Performance*, 4, 89–105.
- Bogaert, A.F., and Fisher, W.A. (1995). Predictors of university men's number of sexual partners. *Journal of Sex Research*, 32, pp. 119–130.
- Burns, P. C., Parkes, A., Burton, S., Smith, R. K. and Burch, D. (2002) *How Dangerous is Driving with a Mobile Phone? Benchmarking the Impairment to Alcohol*. TRL Report No. 574. Crowthorne: Transport Research Laboratory.
- Campbell, M. and Stradling, S. G. (2003). Factors influencing driver speed choices. *Behavioural Research in Road Safety: Thirteenth Seminar*. London: Department for Transport.
- Chapman, P.R., Underwood, G. and Roberts, K. (2002). Visual Search Patterns in Trained and Untrained Novice Drivers. *Transportation Research Part F*, 5, pp. 157–167.
- Chen, L. H., Baker, S. P., Braver, E. R and Li, G. (2000) Carrying passengers as a risk factor for crashes fatal to 16 and 17 year old drivers. *Journal of American Medical Association*, 283(12), 1578–1582.
- Christie, R. (2001). *The Effectiveness of driver training as a road safety measure: a review of the literature*. Royal Automobile Club of Victoria, Report No 01/03.
- Department for Transport (2005). *Driving out Drugs*. London: Department for Transport. [www.dft.gov.uk/transportforyou/roads/roadsafety/drivingoutdrugs](http://www.dft.gov.uk/transportforyou/roads/roadsafety/drivingoutdrugs) (accessed on 24 September 2007).
- Department for Transport (2007a) *Tomorrow's Roads – Safer for Everyone. The Second Three-year Review. The Government's Road Safety Strategy and Casualty Reduction Targets for 2010*. London: Department for Transport. [www.dft.gov.uk/pgr/roadsafety/strategytargetsperformance/2ndreview/print.pdf](http://www.dft.gov.uk/pgr/roadsafety/strategytargetsperformance/2ndreview/print.pdf) (accessed on 27 January 2009).
- Department for Transport (2007b) *The Good, the Bad and the Talented: Young Drivers' Perspectives on Good Driving and Learning to Drive*. Road Safety Research Report No. 74, London.
- Clarke, D. D., Ward, P. J. and Jones, J. (1998) *Overtaking Accidents*. TRL Report No. 301. Crowthorne: Transport Research Laboratory.
- Clarke, D. D., Ward, P. and Truman (2002) *In-depth Accident Causation Study of Young Drivers*. TRL Report No. 542. Crowthorne: Transport Research Laboratory.
- Edwards, I. (2005) An evaluation of the Enhanced Pass Plus scheme operated by Kirklees Metropolitan Council. *Behavioural Research in Road Safety: Fifteenth Seminar*. London: Department for Transport.

- Elander, J., West, R. and French, D. (1993) Behavioural correlates of individual differences in road-traffic crash risk: an examination of methods and findings. *Psychological Bulletin*, 113, 279–294.
- Evans, L. and Wasieleski, P. (1983) Risky driving related to driver and vehicle characteristics. *Accident Analysis and Prevention*, 15(2), 121–136.
- Fishbein, M. and Ajzen, I. (1975) *Belief, Attitude, Intention and Behaviour: An Introduction to Theory and Research*. Reading, Mass.: Addison-Wesley.
- Forsyth, E., Maycock, G. and Sexton, B. (1995) *Cohort Study of Learner and Novice Drivers: Part 3, Crashes, Offences and Driving Experience in the First Three Years of Driving*. Published Project Report No. 111. Crowthorne: Transport Research Laboratory.
- Fuller, R. (2005) Towards a general theory of driver behaviour. *Accident Analysis and Prevention*, 37, 461–472.
- Giedd, J. N. (2004) Structural Magnetic Resonance Imaging of the Adolescent Brain. *Annals of the New York Academy of Sciences*, 1021, 77–85.
- Grayson, G. B. and Sexton, B. F. (2002) *The Development of Hazard Perception Testing*. TRL Report No. 558. Crowthorne: Transport Research Laboratory.
- Gregersen, N. P. (1997) *Evaluation of 16-years Age Limit for Driver Training. First Report*. VTI Report No. 418A. Linköping: Swedish National Road and Transport Institute.
- Groeger, J. A. and Clegg, B. A. (1994) *Why isn't driver training contributing more to road safety?* In G. B. Grayson (ed.) *Behavioural Research in Road Safety IV*. Crowthorne: Transport Research Laboratory.
- Hattakka, M., Keskinen, E., Gregersen, N. P., Glad, A. and Hernetkosi, K. (1999) Results of the EU-project GADGET, Work Package 3. In S. Siegrist (ed.), *Driver Training, Testing and Licensing – Towards Theory Based Management of Young Drivers' Injury Risk in Road Traffic*. BFU-report 40. Berne: Schweizerische Beratungsstelle für Unfallverhütung.
- Horwood, L. J. and Ferguson, D. M. (1999) Drink driving and traffic accidents in young people. *Accident Analysis and Prevention*, 32, 805–814.
- Hosking, S., Young, K. and Regan, M. (2006) *The Effects of Text Messaging on Young Novice Driver Performance*. Report No. 206. Victoria, Australia: Monash University Accident Research Centre, Monash University.
- Keall, M., Frith, W. and Patterson, T. (2004) The influence of alcohol, age and number of passengers on the night-time risk of driver fatal injury in New Zealand. *Accident Analysis and Prevention*, 36(1), 49–61.
- Kuiken, M. and Twisk, D. (2001) *Safe Driving and the Training of Calibration*. (R-2001-29.) Leidschendam: SWOV Institute for Road Safety Research.

- Masten, S. V. (2004). *Teenage Driver Risks and Interventions*. DMV. [http://dmv.ca.gov/about/profile/rd/207\\_teen\\_driver\\_risk\\_report.pdf](http://dmv.ca.gov/about/profile/rd/207_teen_driver_risk_report.pdf) (accessed on 14 April 2009).
- Maycock, G. (2002) *Novice Driver Accidents and the Driving Test*. TRL Report No. 527. Crowthorne: Transport Research Laboratory.
- Maycock, G. and Forsyth, E. (1997) *Cohort Study of Learner and Novice Drivers Part 4: Novice Driver Accidents in Relation to Methods of Learning to Drive, Performance in the Driving Test and Self Assessed Driving Ability and Behaviour*. TRL Report No. 275. Crowthorne: Transport Research Laboratory.
- Mayhew, D.R., Simpson, H.M., Williams, A.F. and Ferguson, S.A. (1998). Effectiveness and Role of Driver Education and Training in a Graduated Licensing System. *Journal of Public Health Policy* 19(1), pp. 51–67.
- McKenna, F. P. (1993) It won't happen to me: unrealistic optimism or illusion of control? *British Journal of Psychology*, 23, 45–52.
- Näätänen, R. and Summala, H. (1976) *Road User Behaviour and Traffic Accidents*. Amsterdam and New York: North Holland/American Elsevier.
- Organization for Economic Co-operation and Development (OECD) (2006) *Young Drivers – The Road to Safety*. Paris: Transport Research Centre, European Conference of Ministers of Transport, OECD.
- Parker, D. and Stradling, S. (2001) *Influencing Driver Attitudes and Behaviour*. DETR Road Safety Research Report No. 17. London: DETR.
- Preusser, D. F., Ferguson, S. A. and Williams, A. F. (1998) The effect of teenage passengers on the fatal crash risk of teenage drivers. *Accident Analysis and Prevention*, 30, 217–222.
- Quimby, A.R. and Watts, D.R. (1981). *Human factors and driving performance*. TRRL Laboratory Report LR1004. Transport Road Research Laboratory, Crowthorne.
- Simon, D. J. and Chabris, C. F. (1999) Gorillas in our midst: sustained inattention blindness for dynamic events. *Perception*, 28, 1059–1074.
- Sowell, E. R., Thompson, C. J., Holmes, T., Jernigan, T. and Toga, A. (1999) In Vivo Evidence for Post-adolescent Brain Maturation in Frontal and Striatal Regions. *Nature Neuroscience*, 2(10), 859–861.
- Tunbridge, R. J., Keigan, M. and James, F. J. (2000) *Recognising Drug Use and Drug Related Impairment in Drivers at the Roadside*. TRL Report No. 464. Crowthorne: Transport Research Laboratory.
- Waylen, A. and McKenna, F. (2002) *Cradle Attitudes – Grave Consequences: The Development of Gender Differences in Risky Attitudes and Behaviour in Road use: Summary Report*. Reading: AA Foundation for Road Safety Research.



[www.iam.org.uk/NR/rdonlyres/3CB04728-6245-4925-AEBE-DFA7E58B665E/0/AA\\_foundation\\_FDN33.pdf](http://www.iam.org.uk/NR/rdonlyres/3CB04728-6245-4925-AEBE-DFA7E58B665E/0/AA_foundation_FDN33.pdf) (accessed on 24 September 2007).

Wells, P., Tong, S., Sexton, B., Grayson, G. and Jones, E. (2008) *Cohort II: A Study of New Drivers*. Road Safety Research Report No. 81. London: Department for Transport.

Williams, A. F. (2000) *Teenage Passengers in Motor Vehicle Crashes: A Summary of Current Research*. Arlington: Insurance Institute for Highway Safety.



## 8

# Has the introduction of hazard perception testing produced safer drivers: evidence from the Cohort II study

Barry Sexton  
Safety, Security and Investigation Division  
Transport Research Laboratory  
Wokingham RG40 3GA

## Abstract

In November 2002, a hazard perception (HP) component was incorporated into the theory driving test. Data from the second Cohort study on new drivers provided information on self-reported accidents in the first three-years of driving. A multivariate analysis of Cohort data, taking into account age, exposure, sex and experience of the new driver showed that the HP element within the theory test does have a beneficial effect in terms of reducing subsequent accident liability for some types of accidents. The size of the effect varies with the type of accident.

The largest effect of having taken the HP test was for ‘non-low-speed public road accidents where the driver accepts some blame’. In the case of the models covering all three years of driving, statistically significant effects for taking the HP test were found for most accident types. The effect was smallest for ‘public road accidents’ and largest for ‘non-low-speed public road accidents where the driver accepts some blame’. The size of the HP test effect in the case of ‘non-low-speed public road accidents’ and ‘active public road accidents’ were similar. Most of the effect of hazard perception was seen in the first 12-months of driving, and these results are presented.

The size of the reduction in self-reported accident liability for ‘non-low-speed public road accidents where the driver accepts some blame’ was such that those who had taken the HP test have a 17% lower accident liability in the first 12-months of driving than those who had not taken the test. The confidence interval on this estimate was quite wide, but there was 95% confidence that the size of reduction was at least 3%. This result indicated that introducing HP into the licensing system has consequential validity.

The analysis also compared different score groups for those that passed the HP test and found that those novice drivers in the highest scoring group had a first-year liability for 'non-low-speed public road accidents where the driver accepts some blame', estimated to be 16% lower than that of the lowest scoring group. The confidence interval on this estimate was also quite wide, but there was 95% confidence that the size of the difference in accident liability between high and low scoring groups was at least 4%. This result indicated that the test has 'predictive validity' and that further benefits in accident reduction may be obtained if new drivers are trained to improve their HP scores.

## Introduction

It has long been recognised that young drivers are over-represented in accidents. There has been an equally long debate about whether the 'young driver problem' arises because young drivers are immature or because they are inexperienced. A basic problem is that age and experience are usually highly correlated: the majority of inexperienced drivers are also young drivers. The age versus experience issue is not just of academic interest, for there are clear implications for safety countermeasures. At a practical level, maturity cannot be accelerated, while the lessons of experience can, in principle, be taught.

Despite the difficulties of separating the effects of age and experience, research at the Transport Research Laboratory (TRL) in the early 1990s (Maycock *et al.*, 1991) showed that experience has a strong effect on accident liability, indicating that new drivers learn something valuable during the first months and years of unsupervised driving.

In the first few years of driving, a new driver is learning not just new skills, but is formulating new rules, developing a new repertoire of strategies and learning new patterns of interaction. However, much of this process takes place in an unstructured and informal way, with no guarantee that what is learned is the most appropriate for the safety of the traffic system. It would clearly be desirable if the lessons of experience could be imparted by some formal intervention, rather than being acquired in an uncontrolled learning situation. A candidate for intervention of this sort is hazard perception (HP).

Research has shown that HP is capable of being improved through training, and a number of studies have indicated that poor HP skills are associated with elevated accident risk (Currie, 1969; Quimby *et al.*, 1986; McKenna and Horswill, 1999). HP thus became a candidate for inclusion in the licensing system. The justification for this is that if HP ability is related to accident involvement, and if the ability is amenable to improvement, then introducing HP training on a wide scale could lead to a reduction in accident liability in the early years of driving. Further, the most effective way of ensuring that HP training is undertaken on a voluntary basis is to include a HP test in the procedure for acquiring a licence to drive.

HP testing was introduced into the licensing system in November 2002. This paper considers the accident liability of new drivers during their first three years of driving and how it has been affected by the introduction of the hazard perception test (HPT).

# HPT – description and objective

The HPT is delivered on a computer and candidates respond by clicking a button. They are presented with a series of video clips which feature everyday road scenes; in each clip there will be at least one developing hazard, but one of the clips will feature two developing hazards. In order to achieve a high score, candidates need to respond to the hazard during the early part of its development. The development of the HPT is discussed by Grayson and Sexton (2002).

## Scanning and anticipation skills

HP is a skill that drivers start to acquire during their early driving career– or even before. It is a skill that is difficult to define, but it is not about reacting quickly to a sudden event, and is more about anticipation. Anticipation depends upon good scanning skills and an awareness of developing scenarios. Defining the type of driving situation that typifies such developing scenarios is necessary in order to develop HPTs that measure the underlying skill of interest.

The view taken was that those drivers with ‘good’ HP would have good scanning skills and good anticipation. ‘Good’ video clips were thus defined as those that would test these characteristics. It also seemed sensible that a hazard should eventually become obvious to even rank novice drivers, and that there should be a minimum of ‘clutter’ leading up to the hazard so that there should be no doubt as to what a candidate was responding. The following criteria were required for HP items in the test:

- develops into an ‘actual hazard’;
- anticipation is possible for experienced driver or trained novice;
- scanning ahead and/or to the side necessary;
- clear and uncluttered scenario; and
- not simply dependent upon reaction time.

## Scoring system

The scoring method is to assign a 0–5 score depending upon the response to a HP event within a pre-defined time window. The earlier within the window that the candidate responds, the higher the score. In practice a 5, 4, 3, 2, 1 score is allocated by dividing the window equally in five sub-time-windows. Candidates who fail to respond in the time-window are given a zero score.

The setting of the scoring window is critical. Scoring windows can be determined without the empirical data, but if no candidates were responding to the hazard, then this would suggest it was a very poor hazardous event that was unlikely to result in a useful item for scoring. Using empirical data and expert judgement to set the scoring

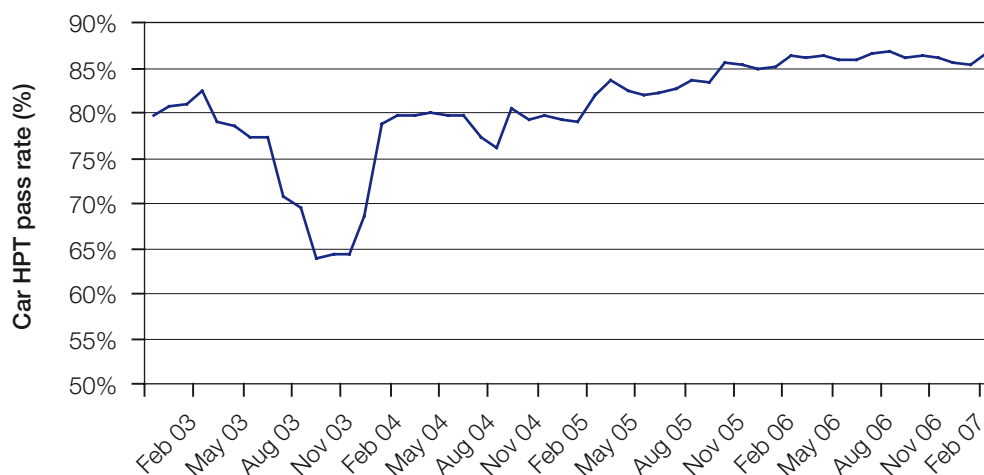
window ensures that a useful item is identified that also has good face validity. Potential hazards were first identified empirically from the distribution of responses, i.e. a high frequency of responses indicated that drivers thought that a hazardous situation was developing. The Driving Standards Agency (DSA) and TRL then looked at the ‘hazard’ and decided if it met the ‘blue-print’ criteria. The scoring ‘window’ was defined as the time interval from when it could first be spotted to the point where it was fairly obvious.

## Hazard perception test

The HPT consists of a series of 14 video clips which feature everyday road scenes, and in each clip there will be at least one developing hazard, but one of the clips will feature two developing hazards which are scored. There may well be other potentially hazardous situations which are not included as a part of the test. Given the maximum score on any one hazard is five, then a maximum of 75 marks is possible. The test contains a mix of clips to include different road scenarios, different vehicle types, pedestrians, weather conditions, etc. Initially, when the HPT was introduced, a candidate had to achieve at least 38 marks to achieve a pass; this was increased to 44 after the first year.

The pass rate for candidates was affected by the change to the pass mark, as indicated in Figure 1 where there is a drop in pass rate during the first year. It then appears that candidates must have been receiving ‘better’ training because the rate rapidly increased to about 80%. The pass rate then settled to about 85%.

Figure 1: Car HPT pass rates (source: DSA)



It is worth noting that the pass mark of 44 for the HPT was set at a level as achieved by 95% of drivers with three years' experience – determined during the research project on the development of the test. This level could also be achieved by 95% of new drivers who had taken the training course developed during the research project. The fact that currently only about 85% of candidates are passing the HPT suggests that there is scope for more, or ‘better’, training to be taken. This, in turn, should lead to a higher pass rate and more candidates with higher HP scores, i.e. more candidates should have better HP skills as determined from the HPT.

## Example

Examples of two pictures at different time points within a clip are shown below. This particular hazard item is in a suburban setting with traffic calming. A cyclist emerges from a right turn and is obscured behind a van, but could have been spotted prior to being obscured by the van. The driver's view of the cyclist just before he disappears behind the van and just after emerging are shown in Figures 2 and 3.

Figure 2: **Cyclist emerging from side road and about to go behind the van**



Figure 3: **Cyclist emerges from behind the van into the path of the oncoming vehicle**



The 'scoring window' would have been just before the cyclist could have been spotted in the side road to a point where he was 'obvious' as he overtakes the stationary van.

# Cohort II study

‘Cohort II’ was a major six-year study, funded by the Department for Transport, of the experiences of driver training and testing for ‘cohorts’ of learner drivers in Great Britain and their subsequent experiences as novice drivers. The aims of the study were:

- to investigate how people learn to drive and to compare this with outcomes from the theory and practical driving tests; and
- to assess the impact of changes to the testing regime and, specifically in this context, investigate the impact of the HPT which was introduced during the period of study on accident involvement.

Cohort II followed the first large-scale investigation of new drivers, the Cohort I study (Forsyth, 1992a, 1992b; Forsyth *et al.*, 1995; Maycock and Forsyth, 1997). It was a large-scale questionnaire survey of learner and newly-qualified drivers in which cohorts of 8,000 candidates taking their practical driving test in a particular week were selected every three months from November 2001 to August 2005.

The project followed the experiences of new drivers in the early part of their driving careers. Candidates who passed the practical test were sent Driving Experience Questionnaires (DEQs) at intervals of 6, 12, 24 and 36 months after passing the test. The DEQs collected information on driving experience, self-reported accidents, offences, as well as attitudes and behaviours.

Information about driving test performance was obtained from the DSA and linked to the questionnaire data. In addition, theory test scores were also made available by the DSA for most of the 16 samples and were matched to the DEQ data. The first four cohort samples can have no HPT experience since they entered the study before it was introduced. The last four cohort samples should all have had to have taken the HPT since they were sampled at least two years after its introduction. The proportion of those having taken the HPT varies by cohort (any candidate who takes their practical driving test must have passed the HPT, otherwise they could not have taken their practical test).

## Accident types

In the DEQ respondents were asked to record the number of accidents and near-accidents they were actually involved in when driving a car or a van during the period since passing the test or since completing the previous DEQ (i.e. those occurring in either a six-month or a twelve-month reporting period). Drivers were also asked to give details about the three most recent accidents, regardless of how they were caused, how slight they were or where they happened, together with the dates of these accidents.

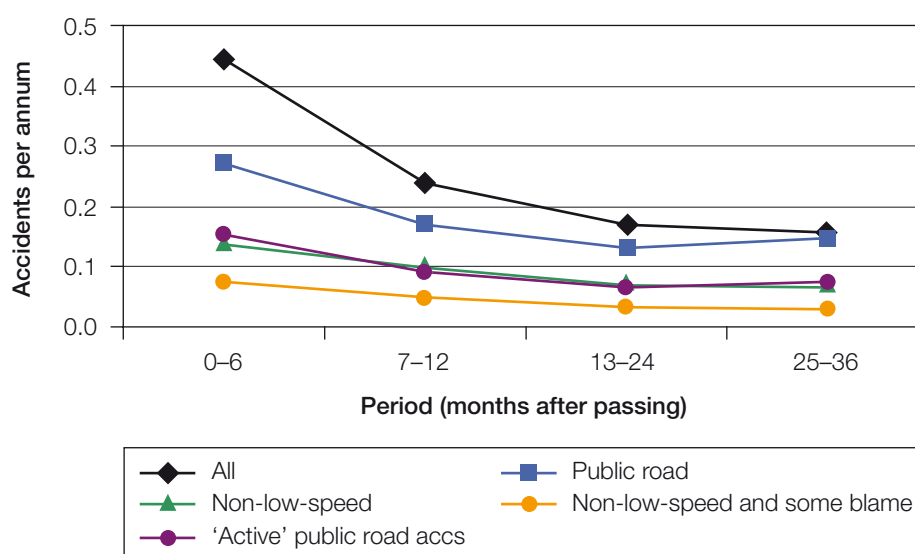


For the purpose of analysis, accidents were grouped into a number of non-exclusive categories:

- all accidents;
- public road accidents (accidents in car parks, private drives, etc., have been omitted);
- non-low-speed public road accidents (low-speed manoeuvring accidents have been omitted);
- non-low-speed public road accidents where an element of blame is accepted by the driver; and
- ‘active’ (first defined by West (1997)) public road accidents in which the first event involves the driver hitting another road user or object, and thus being the most likely to be responsible for the accident.

We can see in Figure 4 how accident rate per year decreases as drivers gain experience.

Figure 4: Accident rate per year by period after passing



It could be argued that the effect of having taken a theory test which included HP is likely to be greatest on accidents where the driver is responsible for the accident ('active' accidents) and during the first six months of driving when they are still relatively inexperienced. There are, however, several other potential factors that could also affect the accident rates in this period, for example driver age, exposure and the increasing experience of the driver need to be properly controlled in the analysis. These are taken into account in the statistical modelling analysis described in a later section.



Figure 5: 'All periods' accident rate by accident type, sex and whether the HPT was taken

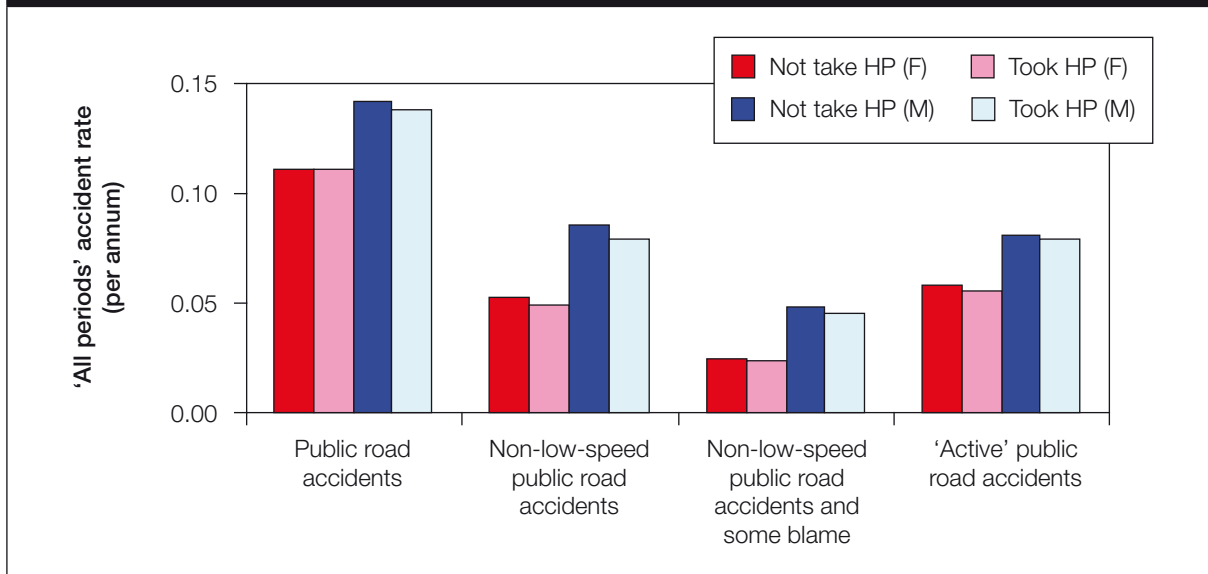
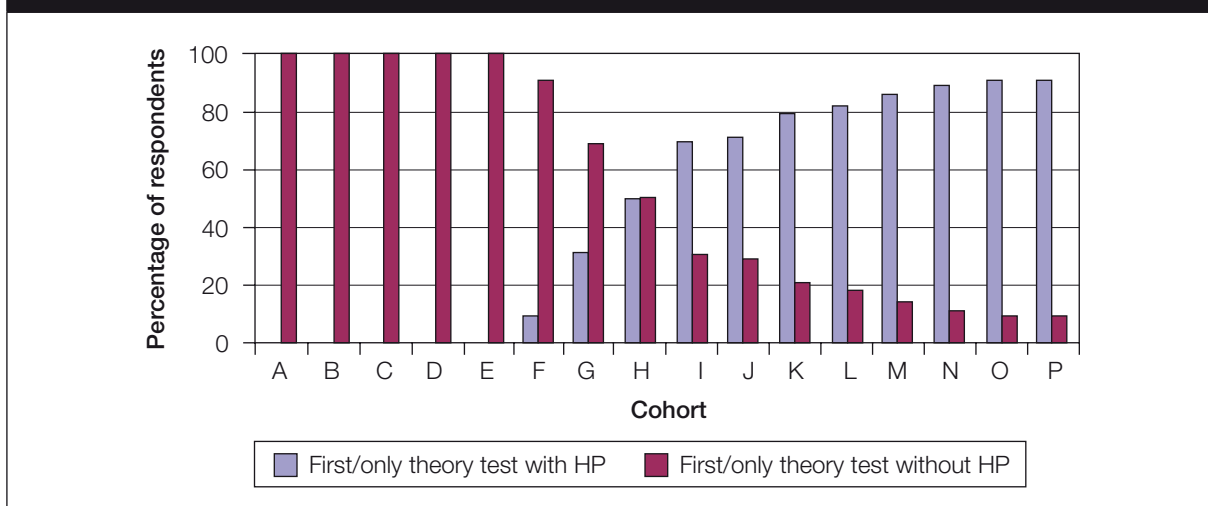


Figure 5 shows the four types of public road accident rates by driver gender and whether the driver took the HPT or not. Drivers who had taken the HPT generally had slightly fewer accidents than those who had not. No adjustments have been made here for other differences between the genders and between those who took the HPT and those who did not, for example different exposure.

## HP variables

As was described earlier, the number of candidates who took (and passed) the HPT varied from sample to sample. This was because the cohort samples spanned the period when HPT was introduced. The score range for those candidates who did pass the test range from 38 (a pass mark in November 2002) to 75 (the maximum possible). Figure 6 shows the percentage in each of the 16 cohort samples who had taken (and passed) the HPT.

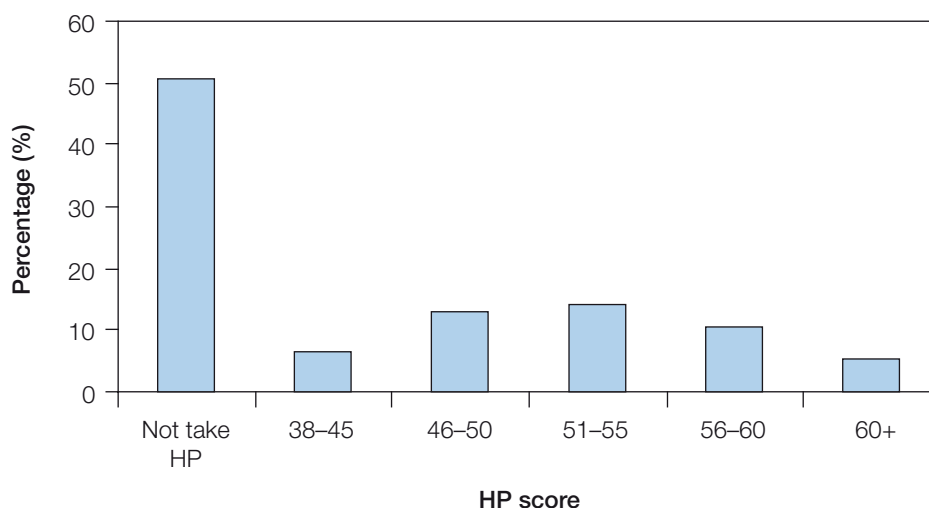
Figure 6: Percentage of candidates with, and without, experience of HP in their theory test



Two hazard perception variables were defined and were considered within the analysis:

- took the test (and passed) or not – dichotomous response variable ('HP take' variable); and
- score band, i.e. low score, medium score, etc. – the HP score distribution is shown in Figure 7 ('HP group' variable).

**Figure 7: Distribution of HP scores (grouped)**



The HP groups were defined as follow:

- 0 – did not take HP (central value taken as 25, see Grayson and Sexton (2002));
- 1 – score of 38 to 45 (central value = 41) on test (this will include some drivers who passed before the pass mark was raised to 44);
- 2 – score of 46 to 50 (central value = 48);
- 3 – score of 51 to 55 (central value = 53);
- 4 – score of 56 to 60 (central value = 58); and
- 5 – score greater than 61 (central value = 63).

Clearly, no score was available for those drivers who had not taken the HPT. However, in order to include those drivers who did not take the HPT, they were assigned a score of 25 which was the average score of those drivers in the HPT development project who took the HPT but who had no HP training – see Grayson and Sexton (2002).

# Analytical approach

The analytical approach allowed the effects on accidents of age, gender, experience and exposure to risk to be established, and the ways that these effects vary with time during the first three years of post-test driving to be investigated. Statistical models are used to control for the effects of these variables while investigating the relationship between accidents and other variables, specifically in this context the impact of HP testing. The Cohort sample was over-represented, to a degree, by female novice drivers compared with male. There may also be other biases, such as over-representation of ‘better’ drivers – something which is difficult to establish. The question of representation is discussed more fully in the Cohort report (Wells *et al.*, 2008). The analysis approach looked at relative effects and provided an indication of the impact of an intervention, such as introducing HP testing.

The modelling reported in this section uses a multivariate regression method known as Generalised Linear Modelling (GLM). Multivariate regression is designed to explore the relationship between a ‘dependent’ or ‘response’ variable (the  $y$ -variable) and any number of ‘independent’ or ‘explanatory’ variables (the  $x$ -variables) upon which the  $y$ -variable is assumed to depend, and which are correlated with one another to varying degrees. In the present analysis, the  $y$ -variable to be modelled is the predicted annualised accident rate in a given period, i.e. predicted number of accidents in the period divided by the duration of the period in years or fractions of a year. In previous TRL work, for example Maycock *et al.* (1991), this variable has been termed accident liability, a practice that is followed here.

The modelling process involved:

- establishing, statistically, the extent to which drivers’ accidents are related to age, gender, experience and exposure – this results in a ‘base’ model; and
- determining the influence of an HP measure on drivers’ accident liability by adding this variable to the base model

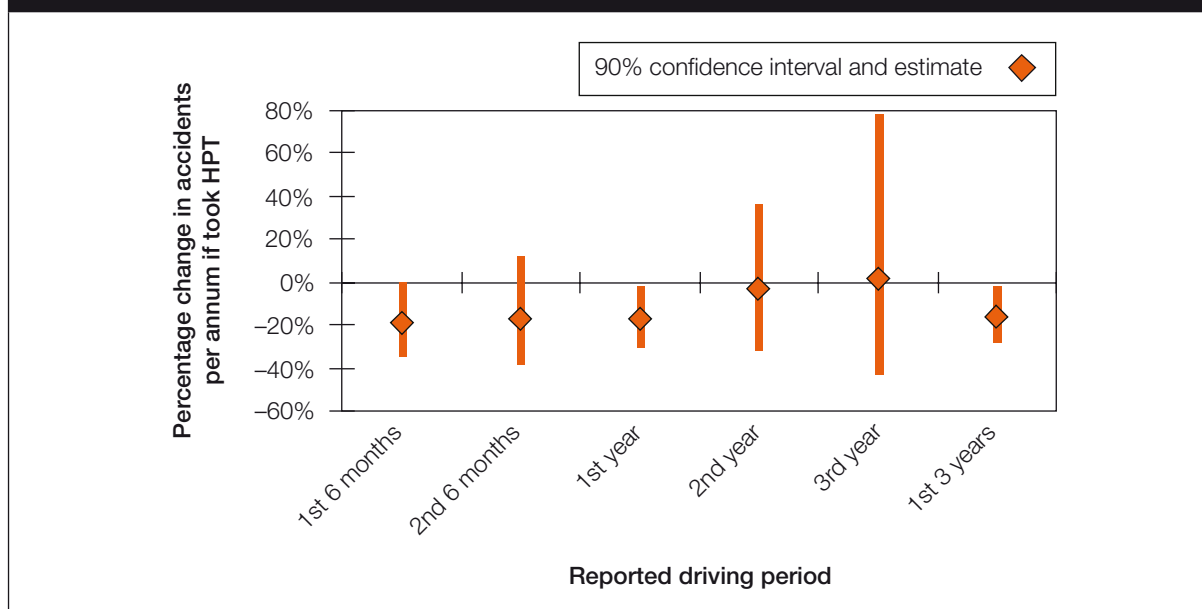
The approach adopted was to consider, for each accident type, a generalised linear model (Negative Binomial seemed to be the most appropriate) and fit an exposure, age, experience and sex variable. There is no specific trend effect included within the model, in-part because there was no evidence of a trend when comparing accident involvement across the 16 cohorts, but also because trend is potentially related to exposure which is already included within the GLM model.

A base model was first derived. An HP measure was then added and it was determined whether the unexplained variation in the accident data was reduced by a statistically significant amount. This provided a measure of the explanatory power of the HP variable.

Models were fitted for each reporting period, for the first two periods combined and for the full three-year period. This generated a number of results which indicated the largest effect during the earlier months of driving. This is illustrated in Figure 8 for non-low-speed accidents where the driver accepted some blame. Estimates for the

second and third year of driving are also based on fewer data, resulting in a very wide confidence interval. Only results for the first year of driving are reported within the main analysis.

**Figure 8: Effect of introducing the HPT – estimated percentage change in non-low-speed accidents where the driver accepts some blame**



## Findings

In the first year of driving, statistically significant coefficients for the HP variable were found for non-low-speed public road self-reported accidents, and for the subset of these for which the driver accepted some blame. The sign of all the modelling coefficients was negative. These results indicate that drivers who took (and passed) the HPT tended, on average, to have a lower accident liability than those who had not taken the test, other differences between these two groups of drivers in terms of age, exposure, experience and time between passing the theory test and passing the practical test being controlled for statistically.

Table 1 shows, for the ‘first year’ model, the percentage reductions in accident liability associated with taking the HPT. The 95% confidence values shown in Table 1 correspond to the minimum reduction in accident liability that is likely for those drivers who passed the HPT compared with those drivers who did not, i.e. we can be 95% confident of at least this size reduction in accident liability.

It can be seen from Table 1 that those who have taken the HPT have an expected accident liability which is lower than those who have not. However, the 95% confidence value indicates that we can only be confident that a reduction applies to non-low-speed public road accidents and to non-low-speed public road accidents where the driver accepts some blame. The negative 95% confidence value in the ‘all public road accidents’ category and the “‘active” public road accidents’ category indicate that there was no statistically significant change in the liability for those accidents.

**Table 1: Estimated percentage reduction in first-year accident liability for those new drivers who took the HPT**

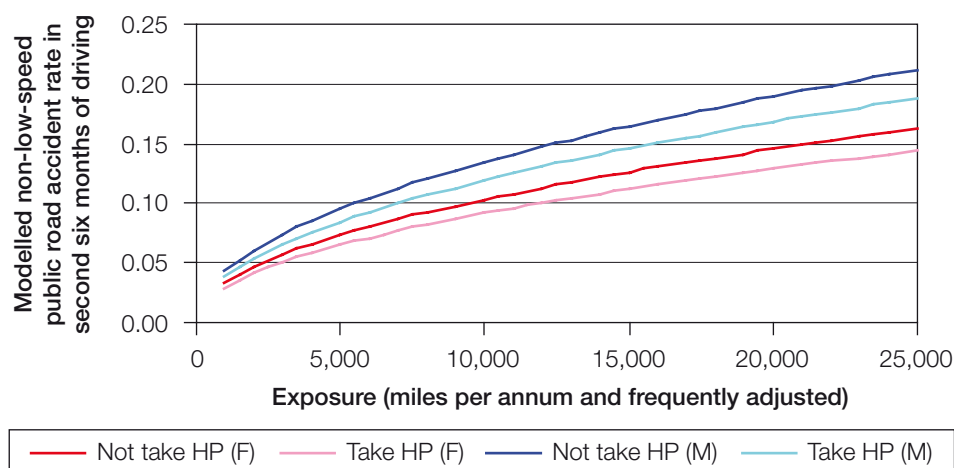
Percentage reduction if take (and pass) HPT		All public road accidents	'Active' public road accidents	Non-low-speed public road accidents	Non-low-speed public road accidents and accept some blame
Per cent	Estimate	1.3	6.8	11.3	17.4
reduction in	95%	-7.5	-4.7	0.3	3.0
first year	confidence				
accident	value*				
liability					

\* These values correspond to the 90% confidence limit for the minimum reduction in accident liability, as shown in Figure 8.

The largest size of effect on accident liability of the 'take HP' variable is 17.4% (for the accident category 'non-low-speed public road accidents where the driver accepts some blame'). This effect is statistically significant, and one can be 95% confident that it is at least 3.0%.

The effect size is illustrated in Figure 9 for female and male drivers who were 20 years old, and in their second six months of driving by exposure (miles plus an adjustment for frequency of driving). Figure 9 shows the modelled results for non-low-speed public road accidents and these are plotted as a function of exposure and whether or not a driver took the HPT. The darker coloured lines are the modelled accident liabilities for those who did not take the HPT and the solid lines are for those who did take the test, i.e. red/pink for female drivers and dark blue/light blue for male drivers.

As was commented on before, models for the individual reporting periods did not all show statistically significant effects of the HPT. Nevertheless, almost all the coefficients were negative, i.e. in the direction of showing a reduction in accident liability following HP testing.

**Figure 9: Non-low-speed public road accidents for drivers aged 20 years, by exposure showing the difference between female drivers who took the HPT or not**

The results indicate the ‘consequential validity’ of HP testing, i.e. that introducing HP testing has had the intended effect of reducing novice driver accidents. The predictive validity of the HPT was explored by investigating whether (for test passers) there is a relationship between the score achieved on the HPT and subsequent accident liability. This was done by introducing a different HP variable (‘HP group’) into the statistical modelling, defined as the actual HP score achieved (treated as a grouped variable) with levels corresponding to the values defined above.

The results demonstrated that there was a statistically significant relationship between the HP score and subsequent accident liability. Table 2 shows, for the ‘first-year’ models, the estimated difference in accident liability between those in the lowest HP score group (score assumed to be 41) and those in the highest scoring group (taken to have a score of 63).

**Table 2: Estimated percentage difference in first-year accident liability between new drivers who just passed and those who scored highly on the HPT**

Percentage reduction if just pass compared with those who score highly on HPT		All public road accidents	‘Active’ public road accidents	Non-low-speed public road accidents	Non-low-speed public road accidents and accept some blame
Per cent reduction in first year accident liability	Estimate	1.4	7.1	9.4	15.6
	95% confidence value*	–5.3	–1.6	0.9	4.5

\* These values correspond to the 90% confidence limit for the minimum difference.

The 95% confidence values indicate that we can only be confident that a reduction applies to non-low-speed public road accidents and to non-low-speed public road accidents where the driver accepts some blame. The negative 95% confidence value for the ‘all public road accidents’ and for the “‘active” public road accidents’ indicate that there was no statistically significant association with HP score.

## Conclusions

The effect on self-reported accidents of introducing HP testing was estimated by comparing accident liabilities of people who had not taken the HPT with those who had taken (and passed) it. This was achieved using statistical modelling to correct for any differences between the two groups in terms of age, gender, exposure and experience.

Adding the HP element to the theory test appears to have had a beneficial effect in terms of reducing novice drivers’ accident liability. The size of the estimated effect varies with the type of accident and is largest for that group of accidents which took place on a public road, were not classified by the driver as ‘low-speed manoeuvring

accidents' and for which the driver accepted some blame. Introducing the HPT was estimated to have reduced such accidents by 17% during the first year of driving, with a 95% confidence that the reduction was at least 3%. This estimate allows for any before and after differences in exposure, age, experience and gender.

It was also found that for all non-low-speed public road accidents, liability was lower for drivers who had taken the HPT. The estimated size of the effect of introducing the HP was about 11%, with 95% confidence that the reduction was at least 0.3%.

The second approach to assessing the validity of the HPT was to investigate the relationship between drivers' scores on the test and their subsequent accident liability. This indicated the 'predictive validity' of the test. Again, statistical modelling was used to adjust for other differences between groups of people with different HP scores. This could be investigated only for people who passed the HPT.

For these people, there was a statistically significant relationship between the HPT score and accident liability: those in the highest scoring group (with a central score of 63 on the HPT) had an accident liability estimated to be 16% lower, in the first year, than that of the lowest scoring group. We can be 95% confident that this value was at least 4.5%. These figures were for public road accidents for which the driver accepts some blame and which he or she does not classify as a low-speed manoeuvring accident. In the case of all non-low-speed public road accidents, those in the highest scoring group had an estimated accident liability that was 9% lower than those in the lowest scoring group, with 95% confidence that the reduction was at least 0.9%.

The existence of this relationship, as well as providing further evidence of test validity, also suggests that future efforts to improve the HP skills of learner drivers are likely to be rewarded by greater reductions in accidents.

Overall, the study provides good evidence that introducing the HPT has had an important road safety benefit, i.e. that it has had good 'consequential validity'. The analysis from the Cohort study has demonstrated a clear benefit in self-reported accident reduction in the first year of driving from the inclusion of HP testing into the driver testing regime.

## References

Currie, L. (1969) The perception of danger in a simulated driving task. *Ergonomics*, 12, 841–849.

Forsyth, E. (1992a) *Cohort Study of Learner and Novice Drivers Part 1: Learning to Drive and Performance in the Driving Test*. TRL Report No. RR338. Crowthorne: Transport Research Laboratory.

Forsyth, E. (1992b) *Cohort Study of Learner and Novice Drivers Part 2: Attitudes, Opinions and the Development of Driving Skills in the First 2 Years*. TRL Report No. RR372. Crowthorne: Transport Research Laboratory.



Forsyth, E., Maycock, G. and Sexton, B. (1995) *Cohort Study of Learner and Novice Drivers Part 3: Accidents, Offences and Driving Experience in the First Three Years of Driving*. TRL Report No. 111. Crowthorne: Transport Research Laboratory.

Grayson, G. B. and Sexton, B. F. (2002) *The Development of Hazard Perception Testing*. TRL Report No. 558. Crowthorne: Transport Research Laboratory.

Maycock, G. and Forsyth, E. (1997) *Cohort Study of Learner and Novice Drivers Part 4: Novice Driver Accidents in Relation to Methods of Learning to Drive, Performance in the Driving Test and Self-assessed Driving Ability and Behaviour*. TRL Report No. 275. Crowthorne: Transport Research Laboratory.

Maycock, G., Lockwood, C. R. and Lester, J. (1991) *The Accident Liability of Car Drivers*. TRRL Report No. RR315. Crowthorne: Transport and Road Research Laboratory.

McKenna, F. P. and Horswill, M. S. (1999) Hazard perception and its relevance for driver licensing. *IATSS Research*, 23, 36–41.

Quimby, A. R., Maycock, G., Carter, L. D., Dixon, R. and Wall, J. G. (1986) *Perceptual Abilities of Accident Involved Drivers*. Research Report No. RR27. Crowthorne: Transport and Road Research Laboratory.

Wells, P., Tong, S., Sexton, B., Grayson, G. and Jones, E. (2008) *Cohort II: A Study of New Drivers. Volume 1 – Main Report*. Road Safety Research Report No. 81. London: Department for Transport.

West, R. (1997) *Accident Script Analysis*. TRL Report No. 274. Crowthorne: Transport Research Laboratory.

## 9

# Influences on speeding in young male drivers

Michael Gormley and Ray Fuller  
School of Psychology  
Trinity College Dublin  
Dublin 2, Ireland

## Introduction

New evidence suggests that young at-risk male drivers may have limited awareness of the consequences of their high-risk behaviour (Falk and Montgomery, 2007). Thus the possibility that serious wide-ranging and sustained consequences could occur as a result of a collision may have little or no impact on their decision making. Furthermore, because young drivers are influenced by perceived norms for their reference group (Kimura, 1993; Åberg *et al.*, 1997; Haglund and Åberg, 2000), if those norms are biased in a high-risk direction (e.g. thinking that other drivers drive faster or violate limits more than they actually do, a concept described as a ‘false consensus’ (Ross *et al.*, 1977)), drivers are likely to ratchet up their own risk-taking inappropriately (e.g. in speed and speeding). Evidence for this kind of false consensus has been reported by Gerrard *et al.* (1996), Åberg *et al.* (1997), and Walton and Bathurst (1998). It is important to determine whether the characteristics described above are found in a contemporary young male driver population because both of the problems described could be amenable to modification through focused media campaigns and/or elements of driver education and training. The staging in Ireland of a leg of the 2008 World Rally Championships, from 15–18 November, presented a unique opportunity to access a large sample of such young male drivers and thus investigate these issues.

## Research aims

The main aims of this study were to determine the following in respect of four age groups of male driver – i.e. 17–19, 20–22, 23–25 and 26–28 years – and in two sub-groups of drivers, who might be described as Problem Drivers (PDs) and non-Problem Drivers (nonPDs):

- reported frequencies of excessive speeding and other dangerous driving behaviours;

- representations (i.e. reported awareness) of the consequences of a severe collision;
- the relationship between a driver's self-reported behaviour and his perception of the same behaviour in his peer group; and
- self-reported expectations of behaviour change over the next five years.

## Method

A convenience sample of approximately 1,039 male drivers distributed across the four age groups (17–19, 20–22, 23–25 and 26–28) were interviewed during suitable opportunities at the Irish leg of the 2008 World Rally Championship.

The interview schedule was designed on the basis of the agreed aims of the study and a draft version was piloted with a small number of respondents. The final questionnaire included:

- demographic data;
- driving history;
- accident and violation history;
- self-reported frequency of various speed violations;
- self-reported frequency of various high-risk driving behaviours;
- expectations of driving behaviour change over the next five years;
- access to representations of the consequences of a serious collision, determined by eliciting responses to a crash scenario; and
- perceived norms for their own reference group on the frequency of violations and risk behaviours (on which they had already rated themselves).

With regard to the question of access to representations of the consequences of a serious collision, we were particularly interested in establishing the rank order in which a response might be given. In other research areas it has been shown that rank order yields important information (e.g. McCusker, 2001). For example, when trying to understand smoking-related behaviour, participants were asked to spontaneously come up with words related to smoking. The proportion of words with negative or positive smoking connotations was found to be the same for smokers and non-smokers. The key difference was that smokers were more likely to identify positive concepts first (Leung and McCusker, 1999). The interpretation was that heavy smokers were just as aware of the negative consequences of their actions, but that such information was less accessible than positive information and therefore is less likely to impact on their behaviour. In a similar vein, it is possible that drivers might

be aware of the risks associated with dangerous driving, but will not necessarily allow this information to influence their driving behaviour.

The data were collected by 30 student fieldworkers who were trained by a fieldwork supervisor. Six experienced data coders coded and entered the questionnaire data into electronic files for analysis by SPSS 16.

## Results

Of the 1,039 completed questionnaires received, 210 were considered not usable, yielding a reduced sample of 829 (all analyses reported were conducted on these 829 drivers only). It was judged that respondents may have been wrongly approached in two ways, resulting in 103 being completed by inappropriate respondents and 98 being handed out for completion, rather than administered through interview. If any questionnaire from an interviewer was considered suspect, then his entire dataset was deemed suspect. Requiring participants to complete the questionnaire on their own does not necessarily invalidate the data, nevertheless it was considered prudent to keep responses obtained under those conditions separate from the main body of data.

### Problem Driver status

Problem Driver status was established by examining the degree of self-reported speeding and dangerous driving behaviour. More extreme levels of self-reported speeding were defined by the driver's admission to driving at 80 km/h in a 50 km/h limit and by driving at 130 km/h in a 100 km/h limit at least once or twice a week in the previous three months. The percentage of drivers reporting these behaviours is presented in Table 1, with the frequency of reporting such behaviour decreasing with age, a difference which was statistically significant when both violations were committed:  $\chi^2(3) = 7.939, p = 0.047$ .

**Table 1: Per cent exceeding speed limits by 30 km/h**

Age group	80 in 50 km/h zone	130 in 100 km/h zone	Both violations
17–19	65.2	59.6	53.1
20–22	60.0	55.3	44.1
23–25	55.9	52.6	40.9
26–28	51.2	48.3	35.1

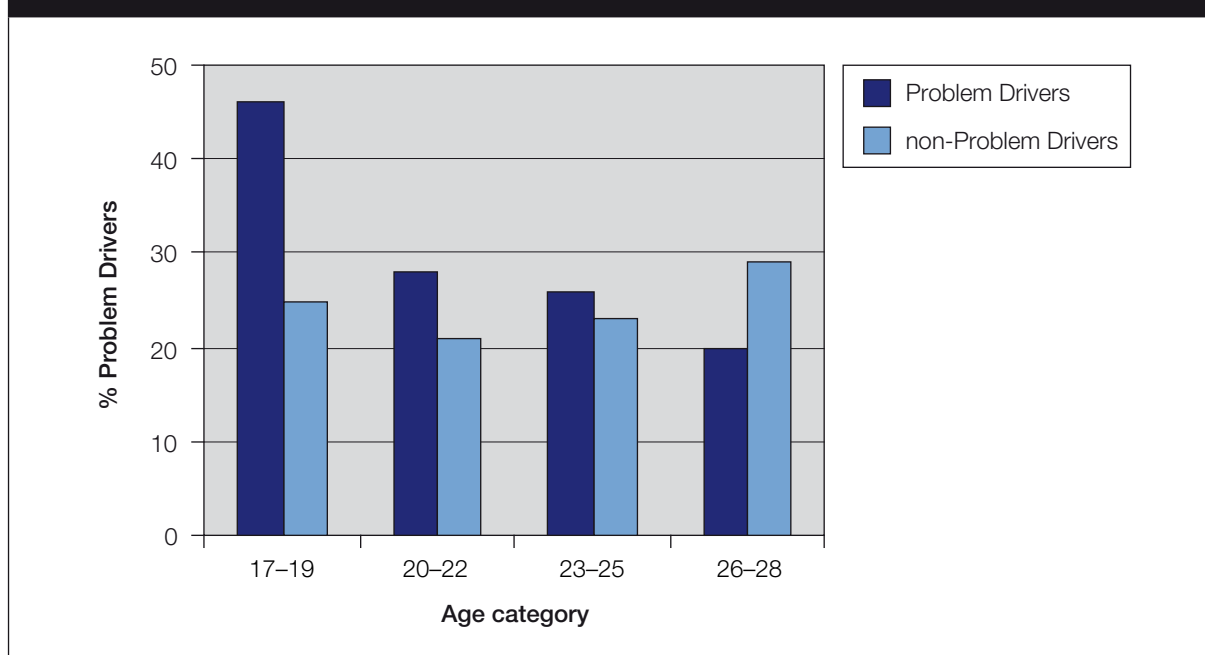
The degree of dangerous driving behaviour was determined by factor analysing the data from four questions relating to the frequency of dangerous overtaking, tailgating, drink-driving and racing in the previous three months. On the basis of this, each driver was then assigned a factor score, based on regressions for the dangerous driving questions, indicating the degree to which he had reported dangerous driving behaviour. Values for each age group are presented in Table 2, which indicate that dangerous driving behaviour was most prevalent in the youngest group and declined significantly with age:  $F(3,727) = 8.43, p < 0.001$ .

**Table 2: Dangerous driving scores**

Age group	1 – mean*	SD
17–19	1.27	1.17
20–22	1.02	0.97
23–25	0.96	0.95
26–28	0.73	0.82

\* To eliminate negative scores and relate value size to degree of dangerous driving.

Using this analysis, each driver was then assigned to a dangerous and a non-dangerous group based on the factor score median split. Drivers who were both speed-limit compliant and non-dangerous make up the non-Problem Drivers (nonPDs), while drivers who were speed limit extreme violators (exceeding limits by 30 km/h) and dangerous, as defined above, make up the Problem Drivers (PDs). The percentage of such drivers in each age group is presented in Figure 1. It is worth noting that, although there are more than twice as many PDs in the youngest driver category compared with the oldest, there is relatively little variation in the proportions of nonPDs across age groups.

**Figure 1: Per cent PDs and non-PDs**

## Demographic characteristics of the sample

### AGE

The sample is distributed across the four driver age groups as presented in Table 3. It may be seen that the four age groups are each well represented.

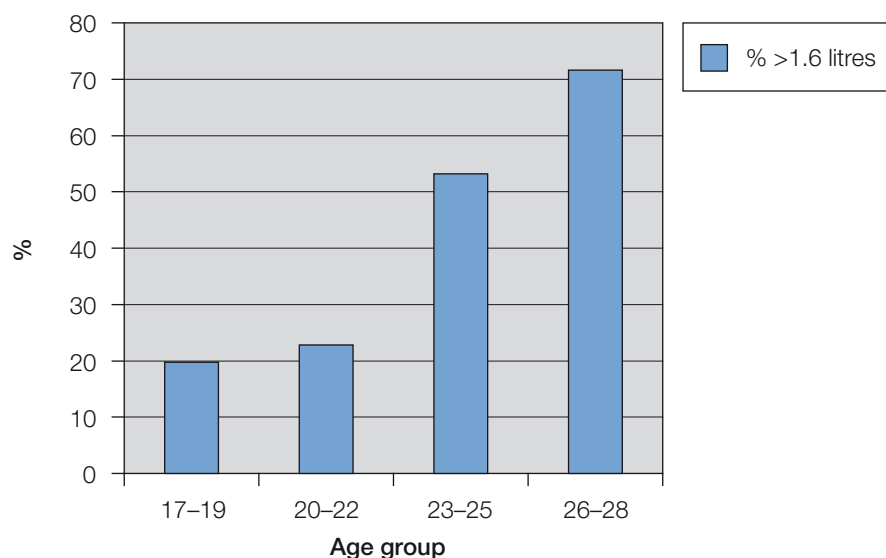
Table 3: Age profile of sample

Age group	Frequency	Per cent
17–19	184	22.2
20–22	236	28.5
23–25	232	28.0
26–28	177	21.3

## ENGINE SIZE

Figure 2 shows the percentage of drivers in each age group who most often drive a car with an engine size greater than 1.6 litres. Older drivers tend to drive more powerful cars ( $\chi^2(18) = 187.2, p < 0.001, \phi = 0.267$ ). PDs were more likely than nonPDs to have an engine greater than 1.6 litre capacity (PDs: 50%; nonPDs: 36%). In particular, proportionally more PDs have engines of 1.7–1.8 litres and fewer have engines of less than 1 litre ( $\chi^2(6) = 20.2, p < 0.01, \phi = 0.227$ ). A similar, but stronger, difference between PD and nonPD drivers was also found in the two youngest groups of drivers (for engines greater than 1.6 litres, PDs: 37%; nonPDs: 18%). The differences between expected and observed values were again for the under 1 litre category. However, it was the greater than 2 litre engine size which also produced significant differences, with the PDs over-represented and the nonPDs under-represented ( $\chi^2(6) = 17.68, p < 0.01, \phi = 0.285$ ). Despite these differences, we should note nevertheless that over all age groups 44% of drivers drove most often with an engine size greater than 1.6 litres.

Figure 2: Engine size greater than 1.6 litres



## YEARS DRIVING

The average number of years driving did not differ between PDs and nonPDs;  $t(365) = 1.78, p = 0.075$  (PDs: 4.08 (2.94), nonPDs: 4.63 (2.93)).

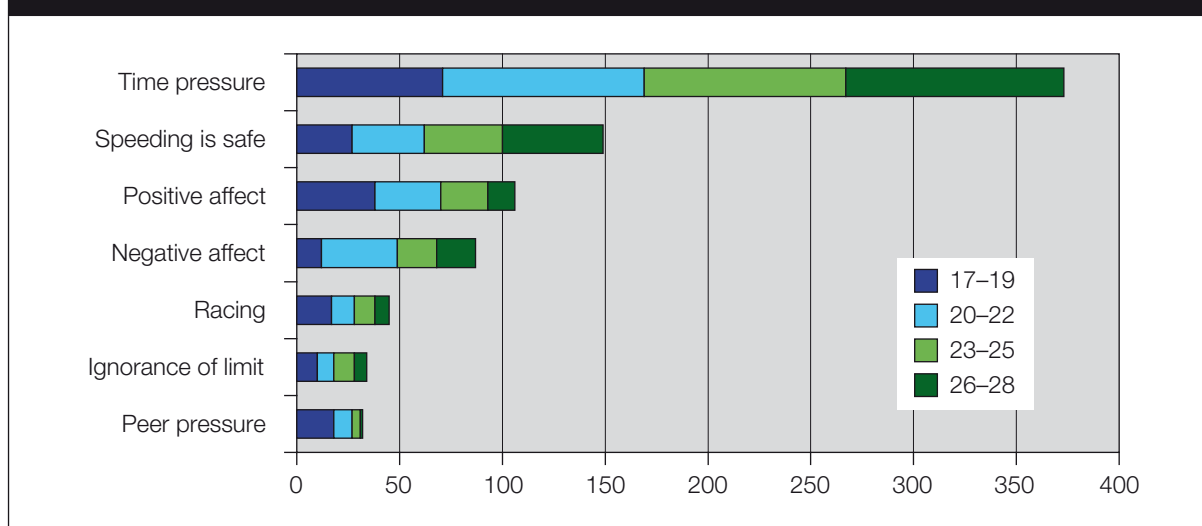
## Reasons for speeding

Reasons for speeding were elicited through an open-ended question, which, in total, yielded 37 different responses. These were reduced to 16 main categories and the incidence of the seven most cited (with frequencies greater than 30), accounting for 89% of all responses, is presented in Figure 3. In order of decreasing frequency, these categories of reasons for speeding may be broadly described as:

- time pressure (including trying to beat the traffic and emergency);
- belief that it was safe (speed limit too low, no-one endangered by my speeding, road conditions good);
- positive affect (i.e. positive feeling, adrenaline rush and enjoyable social activity);
- negative affect (boredom, impatience/frustration, negative mood, road rage, aversion to slow or slowing drivers);
- racing (including testing the car's performance and imitating racing drivers);
- ignorance of the speed limit; and
- impact of peer group (peer pressure, showing off, impressing others).

It should be noted that the frequencies have been weighted as if all four age groups were equivalent to the average sample size for all four age categories of 207.

**Figure 3: Frequency with which each response was given by age category**



The frequency with which each reason for speeding was produced by the four different age categories was statistically analysed using chi-square goodness of fit tests – significant and almost significant results are presented in Table 4.



**Table 4: Frequency with which reason for speeding was given across age category**

	17–19	20–22	23–25	26–28	$\chi^2$	<i>p</i>
For positive affect	38	32	23	13	13.47	0.004
Due to negative affect	12	37	19	19	15.59	0.001
Impact of peer pressure	18	9	4	1	20.75	0.001
Time pressure	71	98	98	106	7.54	0.057
Believed it was safe	27	35	38	49	6.73	0.08

Speeding due to time pressure and because the driver believed it was safe become more prevalent as reasons for speeding with age, a pattern which approaches statistical significance. However, positive affect, racing and peer pressure become less prevalent. Except for racing, this age trend is statistically significant. Thus younger drivers are much more likely to provide reasons for their speeding that include ‘to get an adrenaline rush’, peer pressure and a desire to show off and impress others. The 20–22 year group of drivers is most likely to cite negative affect reasons for speeding.

Table 5 presents reasons for speeding by PD status. Time pressure is the most frequent reason given by both PD and nonPD groups. PDs are more likely to identify positive and negative affect, racing and peer pressure. NonPDs are more likely to identify ignorance of the speed limit. These five reasons produced statistically significant differences between groups. The same pattern was also found for the two youngest age groups (see Table 5).

**Table 5: Reasons for speeding by PD status**

	All age groups				Two youngest groups			
	PDs	NonPDs	$\chi^2$	<i>p</i>	PDs	NonPDs	$\chi^2$	<i>p</i>
Time pressure	87	79	0.386	0.54	49	37	1.67	0.20
Considered safe	33	28	0.41	0.52	16	12	0.57	0.45
Positive affect	52	3	43.65	<0.001	30	3	22.1	<0.001
Negative affect	27	10	7.81	0.005	19	3	11.64	0.001
Racing	17	1	14.22	<0.001	11	1	8.33	0.004
Ignorance of limit	1	22	19.17	<0.001	1	14	11.27	0.001
Peer pressure	10	2	5.33	0.021	8	1	5.44	0.02

## Accident history

Twenty-seven per cent of the sample reported that they had been involved in a car accident as a driver in the previous three years. Twenty-three per cent reported a damage-only accident. Of the 195 drivers in this sub-sample, 133 reported one accident, 39 reported two and 23 reported three or more accidents as drivers. Ninety-nine drivers had been involved in an injury accident involving slight injury (not requiring an overnight stay in hospital). Of these, 83% reported one accident, 11% two and 5% three or more. Serious (requiring an overnight stay in hospital) or fatal injury accidents were reported by 32 drivers. Of these, 30 had had one accident and

two had had two accidents. One hundred and nineteen drivers said they were not to blame for their accidents. On the other hand, 114 admitted that they were partially or mainly to blame. Note, since several drivers reported being involved in more than one accident, a driver could legitimately report being to blame and not to blame for these different accidents.

## ACCIDENT INVOLVEMENT AND AGE OF DRIVER

Accident data for each age group are presented in Table 6. Comparison of the number in each age group involved in accidents is difficult because the period over which the question was asked was three years and the average length of driving experience for the youngest age group was under two years. Nevertheless there is little difference between the other three age groups in accident numbers and the similarity in the distribution of accident types across all groups is remarkable.

**Table 6: Accident involvement by age group**

	17–19	20–22	23–25	26–28
Number in group	184	236	232	177
Number (weighted*) accident involved in last 3 years	32	54	62	60
Weighted total number of accidents	64	107	136	113
% accidents involving damage, but no injuries	63	68	63	64
% accidents involving slight injury	28	25	28	28
% accidents involving serious injury/death	9	7	9	8
% accidents – no blame	50	47	55	49
% accidents – partially or mainly to blame	50	53	45	51

\* Weighted as if each sample was equivalent in size to the average sample.

## ACCIDENT INVOLVEMENT BY PD STATUS

The relationship between PD status and accident involvement for the entire sample is presented in Table 7.

**Table 7: Accident involvement by PD status – whole sample**

	nonPD	PD
Number in group	176	218
Number (weighted) accident involved in last 3 years	46	51
Weighted total number of accidents	76	110
% accidents involving damage, but no injuries	67	64
% accidents involving slight injury	28	29
% accidents involving serious injury/death	5	7
% accidents – no blame	54	44
% accidents – partially or mainly to blame	46	56

Overall it may be seen that there is little difference between PDs and nonPDs in rates of self-reported accident involvement or in the profiles of types of accident and, indeed, analysis confirmed that the only statistical reliable difference was in the total (weighted) number of accidents reported ( $\chi^2 = 6.21, p = 0.013$ ); importantly, PDs reported more accidents.

Analysing the two youngest groups separately (Table 8), it can be seen that PDs were slightly more likely to have an accident and to have significantly more accidents in total ( $\chi^2 = 7.04, p = 0.008$ ). Their accidents were also significantly more likely to involve slight injury ( $\chi^2 = 4.48, p = 0.031$ ) and they were also significantly more likely to report being partially or mainly to blame ( $\chi^2 = 5.83, p = 0.016$ ).

**Table 8: Accident involvement by PD status – 17–19 and 20–22 year groups**

	nonPD	PD
Number in group	86	135
Number (weighted) accident involved in last 3 years	20	26
Weighted total number of accidents	35	61
% accidents involving damage, but no injuries	74	62
% accidents involving slight injury	23	31
% accidents involving serious injury/death	3	7
% accidents – no blame	64	40
% accidents – partially or mainly to blame	36	60

## Representations of the consequences of a serious collision

Representations of the consequences of a serious collision were determined by eliciting responses to a crash scenario that was presented as follows:

‘I am now going to describe to you a crash and when I finish I would like you to tell me what you think the consequences might be.

**“John, a young man of 20, loved driving fast and showing his mates how he could push his car to the limit. One rainy day, with two of his mates with him in the car, he took a corner too fast, lost control and slammed into a tree at 120 km/h (about 75 mph).”**

What do you think might be the consequences of this crash?’

Respondents were encouraged to list as many consequences as occurred to them. In the subsequent analysis, careful attention was paid to the order in which particular responses were given. In all, seven main categories of consequence were identified, namely, in order of frequency:

- death;
- serious injury;

- damage to car/property;
- injury;
- impact on family/friends;
- legal consequences; and
- costs.

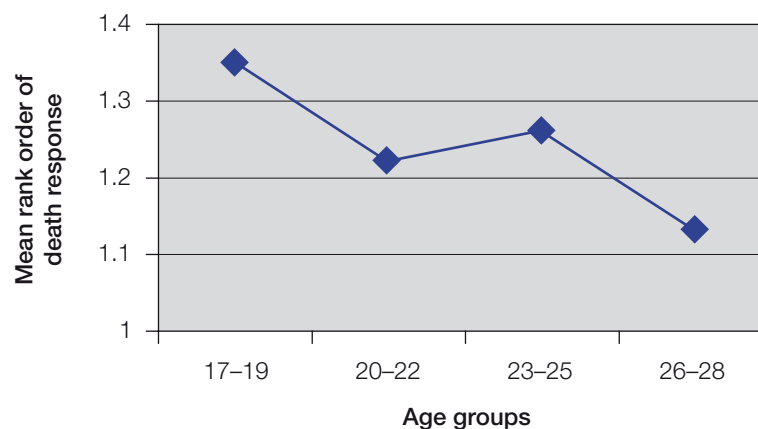
No differences between age groups were found in the frequency of reporting any particular category (see Table 9). However, death was significantly less likely to be mentioned **early** as a consequence by the youngest group of drivers (Kruskal-Wallis test:  $\chi^2 = 11.77$ ,  $p = 0.008$ ) (see Figure 4), despite being mentioned with similar frequency by all four age groups. There were no other differences between age groups in the mean rank order in which particular categories of consequence were mentioned.

**Table 9: Frequency with which different consequence categories were mentioned by age group**

	Total number of consequences (weighted)				$\chi^2$	$p$
	17–19	20–22	23–25	26–28		
Death	149	155	155	157	0.23	0.97
Serious injury	56	57	59	63	0.49	0.92
Damage to car/property	42	34	41	25	5.12	0.16
Injury	29	16	24	18	4.77	0.19
Impact on family/friends	15	20	22	27	3.52	0.32
Legal consequences – less serious*	16	14	23	15	2.94	0.40
Costs	5	10	13	9	3.67	0.30
Legal consequences – serious*	8	5	12	6	3.63	0.30

\* For the purposes of this statistical analysis, serious legal consequences are defined as jail, less serious consequences are defined as all legal consequences other than jail.

**Figure 4: Mean rank order of mentioning death as a consequence of the crash scenario by age group**



Examining these results by PD status, it was found that PDs were much more likely than nonPDs to mention injury as a consequence (see Table 10). This same pattern was also found when looking at the reported consequences of PDs and nonPDs in the two youngest groups. However, there were no other reliable differences in frequencies with which particular consequences were identified and similarly there were no differences between PD groups in the mean rank ordinal position with which particular consequences were brought to mind.

**Table 10: Reported consequences of a crash scenario by PD status**

	Total number of consequences (weighted)			
	nonPD	PD	$\chi^2$	<i>p</i>
Death	153	138	0.77	0.38
Serious injury	59	59	0	1
Damage to car/property	28	42	2.8	0.09
Injury	12	34	10.52	0.0012
Impact on family/friends	24	16	1.6	0.21
Legal consequences – less serious	16	14	0.13	0.72
Costs	7	13	1.8	0.18
Legal consequences – serious	8	5	0.69	0.40

## Relationship between self-reported behaviour and perceived norms of own age group

The relationship between the driver's own behaviour and that of his peer group was analysed by calculating the correlations between measures of self-reported behaviours and perceived norms of their own age group on a number of different behaviours. Participants were most likely to assume that other drivers in their peer group were exposed to similar driving conditions. Correlations between self and perceived peer group driving in a built-up area (where this is a 30 mph/50 km/h limit) or driving on a main road between towns (where there is a 60 mph/100 km/h limit) were respectively 0.54 and 0.62.

### SPEEDING

For each age group, correlations between self-reported speeding and perceived norms are presented in Table 11. The mean correlation within the 50 km/h speed limit increases as the violation increases; 0.42 for travelling at 60 km/h while it was 0.50 for 80 km/h. For the 100 km/h limit, the correlations decreased as the violation became more extreme. The high mean speeding correlations across each group (all > 0.41) indicate a potential influence of perceived norms on the speeding behaviour of the individual.

**Table 11: Correlations between self-reported speeding and perceived norms of own age group**

Behaviour	Correlation*				Mean
	G1 <sup>†</sup>	G2	G3	G4	
Driven in a built-up area (where there is a 30 mph (50 km/h) limit)	0.509	0.372	0.552	0.725	<b>0.54</b>
Driven at 35 mph (60 km/h) in a 30 mph (50 km/h) limit	0.400	0.360	0.378	0.550	<b>0.42</b>
Driven at 40 mph (70 km/h) in a 30 mph (50 km/h) limit	0.280	0.451	0.530	0.580	<b>0.46</b>
Driven at 50 mph (80 km/h) or more in a 30 mph (50 km/h) limit	0.443	0.468	0.528	0.575	<b>0.50</b>
Driven on a main road between towns (where there is a 60 mph (100 km/h) limit)	0.607	0.520	0.651	0.719	<b>0.62</b>
Driven at 70 mph (115 km/h) on a main road between towns	0.513	0.400	0.590	0.425	<b>0.48</b>
Driven at 80 mph (130 km/h) or more on a main road between towns	0.432	0.366	0.469	0.410	<b>0.41</b>
<b>Mean speeding correlations</b>	<b>0.41</b>	<b>0.41</b>	<b>0.51</b>	<b>0.41</b>	

\* All correlations significant at the 0.001 level, two-tailed.  
<sup>†</sup> G1 = 17–19, G2 = 20–22, G3 = 23–25, G4 = 26–28.

## DANGEROUS DRIVING

As with speeding behaviour, the high correlations, although slightly lower ( $> 0.35$ ), again represent the potential influence of peer norms (see Table 12). Self-reported close-following behaviour and racing behaviour are closer to perceived norms than are dangerous overtaking and driving when possibly over the legal blood alcohol concentration (BAC) limit.

**Table 12: Correlations between self-reported dangerous driving and perceived norms of own age group**

Behaviour	Correlation*				Mean
	G1 <sup>†</sup>	G2	G3	G4	
Overtaken dangerously (i.e. made it just in time, caused an oncoming vehicle to slow down or the overtaken vehicle to brake)	0.265	0.284	0.360	0.359	<b>0.32</b>
Followed another vehicle very closely to make them speed up	0.497	0.358	0.448	0.338	<b>0.41</b>
Driven when you may have been over the legal BAC limit	0.328	0.334	0.323	0.277	<b>0.32</b>
Raced another vehicle	0.385	0.404	0.468	0.523	<b>0.39</b>
<b>Mean correlations</b>	<b>0.37</b>	<b>0.35</b>	<b>0.40</b>	<b>0.37</b>	

\* All correlations significant at the 0.001 level, two-tailed.  
<sup>†</sup> G1 = 17–19, G2 = 20–22, G3 = 23–25, G4 = 26–28.

## EFFECTS OF PD STATUS

To examine the relationship between normative influence and the PD variable, correlations with perceived norms were calculated separately for the nonPD and PD groups. Both for speeding and for dangerous behaviours, the correlations were higher for the PDs, consistent with a stronger normative influence in this group. Correlations for the nonPDs were not just lower than for the PDs, but for two dangerous driving behaviours (dangerous overtaking and close following, see Table 13) they were very weak and statistically non-significant. Furthermore, the average correlations across all dangerous behaviours for the nonPDs was very weak ( $< 0.01$ ), while for the PDs it remains relatively strong at 0.49. This suggests that the dangerous driving of nonPDs is much less influenced by perceived peer norms than that of PDs.

**Table 13: Correlations between self-reported dangerous driving and perceived norms for nonPDs and PDs**

Behaviour	Correlation*	
	nonPDs	PDs
Overtaken dangerously (i.e. made it just in time, caused an oncoming vehicle to slow down or the overtaken vehicle to brake)	-0.020 <sup>†</sup>	0.364
Followed another vehicle very closely to make them speed up	-0.005 <sup>†</sup>	0.569
Driven when you may have been over the legal BAC limit	0.199 <sup>‡</sup>	0.487
Raced another vehicle	0.168 <sup>‡</sup>	0.552
Average correlations	0.098	0.493
* All significant at the 0.01 level unless indicated.		
† Non-significant.		
‡ Significant at the 0.05 level.		

## Expected changes in driver behaviour over next five years

Participants were asked if they expected their driving behaviour to change in any way over the next five years and, if so, in which ways. Answers to this question were sorted into the four main categories of more skilful, more responsible, slower and safer. Comparing the four age groups on these responses, it may be seen in Table 14 that the youngest groups were significantly more likely to indicate they would improve on all four categories.



**Table 14: Expected changes in driver behaviour over the next five years for each age group**

	Total n (weighted)				$\chi^2$	<i>p</i>
	17–19	20–22	23–25	26–28		
More skilful*	43	24	18	9	25.92	< 0.001
More responsible	20	29	17	6	15.0	0.002
Slower	24	18	19	8	7.98	0.047
Safer	20	18	10	4	12.62	0.006

\* Skilful here includes elements such as 'more experience' and 'increased awareness'.

PDs were significantly more likely to state that they would become more responsible (Table 15). However, for the two youngest groups of drivers, PDs were more likely to say they would slow down ( $p = 0.059$ ) and become safer ( $p = 0.089$ ), although the statistical reliability of these differences is relatively weak (see Table 16).

**Table 15: Expected changes in driver behaviour over the next five years for PDs and nonPDs**

	nonPDs	PDs	$\chi^2$	<i>p</i>
More skilful	26	20	0.78	0.38
More responsible	6	20	7.54	0.006
Slower	11	19	2.13	0.14
Safer	10	15	1	0.32

**Table 16: Expected changes in driver behaviour over the next five years for PDs and nonPDs in the two younger age groups**

	nonPDs	PDs	$\chi^2$	<i>p</i>
More skilful	22	14	1.78	0.18
More responsible	5	11	2.25	0.14
Slower	5	13	3.56	0.059
Safer	5	12	2.88	0.089

## Discussion

This study set out to investigate conditions for high-risk behaviour in young male drivers and, in particular, to compare drivers in four age groups in the range 17 to 28 years and PDs and nonPDs on four key questions. These questions related to awareness of the consequences of high-risk behaviour, overestimation of norms for speeding violations and dangerous behaviour of peers, and expected changes in behaviour over the following five years.

PDs were defined as those who reported that they had engaged in excessive speeding (exceeding 50 km/h and 100 km/h limits by 30 km/h) and dangerous driving

manoeuvres at least once or twice a week in the previous three months. On these criteria, PDs were the most prevalent among the youngest drivers, with 46% falling into this category. Their numbers declined with age. Nevertheless, one in five in the 26–28 age group were also PDs. The sample obtained had roughly equal numbers of drivers in each of the four age groups: 17–19, 20–22, 23–25 and 26–28 years. There was no difference in the number of years driving between PDs and nonPDs. Older drivers tended to drive more powerful cars, as were PDs, especially in the two younger age groups.

The most prevalent reason given for speeding was time pressure, accounting for about 38% of all responses, followed by ‘thinking that speeding was safe’ (18%), positive affect (13%) and negative affect (11%). Speeding for reasons of positive affect and peer pressure were more prevalent among the younger drivers. PDs, in general, and in the two younger groups, were more likely to give as their reasons both positive and negative affect, as well as racing and peer pressure. They were also less likely to specify ‘ignorance of the speed limit’. PDs reported more accidents in the previous three years, especially in the two youngest groups. These latter groups were more likely to have had slight injury accidents and to be partially or mainly to blame.

With regard to how drivers represent the consequences of a serious collision, death was the most prevalent response in all age groups and contributed 47% of all responses. Interestingly, death was significantly less likely to be mentioned **early** in their listing of consequences by the youngest group of drivers. However, apart from this there were no other reliable age-related trends. It is perhaps also noteworthy that, although ‘impact on family or friends’ was mentioned (6% of responses), no participant made reference to consequences such as permanent disability and its potential effects on employment opportunities and social life.

Do drivers think that their peers violate speed limits and drive more dangerously than they do themselves? Overall, significant correlations were found between their own and perceived peer-group speeding and dangerous driving, consistent with the idea that perceived norms may influence behaviour, although perceived norms for dangerous overtaking and ‘driving when possibly over the limit’ may have less of an influence. Overall correlations were higher for PDs than for nonPDs, suggesting that there may be a stronger normative influence in the PD group. Indeed, nonPDs showed only weak or zero correlations between their behaviour and that perceived of their peers on six out of nine behaviours, suggesting relatively little normative influence. What may be important about the PD results is not only do they engage in speeding and problem-driving behaviour the more they think their peer group does, but they also see themselves as engaging in these behaviours more frequently. This characteristic may make them particularly resistant to change.

## Conclusions

The prevalence of PDs in the youngest groups indicates that they have more room for improvement in motivation for compliance and safety. This has implications for interventions focused on attitude change and which restrict opportunities for

speeding, such as Intelligent Speed Adaptation. This may be particularly important given that PDs in the younger groups tended to drive more powerful cars.

Younger drivers were more likely to speed for reasons of positive affect and as a result of peer pressure. It is also noteworthy that they report death as a consequence in a severe crash with a lower priority than older drivers who, in turn, were more likely to explain such crashes in terms of ignorance of consequences, as well as of excessive speed. It is thus tempting to characterise the youngest drivers as immature, but not able to see this, as being pulled into speeding for the thrill of it and pushed into speeding and dangerous driving by peer pressure and a feeling that others are doing it. Along with all of this they are not so keenly aware of the potentially terminal consequences of their high-risk behaviour. Nevertheless, it is perhaps heartening from a perspective of improved safety that the two youngest groups of drivers were most likely to state an intention to improve over the following five years, in terms of becoming more skilful and responsible, slower and safer.

Compared with nonPDs, PDs are more likely to be younger drivers and to have had accidents in the previous three years. Especially in the two younger groups, they report more slight injury accidents and that they are more likely to be at blame for their accidents. They drive more powerful cars and are more likely to give as reasons for their speeding positive and negative affect, racing and peer pressure. Indeed, they do show stronger correlations between their own speeding and dangerous driving and what they perceive their peers to do, and they think that they actually engage in these behaviours **more** than their peers. Nevertheless, there is some hope in that they are more likely to say they would become more responsible over the next five years and, in the two younger groups, that they would become safer and slow down.

## References

- Åberg L., Larsen, L., Glad, A. and Beilinson, L. (1997) Observed vehicle speed and drivers' perceived speed of others. *Applied Psychology: An International Review*, 46, 287–302.
- Falk, B. and Montgomery, H. (2007) Developing traffic safety interventions from conceptions of risks and accidents. *Transportation Research Part F*, 10, 414–427.
- Gerrard, M., Gibbons, F. X., Benthin, A. C. and Hessling, R. M. (1996) A longitudinal study of the reciprocal nature of risk behaviors and cognitions in adolescents: what you do shapes what you think, and vice versa. *Health Psychology*, 15, 344–354.
- Haglund, M. and Åberg, L. (2000) Speed choice in relation to speed limit and influences from other drivers. *Transportation Research Part F*, 3, 39–51.
- Kimura, I. (1993) The relationship between drivers' attitude toward speeding and their speeding behavior in hypothetical situations. *Hiroshima Forum for Psychology*, 15, 51–60.

Leung, K. S., and McCusker, C. G. (1999) Accessibility and availability of smoking-related associations in smokers. *Addiction Research*, 7(3), 213–226.

McCusker, C. G. (2001) Cognitive biases and addiction: an evolution in theory and method. *Addiction*, 96(1), 47–56.

Ross, L., Green, D. and House, P. (1977). The ‘false consensus effect’: an egocentric bias in social perception and attribution process. *Journal of Experimental Social Psychology*, 13, 279–301.

Walton, D. and Bathurst, J. (1998) An exploration of the perceptions of the average driver’s speed compared to perceived driver safety and driving skill. *Accident Analysis and Prevention*, 30, 821–830.

# 10

## EU research projects IMMORTAL and DRUID: epidemiology of drink and drug driving

René Mathijssen and Sjoerd Houwing  
SWOV Institute for Road Safety Research  
Leidschendam  
The Netherlands

### Abstract

This paper presents the design and results of epidemiological studies into the risk of drink and drug driving, conducted in the framework of EU research projects IMMORTAL (Impaired Motorists, Methods of Roadside Testing and Assessment for Licensing) and DRUID (Driving under the Influence of Drugs, Alcohol and Medicines). The aim of both EU projects is more or less the same: to provide evidence to propose intervention methods for driver impairment, and support the future development of European policy governing driver impairment legislation.

In the framework of IMMORTAL, a prospective case-control study was conducted in the Dutch police district of Tilburg, where the prevalence of psychoactive substances among injured drivers (cases) was compared with the prevalence in the general driving population (controls). Eight drug groups were included in the study: alcohol, benzodiazepines, tricyclic antidepressants, methadone, opiates, (meth)amphetamines (including ecstasy), cannabis and cocaine. Among the general driving population, cannabis (4.5%), benzodiazepines (2.1%) and alcohol ( $2.1\% \geq 0.2$  g/L BAC) turned out to be the prevailing substances. Drugs of abuse were strongly concentrated in male drivers aged 18–24. No less than 17.5% of these drivers were positive for illegal drugs. Psychoactive prescription drugs were strongly concentrated in female drivers aged 50 and older: 11.3% were positive. Comparison of the road and hospital samples showed that extremely high risk rates (odds ratios higher than 100) were associated with drug-free blood alcohol concentration (BAC) levels above 1.3 g/L and with alcohol/drug combinations at BAC levels above 0.8 g/L.

The ongoing research project DRUID is much more ambitious than the IMMORTAL project was. Case-control studies will be conducted in no less than seven EU countries. Partners that will conduct the various national case-control studies have reached an agreement on the general design of these studies. In addition to the case-control studies, prevalence studies will be conducted in even more EU countries, namely 13. However, for practical reasons, the prevalence studies will not be discussed in this paper.

## Introduction

Between 2000 and 2004, SWOV (the Dutch national road safety research institute (Stichting Wetenschappelijk Onderzoek Verkeersveiligheid)) conducted a case-control study in the Tilburg police district, in the south of the Netherlands. The study was conducted in the framework of the EU research project IMMORTAL (Impaired Motorists, Methods of Roadside Testing and Assessment for Licensing). The objective of the study was to examine the relative injury risk of car drivers associated with the use of eight defined groups of psychoactive substances, taken alone or in combination with each other. The eight drug groups included in the study were:

- alcohol;
- benzodiazepines;
- tricyclic antidepressants;
- methadone;
- opiates;
- amphetamines;
- cannabis; and
- cocaine.

The opiates group was subdivided into morphine, heroin and codeine. The amphetamines group was subdivided into amphetamine, methamphetamine and ecstasy (MDMA, MDEA and MDA). Alcohol use was subdivided into five blood alcohol concentration (BAC) classes: < 0.2 g/L, 0.2–0.5 g/L, 0.5–0.8 g/L, 0.8–1.3 g/L and  $\geq$  1.3 g/L.

In October 2006, a new and more ambitious EU research project started, with the aim of, among other things, assessing the risk of drink and drug driving by conducting multi-centre case-control studies in seven countries. This project is called DRUID – Driving under the Influence of Drugs, Alcohol and Medicines. Designs of the IMMORTAL and DRUID epidemiological studies will be discussed, as well as results of the former study.

The DRUID study is granted by the European Commission (DG-TREN), as was the IMMORTAL study.

## The IMMORTAL case-control study in the Netherlands

The IMMORTAL case-control study in the Tilburg police district was conducted between May 2000 and March 2004 (Mathijssen and Houwing, 2005).

**Cases** were seriously injured drivers who were admitted to the Emergency Department of the Tilburg St Elisabeth Hospital. Blood and/or urine samples were taken on admission. Hospital and ambulance records were examined to control for drugs administered by (para)medics before blood or urine sampling. All patients, or their legal representatives, were asked for their informed consent to be included in the study. The hospital's Medical Ethics Committee approved the study protocol.

**Controls** were selected at random from moving traffic during 61 roadside survey sessions in the Tilburg police district, which covers the hospital's catchment area. It consists of the city of Tilburg and three smaller municipalities, covering an area of 322 km<sup>2</sup> and a total population of approximately 260,000.

The **relative injury risk** of the psychoactive substances involved in the study was determined by comparing the prevalence of these substances among cases and controls. Odds ratios were computed using the statistical package SAS. Subjects who had used one particular substance or a combination of different substances were related to subjects who had used none of the substances included in the study; 95% confidence intervals were used for significance.

## Design and results of the roadside survey (control sample)

The 61 roadside sessions were equally divided over the six different police precincts that comprise the Tilburg police district. About 50 different research sites were selected, most of them along main urban and rural roads. These road types accounted for 88% of serious road injuries in the Netherlands during the period 2000–03.

In order to be able to construct a representative control sample, the week was systematically divided into 28 consecutive six-hour periods. For the sake of statistical analysis, these were next aggregated into eight day/time categories, which were supposed to be more or less homogeneous with respect to traffic volume and substance use. The eight categories were:

1. The five weekday mornings (Monday to Friday), from 4 am till 10 am.
2. The five weekday 'afternoons' (Monday to Friday), from 10 am till 4 pm.



3. The four weekday 'evenings' (Monday to Thursday), from 4 pm till 10 pm.
4. The four weekday nights (Monday to Thursday), from 10 pm till 4 am.
5. The two weekend mornings (Saturday and Sunday), from 4 am till 10 am.
6. The two weekend 'afternoons' (Saturday and Sunday), from 10 am till 4 pm.
7. The three weekend 'evenings' (Friday to Sunday), from 4 pm till 10 pm.
8. The three weekend nights (Friday to Sunday), from 10 pm till 4 am.

Each of the 61 survey sessions covered one six-hour period. During each session, four different research sites were visited, thus strongly diminishing the predictability of the test sites for (impaired) drivers.

## **DRIVER SELECTION, DATA AND SPECIMEN COLLECTION AT THE ROADSIDE**

Drivers were stopped by the police at the request of the acting research coordinator, as soon as an interviewer/nurse was ready for interviewing and body fluid collection. Stopped drivers were asked to cooperate with the research team on a voluntary basis. Drivers who agreed to cooperate were interviewed on their drug and medicine use and time of administration. Subsequently, they were requested to deliver a urine specimen. If they were not able or willing to do so, they were asked to provide a blood sample. A trained research nurse performed the venipuncture.

After the interview and the body fluid sampling, all subjects were breath-tested for alcohol by a police officer. The breath test was compulsory for all stopped drivers. Breath test results were anonymously reported to the research team. Apart from self-reported drug use and time of administration, data collection also comprised date and time of selection, gender and age of the subject, and signs of impairment.

## **RESULTS OF THE ROADSIDE SURVEY**

A total number of 3,851 drivers from the general driving population were stopped and asked to cooperate. Only 52 (1.4%) of them declined their cooperation with the researchers. All of the 3,799 consenting drivers were interviewed and breath tested by the police, but 425 (11.2%) were not willing or able to provide a urine or blood specimen. For these drivers, selectivity was examined with regard to gender, age, BAC and self-reported drug use.

Table 1 shows the missing specimen rates by gender and age. Among male drivers, this rate was slightly lower than among female drivers. Differences by age were much larger: the younger the driver, the higher the missing specimen rate. Among female drivers aged 18–24, this rate was 2.4 times higher than among male drivers of 50 years and older.

Table 1: Missing specimen rates, by gender and age

Gender	Age				Total (%)
	18–24 (%)	25–34 (%)	35–49 (%)	50+ (%)	
<b>Male</b> ( <i>n</i> = 2,682)	15.1	13.2	10.1	6.5	10.8
<b>Female</b> ( <i>n</i> = 1,117)	15.5	15.4	10.7	7.2	12.1
<b>Total</b> ( <i>n</i> = 3,799)	15.2	13.9	10.3	6.7	11.2

Table 2 shows the differences in psychoactive substance use between drivers who did and did not provide a urine or blood specimen. For drivers who did provide a specimen, drug and medicine use was based on toxicological analysis. For drivers who did not, it was based on self-reporting. Only drivers who reported drug and medicine use less than once a week before the interview were considered to be positive. All drivers were breath tested for alcohol.

Table 2: Psychoactive substance use, by specimen delivery

Specimen delivered	Psychoactive substance distribution					
	Negative (%)	Illegal drugs (%)	Medicinal drugs (%)	BAC 0.2–0.5 g/L (%)	BAC $\geq$ 0.5 g/L (%)	BAC $\geq$ 0.2 g/L + drug (%)
Yes*	86.2	6.2	2.5	2.4	2.0	0.7
No†	85.2	7.1	1.2	1.6	3.1	1.9

\* Substance distribution based on toxicology.  
† substance distribution based on self-reporting

The figures in Table 2 indicate that drivers with missing specimens had higher rates of illegal drug use, illegal BAC levels, and combined alcohol and drug use. The actual differences regarding illegal drug use were probably even somewhat larger than the figures in the table indicate. Out of the 3,374 drivers who delivered a specimen, 6.1% reported they had used illegal drugs, but according to the results of toxicological analysis, 6.9% of the specimens were positive.

Based on the above analyses, it was concluded that missing specimens biased the sample of drivers who provided a urine or blood specimen. In order to minimise this bias, it was decided to consider the drivers with missing specimens as valid controls, using their self-reported drug use as an estimate of their actual drug use.

### Weighing of the control sample

The sample distribution over different times and days was not equal to the distribution of traffic volume. The reason for this was the more or less constant sampling capacity of the research team, regardless of traffic flow, which varied

strongly by day of the week (weekdays versus weekend) and by time of the day. Furthermore, the police had a quite understandable preference for enforcement activities during high-risk hours, i.e. the night-time hours with low traffic volumes. So, in order to make the control sample representative of the whole week, it had to be weighted. The weighing procedure was based on 1999–2000 trip data, collected by the Dutch Central Bureau of Statistics (CBS).

Table 3 shows a comparison of the control sample and CBS trip distributions. The comparison demonstrates that weekend nights (category 8) and, to a lesser degree, weekday nights (category 4) were strongly over-represented in the control sample. Drink-driving is strongly concentrated in the night-time hours. As a consequence, drink-driving was over-represented in the unweighted control sample. Weighting of the control sample solved this problem. Weight factors for each of the eight day/time categories were computed by dividing traffic volume (trip) fractions by control sample fractions.

Table 3: Comparison of control sample and CBS trip distributions		
Day/time category	Distribution control sample (%)	CBS trip distribution (%)
1	4.1	15.0
2	12.8	25.7
3	15.4	19.3
4	8.5	3.2
5	6.9	4.8
6	9.2	12.8
7	17.9	16.6
8	25.2	2.6
Total	100	100

### Substance use by gender and age

Table 4 shows the prevalence of psychoactive substances among the general driving population of the Tilburg police district, by gender.

Among all drivers, 9.9% were positive for one or more of the psychoactive substances included in the study. There was, however, a significant difference between male and female drivers: 11.2% of males were positive compared with 6.9% of females. When considering only illegal drugs and illegal BAC levels, the difference between males and females was even larger: 7.7% of males were positive compared with 2.9% of females. Furthermore, male drivers had a 70% share in the traffic flow.

Table 5 displays the distribution of psychoactive substances by gender and age, allowing a more detailed insight into the correlation between demographic factors and the use of psychoactive substances.

Table 4: Substance distribution among the general driving population, by gender

Substance	Distribution by gender		
	Male drivers (%)	Female drivers (%)	All drivers (%)
None	88.8	93.1	90.1
Cannabis alone	4.8	1.5	3.9
Amphetamine alone	< 0.01	–	< 0.01
Ecstasy alone	0.4	0.2	0.3
Cocaine alone	0.4	0.09	0.3
Morphine/heroin alone	0.03	–	0.02
Codeine alone	0.5	0.6	0.5
Benzodiazepines alone	1.6	2.8	2.0
Tricyclic antidepressants alone	0.2	0.5	0.3
Methadone alone	–	–	–
Combination of drugs	0.6	0.3	0.5
Alcohol 0.2–0.5 g/L BAC	1.3	0.1	0.9
Alcohol 0.5–0.8 g/L BAC	0.4	0.4	0.4
Alcohol 0.8–1.3 g/L BAC	0.2	0.2	0.2
Alcohol $\geq$ 1.3 g/L BAC	0.3	0.1	0.2
Alcohol 0.2–0.5 g/L BAC + drugs	0.1	0.01	0.09
Alcohol 0.5–0.8 g/L BAC + drugs	0.2	0.01	0.2
<i>Alcohol &lt; 0.8 g/L BAC + drugs</i>	0.3	0.02	0.2
Alcohol 0.8–1.3 g/L BAC + drugs	0.06	–	0.04
Alcohol $\geq$ 1.3 g/L BAC + drugs	0.05	–	0.03
<i>Alcohol <math>\geq</math> 0.8 g/L BAC + drugs</i>	0.1	–	0.08
Total ( <i>n</i> = 3,799)	100	100	100

Table 5: Substance distribution by gender and age

Gender and age	Substance distribution							
	None (%)	Single illegal drug (%)	Single medic. drug (%)	Drug combination (%)	BAC 0.2–0.5 g/L (%)	BAC $\geq$ 0.5 g/L (%)	BAC 0.2–0.8 + drugs (%)	BAC $\geq$ 0.8 + drugs (%)
<b>Male drivers</b>								
18–24	79.5	14.6	1.2	1.4	0.9	0.9	1.0	0.6
25–34	85.5	10.9	0.5	0.8	1.0	0.8	0.4	0.1
35–49	91.6	3.4	2.2	0.5	1.3	0.8	0.2	–
50+	92.1	0.6	4.2	0.05	1.6	1.3	0.2	–
Total	88.8	5.7	2.3	0.6	1.3	1.0	0.3	0.1
<b>Female drivers</b>								
18–24	95.5	2.3	0.3	–	0.6	1.3	–	–
25–34	94.5	3.4	1.1	0.8	0.04	0.07	0.04	–
35–49	95.7	1.7	2.0	0.03	0.08	0.5	0.03	–
50+	86.8	0.04	11.3	0.5	0.04	1.4	–	–
Total	93.1	1.8	3.9	0.3	0.1	0.7	0.02	–

Among male drivers, 6.7% were positive for illegal drugs. By far the highest prevalence of illegal drugs was found among young males aged 18–24. No less than 17.6% of the young male drivers were positive: 14.6% for a single illegal drug, 1.4% for a combination of two or more illegal drugs, and 1.6% for a combination of alcohol and one or more illegal drugs. On top of that, 0.9% had an illegal BAC without having used illegal drugs. Among male drivers above the age of 24, 5.2% were positive for illegal drugs and 1.0% had an illegal BAC without having used illegal drugs. The highest prevalence of psychoactive prescription drugs among male drivers was found in the age group of 50 and older: 4.2%. Among all male drivers, 2.3% were positive.

Among female drivers, the rate of illegal drug use was significantly lower than among male drivers: 2.2% of the females were positive. The prevalence among females aged 18–24 was not significantly higher than among older females: 2.2% and 2.1%, respectively. None of females under the age of 25 were positive for a combination of two or more psychoactive substances, while such a combination was found among 0.4% of older females. On the other hand, 1.3% of the young females had a (drug-free) illegal BAC, versus 0.6% of the age groups above 24.

Psychoactive prescription drug use was significantly higher among females than among males, 3.9% of the females being positive. The use of these medicines was strongly concentrated among females aged 50 and older: 11.3% of them being positive.

### Substance use by day of the week and time of the day

Table 6 shows the prevalence of psychoactive substances among the general driving population by day of the week and time of the day, allowing a more detailed insight into high-prevalence periods.

**Table 6: Substance distribution by day of the week and time of the day**

Day and time of day	Substance distribution							
	None (%)	Single illegal drug (%)	Single medic. drug (%)	Drug combination (%)	BAC 0.2–0.5 g/L (%)	BAC $\geq$ 0.5 g/L (%)	BAC 0.2–0.8 + drugs (%)	BAC $\geq$ 0.8 + drugs (%)
Mon–Sun 04:00–22:00 h	90.8	4.4	2.8	0.4	0.7	0.7	0.2	0.06
Mon–Thu 22:00–04:00 h	77.4	8.4	3.1	0.9	4.3	4.3	0.9	0.3
Fri–Sun 22:00–04:00 h	79.6	6.1	1.4	1.5	4.5	4.5	1.6	0.4
Whole week	90.1	4.5	2.8	0.5	0.9	0.9	0.2	0.08

Illegal drug and alcohol use prevailed during the night-time hours (10 pm to 4 am). The combined use of alcohol and illegal drugs was at a higher level during weekend night-time hours than during weekday night-time hours. The prevalence of prescription drugs, on the other hand, was lower during weekend night-time hours than during the rest of the week. Significantly more drivers were tested positive for illegal drugs (5.4%) than for alcohol (2.1%).

### Concomitant drug use

For drug/drug and alcohol/drug combinations, which were detected in 0.8% of the control drivers, the prevalence of the various separate drugs was determined.

**Table 7: Prevalence of drugs taken alone and in combination with other drugs**

Substance	Prevalence		
	Alone (%)	Combined with other drug(s) (%)	Total (%)
Cannabis	3.9	0.6	4.5
Amphetamine	0.003	0.03	0.03
Ecstasy	0.3	0.3	0.6
Cocaine	0.3	0.4	0.7
Morphine/heroin	0.02	0.04	0.06
Codeine	0.5	0.07	0.6
Benzodiazepines	2.0	0.1	2.1
Tricyclic antidepressants	0.3	0.04	0.3
Methadone	–	0.04	0.04
Alcohol (BAC $\geq$ 0.2 g/L)	1.8	0.3	2.1
Total	9.1	0.8	9.9

Table 7 shows that among the drug/drug and alcohol/drug combinations, cannabis prevailed (70%), followed by cocaine (44%) and ecstasy (36%). On the other hand, only 13% of the cannabis-positive drivers had also used one or more other drugs. Among the cocaine and ecstasy-positive drivers, the corresponding shares of concomitant drug use were 52% and 46%, respectively.

## Design and results of the hospital trial (case sample)

In principle, all drivers who were admitted to the hospital had to be included in the trial. In practice, only 207 injured drivers were included, and they were either blood or urine sampled. This number was about half the expected number of 350–400 cases. The main reasons for the relatively small sample size were the lack of a special trial nurse in the emergency department and the frequent change of the medical teams that manned the department. The in-hospital data collection was beyond the direct control of the SWOV researchers. According to the surgeons in charge, however, the sample of included drivers was not in any way selective.

**Table 8: Substance distribution among injured drivers, by gender**

Substance	Distribution by gender		
	Male drivers (%)	Female drivers (%)	All drivers (%)
None	46.0	75.6	55.4
Cannabis alone	5.0	–	3.4
Amphetamine alone	–	–	–
Ecstasy alone	–	–	–
Cocaine alone	–	–	–
Morphine/heroin alone	0.7	–	0.5
Codeine alone	1.4	–	1.0
Benzodiazepines alone	2.2	6.7	3.6
Tricyclic antidepressants alone	–	–	–
Methadone alone	–	–	–
Combination of drugs	6.5	8.9	7.2
Alcohol 0.2–0.5 g/L BAC	0.7	2.2	1.2
Alcohol 0.5–0.8 g/L BAC	2.2	2.2	2.2
Alcohol 0.8–1.3 g/L BAC	3.6	–	2.5
Alcohol $\geq 1.3$ g/L BAC	16.6	4.4	12.7
Alcohol 0.2–0.5 g/L BAC + drugs	2.2	–	1.5
Alcohol 0.5–0.8 g/L BAC + drugs	0.7	–	0.5
<i>Alcohol &lt; 0.8 g/L BAC + drugs</i>	2.9	–	2.0
Alcohol 0.8–1.3 g/L BAC + drugs	2.2	–	1.5
Alcohol $\geq 1.3$ g/L BAC + drugs	10.1	–	6.9
<i>Alcohol <math>\geq 0.8</math> g/L BAC + drugs</i>	12.2	–	8.3
Total ( <i>n</i> = 184)	100	100	100

Out of the 207 included drivers, 23 drivers could not be evaluated. For two drivers, consent was declined; for another two, personal and crash data were missing; and for 19 drivers, specimens of body fluid were missing or containing insufficient material for toxicological analysis. For the remaining 184 valid cases, 121 blood specimens (66%) and 63 urine specimens (34%) were analysed.

Since comparison with the official Road Accident Statistics showed that male drivers were somewhat over-represented, the case sample was weighted for the distribution by gender.

Table 8 gives a detailed picture of the prevalence of psychoactive substances among seriously injured drivers, by gender. A further subdivision of the prevalence of psychoactive substances among injured drivers, for example by gender and age, was considered as being not very useful because of the small sample size.

Table 8 shows that 54.0% of male drivers and 24.4% of female drivers were positive for one or more of the psychoactive substances included in the study. When considering only illegal drugs and illegal BAC levels, the difference between male and female drivers was even greater: 49.6% of male drivers and 15.6% of female drivers were positive. Among male injured drivers, no less than 26.6% had a BAC  $\geq 1.3$  g/L.



## Relative risk calculations

The relative risk of using one or more of the psychoactive substances involved in the study was determined by comparing the prevalence of these substances among case and control drivers. Odds ratios were computed using the statistical package SAS. Odds ratios approximate relative risk in the case of a rare event, such as a road accident.

Subjects who used one particular substance or a combination of different substances were related to subjects who used none of these substances. An odds ratio of 1.0 was designated to the injury rate of 'negative' drivers (the reference group); 95% confidence intervals were used for statistical significance. In the framework of the IMMORTAL study, only unadjusted odds ratios were calculated. However, unadjusted odds ratios may be biased by differential risk factors associated, for example, with gender, age, light and weather conditions, etc. Therefore adjusted odds ratios were also calculated, albeit after the IMMORTAL project was officially finished. Table 9 shows both unadjusted and adjusted odds ratios. Adjusted odds ratios were computed using a logistic regression model. Covariates included in the analysis were: year (two categories), quarter of the year (four categories), day and time (eight categories), gender (two categories) and age (four categories).

**Table 9: Relative injury risk associated with psychoactive substance use**

Substance	Unadjusted odds ratios	Adjusted odds ratios	95% C.I. (adjusted ORs)
None	1.00	1.00	
Cannabis alone	1.45 (NS)	1.29 (NS)	0.57–2.95
Amphetamine alone	Undefined (< 1)	Undefined (< 1)	–
Ecstasy alone	Undefined (< 1)	Undefined (< 1)	–
Cocaine alone	Undefined (< 1)	Undefined (< 1)	–
Morphine/heroin alone	32.4 (NS)	11.7 (NS)	0.63–219
Codeine alone	3.04 (NS)	6.89	1.23–38.6
Benzodiazepines alone	2.98	3.48	1.29–9.35
Tricyclic antidepressants alone	Undefined (< 1)	Undefined (< 1)	–
Methadone alone	Undefined	Undefined	–
Combination of drugs	24.0	10.2	4.38–10.9
Alcohol 0.2–0.5 g/L BAC	2.12 (NS)	1.03 (NS)	0.23–4.53
Alcohol 0.5–0.8 g/L BAC	8.28	5.35	1.63–17.6
Alcohol 0.8–1.3 g/L BAC	17.6	6.50	2.07–20.5
Alcohol $\geq$ 1.3 g/L BAC	87.2	108	45.7–256
Alcohol < 0.8 g/L BAC + drugs	12.9	7.39	1.99–27.4
Alcohol $\geq$ 0.8 g/L BAC + drugs	179	104	34.2–316

A moderately increased risk of serious road injury was associated with the use of benzodiazepines and with BAC levels between 0.5 and 0.8 g/L. Higher risks were associated with the use of codeine, with simultaneous use of two or more drugs, with BAC levels between 0.8 and 1.3 g/L, and with BAC levels below 0.8 g/L when alcohol use was combined with drug use. Extremely high odds ratios were

associated with BAC levels above 1.3 g/L (OR = 108) and with BAC levels above 0.8 g/L when alcohol use was combined with drug use.

The single use of tricyclic antidepressants and of most illegal drugs involved in the study was not associated with a significantly increased injury risk. In the case of heroin, this was mainly due to the fact that single use is almost non-existent. The relatively low odds ratio for cannabis may partly be resulting from the fact that blood specimens prevailed among cases (66%), whereas urine specimens prevailed among controls (85%).

## Methodology of the DRUID case-control studies

The intention of the DRUID epidemiological studies is to assess the prevalence of drug and alcohol use among motorists at a European level and to calculate risk rates based on multi-centre case-control studies. These risks will be calculated in seven European countries, based on a case-control design of the studies. The seven countries involved are Belgium, Denmark, Finland, Hungary, Italy, Lithuania and the Netherlands.

### Selection of cases and controls, and relative risk calculations

**Cases** consist of drivers admitted to hospitals' emergency departments who have a MAIS (Maximum Abbreviated Injury Scale) score of two or higher, or an equivalent score on another injury scale. The use of this inclusion criterion has to guarantee a homogeneous group of cases in all participating countries. From the cases, blood samples will be collected.

**Controls** consist of a sample of the general driving population in the hospitals' catchment areas. A random sample of car drivers will be drawn from moving traffic on main urban and rural roads. In most countries, saliva samples will be collected at the roadside, but in one or two countries blood samples will be collected. The distribution of the control sample will be stratified according to the distribution of the seriously injured drivers by day of the week and time of the day. This method was inspired by the well-known Grand Rapids study by Borkenstein *et al* (1974). In this study and in later US studies into the relative risk of drink driving, control drivers were stopped and tested at the same day and time where an accident had happened, one week after. For organisational and financial reasons, this method is not feasible, however, if blood samples have to be taken at the roadside. But by selecting the DRUID control sample as described above, the results of both types of case-control study are probably better comparable than if the DRUID control sample were distributed according to traffic volume.

The main outcome measure of the DRUID case-control studies will consist of adjusted odds ratios of getting seriously injured when driving under the influence of

various psychoactive substances, calculated by unconditional logistic regression (Houwing *et al.*, 2007).

## Sources of potential bias

With regard to the DRUID case-control studies, several sources of potential bias have to be considered. One source results from the fact that, in most countries, cases will be blood-tested while controls will be saliva-tested. Drug concentrations found in saliva, however, cannot be converted into blood concentrations by using a fixed factor. Furthermore, with respect to some frequently used drugs like cannabis and benzodiazepines, saliva analysis is less sensitive than blood analysis. In order to get a better insight into the different outcomes of both methods of analysis, some countries will try to obtain both blood and saliva samples from drivers who are suspected of being positive for one or more of the drugs under scrutiny. Suspicion can be based on subjects' self-reported drug use, including the time of consumption and/or any clinical signs of impairment displayed by them.

Furthermore, case-control studies may suffer from serious selection bias. This is especially the case if injured drivers' informed consent is needed for testing them. However, sometimes medical ethics committees do not require informed consent if the collection of body fluid samples does not require a distinct medical intervention **and** if the test results are anonymous. Another possible source of selection bias is test refusal by control subjects, if they can only be tested on a voluntary basis. Insight into the magnitude of this problem can only be gained on the basis of self-reported drug use and time of administration, and of clinical signs of impairment.

Not all problems associated with data collection and statistical analysis have been solved yet. In particular, the problems regarding potential bias resulting from the selection of cases and controls, and from the different types of body fluid that will be collected and analysed, require attention and further discussion among the DRUID partners.

## References

- Borkenstein, R. F., Crowther, R. F., Shumate, R. P., Ziel, W. B. and Zylman, R. (1974) The role of the drinking driver in traffic accidents (the Grand Rapids Study), 2nd ed. *Blutalcohol*, Supp. 1.
- Houwing, S., Bernhoft, I. M., Commandeur, J., Hansen, A., Haukka, J., Hels, T. and Mathijssen, R. (2007) Drug-related crash risk calculation in the DRUID project. Contribution to the *International Conference on Alcohol, Drugs and Traffic Safety ICADTS T2007*, Seattle.
- Mathijssen, R. and Houwing, S. (2005) *The Prevalence and Relative Risk of Drink and Drug Driving in the Netherlands: A Case-control Study in the Tilburg Police District*. R-2005-9. Leidschendam: SWOV Institute for Road Safety Research.

# 11

## The UK Interlock demonstration project

Andrew Clayton  
RSN Associates  
Birmingham B31 2EW

### Background

Significant inroads have been made in the past two decades in the fight against drink driving. Many types of countermeasures have been developed and implemented. Despite the dramatic reduction in drink driving and the dramatic change in societal attitudes related to this behaviour, drink driving is still a significant cause of accidents and casualties.

One of the relatively recent countermeasures is alcohol ignition interlocks, a technological solution that prevents engine operation if a breath sample containing alcohol above a set level is provided by the driver.

Many types of interlock programmes for drink-drive offenders are currently in operation, mostly in North America (Clayton and Beirness, 2008). They range from discretionary to mandatory and vary as to the mandating authority. Participation rates are low (typically 10%, with the highest rate of 62% for one mandatory programme). Reconviction rates while on the programme are substantially lower, but this beneficial effect disappears once the device is removed.

Experts advise that future programmes should enrol offenders as soon as the offence is committed, and include counselling and rehabilitation in parallel. Tailoring the length of the programme to the individual is also advised, ideally basing this on the performance of that individual while on the interlock programme.

The Road Safety Act 2006 (section 15) permits the introduction of an experimental scheme for alcohol ignition interlocks in Great Britain.

This project reviewed existing interlock programmes and examined the practicalities of setting up such a programme. It used interviews, focus groups and a longitudinal randomised control design to assess the impact of the interlock on drink drive offenders and their families (Beirness *et al.*, 2008).

# Method

A sample of 183 convicted drink-drive offenders who had attended Drink Drive Rehabilitation (DDR) courses in the two study areas (West Midland and Greater Manchester) were recruited for the longitudinal experimental part of the study. They were randomly assigned to either the interlock ( $n = 89$ ) or the control ( $n = 94$ ) group.

Service centres capable of installing and maintaining interlocks were identified and trained to provide the technical expertise required for the programme. Research team members were trained to collect data using a large battery of standard and custom-made measurement tools examining travel habits, alcohol consumption and attitudes.

The interlock group agreed to have the device installed in the car they used for a period of 12 months. During this time they were required to report to the interlock service centre at periodic intervals for routine maintenance and calibration of the device, and to download the data captured by the data recorder. At each service appointment, participants were engaged in an interview with a member of the research team.

Following the initial interview at the time of interlock installation (i.e. month 0), interviews were scheduled to occur at six set-times during the 12-month interlock period. A final follow-up interview was scheduled to occur six months after the removal of the interlock device. Participants assigned to the control condition did not have an interlock installed, but followed an identical schedule of interviews. Family members of interlock clients were also interviewed at months 0, 7 and 18.

# Results

## Sample characteristics

Participants reflected the typical demographic characteristics of drink-driving offender populations. The overwhelming majority of participants in both the interlock and control groups were men. All age groups were represented, with most participants being between the ages of 25 and 44. Three-quarters of all participants had AUDIT (Alcohol Use Disorders Identification Test) scores in excess of 8 – any score above this threshold is considered to represent hazardous or harmful drinking. The average AUDIT score was 12.2.

## Attrition rates

Of the original 89 interlock participants, 39 (43%) failed to complete the full 12 months. This includes three who completed the initial interviews, but never returned for installation. Overall, 64% of withdrawals from the study occurred within the first three months of having the interlock installed. The main reasons given for early withdrawal were 'technical problems' with the device, the annoyance associated with having to provide a breath test at every start and the frequent re-tests. For some,

the interlock simply interfered too much with their lifestyle, i.e. their ability to drink and drive. One participant disconnected the device and was subsequently arrested for a drink-driving offence.

Of the 94 participants in the control group, 11 (12%) withdrew before the end of 12 months. In contrast to the interlock group, all but one of the 11 withdrew following month five. Two were reconvicted of a drink-drive offence; two others died during the course of the study. The others withdrew for personal reasons.

## Interlock data

Data from the logger contained in the interlock were a valuable source of information on potential drink-driving behaviour. Key events included:

- stationary fail – breath sample with blood alcohol concentration (BAC) > 20 mg/100 ml when starting the vehicle;
- start violation – starting the vehicle without providing a breath sample (e.g. hot wiring the vehicle);
- missed re-test – failure to provide a breath sample within 10 minutes of a re-test request; and
- failed re-test – breath sample with BAC >20 mg/100 ml.

Over 90% of the recorded key events were stationary fails. Most participants (66%) had fewer than three stationary fails per month. There were 328 recorded BACs over 80 mg/100 ml corresponding to 172 potential drink-driving trips. (Not every high BAC was a potential trip because participants often tested themselves repeatedly after failing the first attempt.) Typically, these events occurred during the early months of the project, during the morning (9 am to 1 pm) and on weekends.

Attempts to circumvent the interlock were not uncommon. Several participants reported having had someone else provide a breath sample so they could start the car. Some did so only on a single occasion for a specific reason; others did so frequently.

It should be noted that the usual requirement to provide the alcohol breath sample using the hum and blow technique was disabled for this project, with only a simple breath sample being required. As the hum and blow technique requires considerable practice, it is an effective means of preventing untrained bystanders from providing a breath sample.

Other potential circumventions were less frequently observed. Push-starting the vehicle was noted on two occasions, ostensibly to get the car to the service centre. Use of the emergency override, which is intended for use in genuine emergencies only, was recorded on several occasions. Sometimes the ‘emergency’ was simply ‘needing to use the car’.



## Reported issues with interlock

Interviews with interlock participants at each service interval provided a wealth of information about individual reactions to, and experience with, the interlock. The most commonly reported issues were as follows:

- The ‘morning after’ effect – many participants simply did not understand the length of time required to eliminate all the alcohol from the body. Alternatively, they may not have realised how high a BAC they had attained the night before.
- Warm-up time – participants were advised to remove the sample head from the vehicle and store it in the house or other warm place to minimise the length of the warm-up time. Nevertheless, about a quarter of the interlock group commented on the warm-up time. The delay was estimated at 5–10 minutes; a critical amount of time for many people first thing in the morning.
- Rolling re-tests – one of the anti-circumvention features built into the interlock device is the requirement for repeated random breath tests (rolling re-tests) after the vehicle has been started. About 15% of participants commented on the rolling re-tests. The main issues were the frequency of these re-tests and the ability to provide a sample safely in traffic. Although the manual clearly states that drivers should pull over and stop before providing a re-test, several participants admitted providing a re-test while driving.
- Invalid samples – the problem of providing an invalid sample is likely to be greatest immediately after installation as participants become familiar with the device. However, about 10% of participants voiced complaints about difficulties providing a valid sample. Some had difficulty providing the required volume and/or pressure of breath.
- Embarrassment – a few participants commented on the embarrassment caused by having to wait in a public place (e.g. a petrol station or work car park) for the device to warm up or to simply provide a valid sample.

## Perceived benefits of interlock

As the study progressed and participants gained experience with the interlock, there appeared to be greater acceptance of the device and a growing recognition of how it could be of value to them. Many indicated that it made them at least think seriously about their drinking, if not help change their drinking patterns outright. Several participants credited the interlock with helping them avoid drink driving and/or reduce their drinking.

The major benefit of the interlock was seen as the impossibility of committing another drink-drive offence. The device was a safety valve that prevented them from making a bad decision after drinking. Many participants also regarded changed drinking habits as a benefit.

Most of the reported drawbacks of interlocks related to technical issues, such as the perceived long warm-up time, invalid samples and the frequency of re-tests. For some, the major drawback was not being able to drive after a few drinks.



## Views of spouses

For spouses and partners, the main benefit mentioned was that it gave them peace of mind, a feeling of security knowing that their spouse could not drive after drinking. Most respondents also reported that the interlock had changed their partner's drinking behaviour. Drinking was an issue in many families and the interlock was seen as a means of addressing the issue in a positive manner.

## Follow-up interviews

Follow-up interviews at month 18 were conducted with 50 interlock participants and 83 participants in the control group. Overall, there was a decrease of about 10% in the number of participants who scored above the threshold of 8 on the AUDIT over the 18-month period of the study. There was no difference on this measure between those in the interlock and control conditions. About half of all participants had lower scores on the AUDIT at month 18 than at month 0. This suggests an overall decrease in the level of problem drinking over the course of the study for both interlock and control group participants.

In total, 54% of interlock participants reported consuming less alcohol at month 18 than at the beginning of the study, compared with 40% of control participants. The difference between the two groups, however, was not statistically significant.

In terms of Prochaska and DiClemente's (1986) stages of change model, about a quarter of all participants moved up one stage towards making positive changes in their drinking behaviour over the course of the study. Although a greater percentage of interlock participants (30%) compared with control participants (19%) moved up a stage, this difference was not statistically significant.

## Conclusions

In interpreting the findings from this study, it must be recognised that the participants were self-selected volunteers who responded to a mail invitation. All had served a period of disqualification and had completed a DDR course. All were fully re-licensed. The participants were compensated for their time, travel and inconvenience. The installation of the interlock, its maintenance and de-installation were provided free of charge to participants. Hence, the findings may not be representative of those obtained from other drink-drive offenders who participate in interlock programmes under other circumstances, such as those who are mandated to participate and/or must pay for the interlock themselves.

Questionnaire data revealed some evidence of positive changes in drinking for both interlock and control group participants. This was corroborated to some extent in the interviews, in which many participants and family members reported a positive impact on the extent of drinking over the course of the study. However, it was also apparent that drinking remained an issue for many participants and their families. Although many reported reduced drinking, the extent of reported consumption at the end of the study remained high relative to that of the general population.

Without further change in the extent of consumption, many programme participants remain at risk of further alcohol problems, including subsequent drink-drive offences. It must be recognised that, in the absence of concurrent remedial intervention for alcohol abuse, the interlock is unlikely to have a profound and lasting effect on well-entrenched drinking behaviours.

Despite repeated complaints about the lengthy warm-up time and the number of re-tests required, most interlock participants found the device to be an acceptable instrument that had a beneficial impact. It was apparent that being able to drive was important to these individuals; for many, drinking was important as well. The interlock helped prevent the inevitable overlap between the driving and drinking.

Should a programme be pursued in Great Britain, the challenges reported above need to be acknowledged and at least partly resolved. Accurate information from credible sources directed at key stakeholders and potential programme participants will be required to enhance the knowledge of, and provide stakeholder support for, the interlock programme.

## References

- Beirness, D. J., Clayton, A. and Vanlaar, W. (2008) *An Investigation of the Usefulness, the Acceptability and Impact on Lifestyle of Alcohol Ignition Interlocks in Drink-Driving Offenders*. Road Safety Research Report No. 88. London: Department for Transport.
- Clayton, A. and Beirness, D. (2008) *A Review of International Evidence on the Use of Alcohol Ignition Interlocks in Drink-Drive Offences*. Road Safety Research Report No. 89. London: Department for Transport.
- Prochaska, J. O. and DiClemente, C. C. (1986) Towards a comprehensive model of change. In W.R. Miller and N. Heather (eds), *Treating Addictive Behaviors: Processes of Change*. New York: Plenum. pp 2–29.

# Roadside surveys of drivers' alcohol levels: some issues of methodology

Richard E. Allsop  
Centre for Transport Studies  
University College London  
London WC1E 6BT

## Abstract

It may be timely to consider carrying out further roadside surveys of drivers' alcohol levels in Britain to update and supplement the results of surveys in previous decades. A review of methodology for such surveys was therefore commissioned by the Road User Safety Division of the Department for Transport in late 2007 from Paul Jackson of Clockwork Research Ltd. The review covered previous surveys in Britain, surveys in a number of other European countries and further afield, and a range of issues relevant to further surveys in Britain, namely the purpose of further surveys, what data the surveys should collect, by what kind of staff the data should be requested from drivers, over what periods of time data should be collected, and how the sites for data collection should be chosen. This paper summarises the report of the review and provides comments on the issues covered from the writer as one of the independent members of the Scientific Steering Committee for the review.

## Context

The estimated annual number of deaths in Great Britain in road traffic accidents in which at least one driver had a blood alcohol level above the current legal limit of 80 mg/100 ml has fluctuated around 550 since the early 1990s, while the number of deaths in other road traffic accidents has been falling gradually. This led the Department for Transport, in its second three-year review of the road safety strategy to 2010 (Department for Transport, 2007), to commit itself to undertake a consultation about the enforcement of the law on drink driving. Later that year it was indicated that the consultation would also cover the level of the legal limit.

As it had been nearly 10 years since the last roadside surveys of drivers' alcohol levels in Britain and because consideration of responses to the envisaged consultation and any subsequent action might well be informed usefully by the results of fresh roadside surveys, the Road User Safety Division of the Department for Transport commissioned from Clockwork Research Ltd late in 2007 a review of the methodologies employed in such surveys. The review was undertaken by Paul Jackson with the help of a Scientific Steering Committee, including an expert from the Netherlands, and advice from elsewhere in Europe and from North America. The report was received early in 2008 and subsequently published (Jackson, 2008).

## Previous surveys in Britain

Full-scale surveys, some of them preceded by small pilot surveys, were undertaken in various parts of Great Britain in various years between 1964 and 1999. They had in common that they covered evening and night hours on Thursday, Friday and Saturday, extending into the early hours of Sunday. The extent of these surveys is summarised in Table 1.

Table 1: Extent of previous surveys in Great Britain		
Dates	Hours and location	Number of breath samples
1964 December	18:00–24:00 at three sites in Surrey	95% of 1,850 drivers
1988 April – June	22:00–03:00 at 46 sites in Sussex and Warwickshire	94% of 2,650 drivers
1990 April – October	19:00–02:00 at 442 sites in nine Counties and West Mercia	98% of 13,700 drivers
1998 October	22:00–02:00 in 11 police force areas	High percentage* of 10,700 drivers
1999 April	22:00–02:00 in 10 police force areas	High percentage* of 9,600 drivers
* Percentage response rates were not recorded in the 1998 and 1999 surveys, but these surveys were staffed by the police and it is understood that few drivers who are invited by the police to help in a survey decline to do so.		

In relation to the staffing of sites in these surveys, it is important to remember that in Britain only police officers have the power to stop drivers to invite participation in a survey and that

police officers do not have a general power to require a breath sample. However, if they obtain a sample over the limit, they see themselves as obliged to treat the driver concerned as an offender. After drivers have been stopped by a police officer, the staff dealing with drivers participating in these previous surveys have ranged from wholly scientific, through a mix of scientific and support staff, to wholly police staff. Information other than breath samples has been obtained by combinations of interviewing at the site and subsequent return of self-completion questionnaires.

Sites for each of these surveys have been selected either on police advice or by the police, having regard to the considerable restriction on choice imposed by the practical requirements of being able to stop passing drivers safely in order to invite participation, and then having an adjacent off-road area in which to interview and obtain breath samples from participating drivers and deal safely with drivers whose alcohol levels are too high for them to be allowed to continue driving. Nevertheless, all surveys from 1988 onwards have achieved a mix of urban and rural sites, and from 1990 onwards the sites have been spread over a mix of police force areas.

## Some experience in other countries

The report provides a good deal of detail about experience in 10 other countries, notably the following:

- In the Netherlands, where the police have the power to require a breath test of any driver, police in the province of Zeeland include in their enforcement programme a monthly Saturday night survey, rotating among the three police districts in Zeeland, in which drivers are stopped at random between 21:00 and 04:00 hours to obtain 4,500 breath samples annually, and the results are passed to a statistician for analysis.
- A national survey in Belgium, carried out in the autumn of 2003 and intended to be repeated, covered all hours of the week and was carried out at sites chosen in each region by the police from a list of randomly selected sites. Traffic data by site and hour allow the observed alcohol levels to be weighted according to the vehicle-distance driven that they represent.
- In British Columbia, Canada, a stratified random sample of candidate sites is selected in each city by superimposing a grid upon the road map of the city.
- In the USA, a nationwide stratified sample of sites was selected with the help of an existing system designed to select samples of traffic accidents for investigation. This enabled observed alcohol levels to be weighted according to the frequency of occurrence of traffic accidents (as distinct from vehicle-distance driven).

## Some issues concerning further surveys in Britain

### Why carry out further surveys?

A single survey over a chosen short period in time can provide estimates of the prevalence of different levels of alcohol among drivers in that period, and

information about the characteristics, attitudes and drinking behaviour of drivers, especially those found to have been drinking.

A series of comparable surveys carried out over time can, in addition, provide information about trends in drink driving and estimates of the effect of changes in laws affecting drink driving and in the enforcement of these laws.

## **What data should be collected?**

The overwhelming priority in the design and conduct of roadside surveys of drivers' alcohol levels is to obtain breath alcohol samples from a very high percentage, in the upper nineties per cent, of drivers stopped at random at each survey site, together with such other information about these drivers as is needed for analysis jointly with their recorded breath alcohol levels, and simple observable and easily ascertainable characteristics of those who refuse to provide samples.

The requirement for such a high percentage participation by the sample of drivers who are stopped stems from the smallness of the proportion of drivers who have other than low or zero alcohol levels – only a few per cent even in the night hours at weekends, which implies that anything more than a similarly small rate of refusal to provide a breath sample casts doubt upon the estimated proportion of drivers who have appreciable alcohol levels.

Nothing else should be sought from the stopped drivers that might reduce the percentage who agree to provide breath samples.

## **Who should collect the data?**

Only a police officer is permitted to stop passing vehicles and invite drivers to participate in the survey. It is important that this should be done in such a way that every passing driver has an equal chance of being stopped. This can be well approximated, for example, by the police officer looking away from the traffic for a signal from the survey staff that they are ready for a next participant, and at the signal turning briskly towards the traffic and stopping the next approaching vehicle that is far enough away to stop safely. This may require specific training to help the officers to set aside for this purpose their innate skill in picking out likely suspects from a passing stream of traffic. The aim is absolutely not to maximise the proportion of drinking drivers in the sample.

Dealing with drivers who have agreed to participate requires a mix of scientific staff whose duties should be allocated with the aims of:

- maximising the proportion who agree to provide a breath sample;
- securing required information by interview;
- handing out self-completion questionnaires in a way that maximises the proportion returned;
- dealing ethically with drivers found to be unfit to continue to drive; and

- minimising risks to the health and safety of participants and staff.

This may indicate within the survey site a front-line role for carefully chosen and trained scientific staff, with police officers, also carefully trained for their role, evidently but unobtrusively on hand to assist when high alcohol levels are detected or other difficulties arise.

## When should data be collected?

For comparison with results of previous surveys, it is clearly important that future surveys should include the hours 22:00 to 02:00 on Thursday, Friday and Saturday nights. In addition, it is for consideration to what degree coverage is extended over the week to include, probably with different weightings for statistically efficient use of resources:

- early to mid-morning on weekdays to include those who have drunk so heavily the night before that they still have high alcohol levels in the morning;
- Sunday and weekday evenings; and
- early to mid-afternoon to include the consequences of lunchtime drinking.

It is also for consideration whether, instead of conducting the whole of a year's survey in one month or season, to cover different parts of the year systematically by means of several survey waves.

This, in turn, leads on to the question whether the next survey should mark the beginning of a rolling programme of surveys continuing from year to year – possibly on a reduced scale in each year, so that the size of sample that might be appropriate for a one-off survey confined to a single year is achieved every, say, three years of the rolling programme. Such a programme would offer scope for detecting changes over time in the prevalence of drink driving, and effects of changes in the law or its enforcement.

## Where should data be collected?

Practicality and the indispensable role of the police in the conduct of a roadside survey imply that the survey work will be conducted in a limited number of police force areas. These should be such as to cover, in sensible proportions, a mix of conurbation areas, free-standing cities and towns, rural areas with numerous towns and villages, and more rural areas with only fewer and smaller towns and villages.

Experience in other countries suggests that in each of these police force areas, the broad localities in which to look for sites on each type of road could be selected by stratified random sampling of the road network. Within these localities, the practical experience and local knowledge of the police will, as in previous surveys, be valuable in identifying practicable survey sites. The initial sampling of the road network opens the way to the weighting of observations by vehicle-distance when estimating the overall distribution of alcohol levels in the driving population.



After suitable sites have been chosen, the scheduling of survey work at the various sites should aim, subject to achieving the required coverage of sites and times of the week, to minimise the predictability to local people of survey work at any particular site.

## Two messages for decision makers

In conclusion, two pieces of advice are offered to those who will decide whether and how surveys are undertaken:

- **beware of false economies – further surveys will be expensive, but if they are worth doing, they are worth doing well; and**
- **beware of reducing the response rate by overloading the survey – stay focused on getting breath samples from the upper 90s per cent of drivers stopped.**

## Acknowledgements

The writer is grateful to the Road User Safety Division for the invitation to present this paper and to Paul Jackson for being content for him to do so.

## References

Department for Transport (2007) *Tomorrow's Roads – Safer for Everyone. The Second Three-year Review. The Government's Road Safety Strategy and Casualty Reduction Targets for 2010*. London: Department for Transport.

Jackson, P. G. (2008) *A Review of Methodologies Employed in Roadside Surveys of Drinking and Driving*. Road Safety Research Report No. 90. London: Department for Transport.

# 13

## The deterrent effect of penalty points on speeding drivers

Claire Corbett,<sup>1</sup> Emma Delmonte,<sup>2</sup> Allan Quimby<sup>2</sup> and Graham Grayson<sup>2</sup>

<sup>1</sup> Brunel Law School

Brunel University

Uxbridge UB8 3PH

<sup>2</sup> Transport Research Laboratory

Crowthorne House

Nine Mile Ride

Wokingham RG40 3GA

### Introduction

As is evident from the annual speed monitoring statistics for different kinds of roads, restraining drivers' speeds has proved to be a difficult task, despite the engineering, educative and enforcement countermeasures that have been introduced over the years. New technologies to control drivers' speeds are waiting in the wings for roll-out, but, for the present at least, enforcement by automatic speed cameras is probably the principal means of influencing the speeds chosen by drivers.

Nowadays more conditional offers of fixed penalties are made following detection by speed camera devices than by police patrols – with 88% of speeding offences being made by these means in 2005 (see p.15 and Table D, Ministry of Justice, 2007).

In addition to a fine by way of a conditional fixed penalty or by court sanction, detected drivers acquire between three and six penalty points (three with a conditional fixed penalty) which stay on a driver's licence for four years, although they are 'live' for only three years. Upon accumulation of 12 points, disqualification should occur under section 3 of the Road Traffic Offenders Act 1988, meaning that drivers can be caught speeding repeatedly provided that no more than 11 points remain on their licence at any time. In practice, this is likely to mean that drivers can be caught up to four times for speeding in any three-year period before disqualification occurs.

Table 1: Comparison of disqualifications and penalty points, 1995–2005

	1995	2005	Per cent change
Persons disqualified under points system (excluding those disqualified for current offence)	32,000	29,000	–9%
Endorsements without disqualifications (speeding + traffic light offences)	781,000	2,239,000	+287%

(From Motoring Offence and Breath Test Statistics, 2005, Table 16)

As Table 1 shows, the number of licence endorsements has increased massively in recent years. Between 1995 and 2005, for example, the number of endorsements without disqualification for speeding and traffic light offences increased by 287% (Table 16, Ministry of Justice, 2007). Yet, over the same period, the number of disqualifications resulting from the ‘totting-up’ of penalty points **decreased** by more than 9%. This would seem to indicate that many drivers who accumulate up to 11 penalty points are either acting as if deterred by the threat of disqualification, or they are avoiding disqualification in some other way.

This project commissioned by the Department for Transport was therefore designed to examine whether the threat of disqualification deters drivers from speeding, and, more specifically, the extent to which penalty points act as a deterrent on drivers’ speed choices.

## Aims and Objectives

The aims and objectives of the project were as follows.

### Aim

- To inform understanding of the deterrent effect of speed cameras, and the motivations underpinning the behaviour of repeat speed offenders.

### Objectives

- An analysis of the subset of the Driver and Vehicle Licensing Authority (DVLA) database, as provided, to inform understanding of the relationship between speeding convictions and re-offending.
- To develop profiles of the group or groups most likely to be speed offenders, particularly repeat offenders.

# Phase I and II

The project brief further specified that the study should have two phases, the first to be an analysis of the DVLA database, and the second to be a quantitative and qualitative analysis of the drivers of most interest to the study topic.

**Phase I** comprised a series of analyses of DVLA conviction data for speeding offences using two datasets: the first consisted of an extract from the full DVLA Driver File maintained by the DVLA and included details of all speeding offenders and those who had been disqualified under the totting-up procedures at that time. The second dataset comprised the Transport Research Laboratory (TRL) Archive which contains the details of 1% of British driver licence details and their convictions over the last 20 years (with none removed).

**Phase II** comprised three components, the first of which was a postal survey of different groups of speeding drivers and a control group. The original intention was that this phase of the study would concentrate on two groups of drivers, but the results from Phase I of the project suggested that the picture would be enhanced by targeting two more groups:

- (a) those who had acquired several speeding convictions, and were now on nine points and therefore likely to be disqualified on their next conviction for speeding; these could be termed the 'Brinkers', i.e. those on the brink of disqualification;
- (b) those who had held more than six points on their licence for a stipulated period during the last four years, and whose points tally had since been reduced; these could be termed the 'Returners', i.e. those who had returned from being at immediate risk;
- (c) those who had been disqualified through the totting-up of speeding offences, and who had had their licence returned in the last two years (the 'Previously Disqualified'); and
- (d) those currently with no penalty points on their licence and who had not acquired any points in the last four years (the 'No Pointers').

The inclusion of a 'No Pointers' group not only provided a control group with which to contrast data from the different points groups, but also aided compliance with the Data Protection Act. This transpired since the covering letter and questionnaire sent from the DVLA did not distinguish between those with or without penalty points, which avoided identifying any with driving convictions and any possible ramifications of that.

In total, 6,000 drivers were targeted in these four groups, with higher proportions of the three expected 'hard to reach' – (a), (b) and (c) – groups. It should be noted that drawing these three latter groups precluded the possibility of including any driver with less than two years' experience, since such drivers are subject to the New Drivers Act 1995 which provides for a driving licence to be revoked upon reaching

six penalty points within two years of passing the driving test. New drivers could only feature in group (d).

Questionnaire topics covered included:

- demographics and driving histories of drivers with penalty points, at least some of which were for speeding;
- the frequency of reported speeding, and normal and preferred speeds;
- explanations for non-compliance with the speed limit in general, and when last prosecuted;
- driving styles in general and near cameras;
- awareness of totting-up procedures;
- means adopted to avoid disqualification;
- the use of equipment for the detection of speed cameras; and
- ways of encouraging compliance with the speed limits.

A total of 1,192 drivers returned the questionnaire, giving an overall response rate of 19.9%, adjusted to 20.5% if questionnaires returned undelivered are excluded. Of those returned, 77 were unusable for one reason or another, leaving 1,115 on which to conduct analyses.

The second Phase II component was to follow-up the survey with a small-scale in-depth telephone interview study using a stratified random sample of 43 respondents to the survey. The third component comprised two focus groups arranged with drivers who were attending a speed awareness course. The purpose of these qualitative components was to delve more deeply into the findings of the postal survey and readers are referred to the main report for further details (Corbett *et al.*, 2008). Nevertheless, their findings are incorporated into the main conclusions and recommendations at the end of this paper.

## Key findings from the DVLA data analyses

Analyses were carried out to examine:

- trends in convictions for speeding and disqualifications over time;
- patterns in the conviction histories of drivers;
- changes in the age and sex distributions of convicted drivers over time; and
- evidence that drivers modify their behaviour when at risk of disqualification.

The results of all these analyses are available in Broughton (2008), but the key findings are as follows. The trend for speeding convictions recorded in the TRL Archive mirrors that shown by published national data, where there is a steady increase to 2002, a sharp increase in 2003 and little change subsequently. The trend for TT99 (totting-up) disqualifications also reflects the trend in the national data, with little change over the past decade. So the 1% sample provides a fair reflection of the bigger picture.

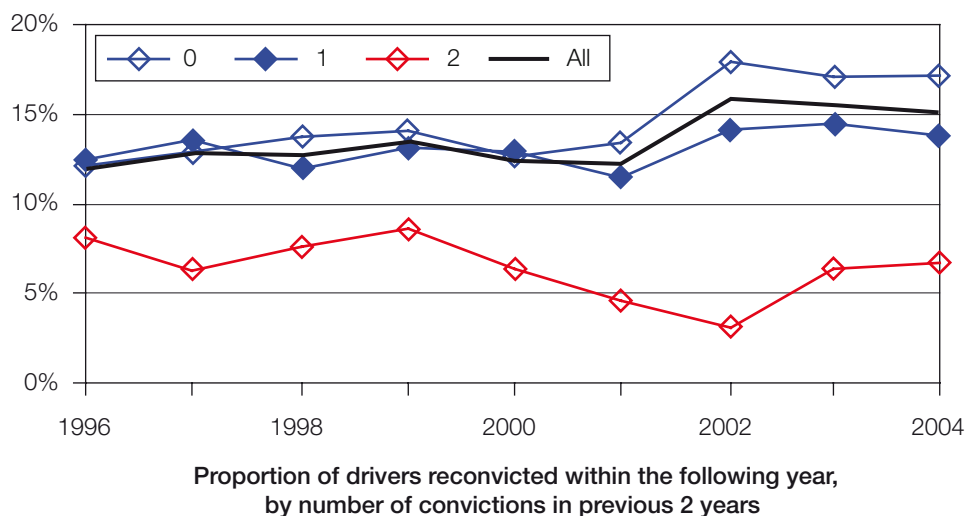
The Archive data show, however, that only a minority of TT99 disqualifications are the result of speeding convictions. Between 2001 and 2005, 65% of TT99 disqualifications in the Archive resulted from insurance offences, compared with 24% from speeding offences.

The analysis of TT99 disqualifications in the Archive data showed that there is a very small proportion of speeding offenders – about 0.3% since 1994 – who, following an initial speeding conviction, accumulate three or more further convictions in the next 36 months. So drivers disqualified for ‘totting-up’ points just for speeding are relatively rare.

Interestingly, those with speeding convictions have got older and comprise more females than before, comparing 1997–99 with 2003–05. So, for example, in that time period the number of male offenders at least 60 years old increased by 540%, and the number of their female counterparts rose by 1,200% (but from a low base number).

A key finding is that drivers do modify their behaviour upon accumulating penalty points. As Figure 1 shows, drivers with one previous speeding conviction (probably now on six points) were almost as likely as those with no previous convictions (three points) to be reconvicted in the following year as in the previous two years. But drivers with two previous convictions (probably now on nine points) were much less likely to be reconvicted in the following year as in the previous two years.

Figure 1: Key findings from the DVLA data analyses



In addition, while the proportion of those who were reconvicted of speeding increased in 2002 among those with 0 or 1 previous conviction (i.e. probably now with three or six points), it did not rise among those with two previous convictions (i.e. probably now with nine points). This strongly suggests that the threat of disqualification is causing drivers – especially those with several convictions – to adapt their behaviour in some way to reduce the risk of a further conviction and consequent disqualification.

Lastly, with the surge in speed camera devices between 1995 and 2005, especially since 2002, the number of convicted speeding drivers has increased. However, individuals' subsequent pattern of convictions has largely remained unchanged – so drivers are behaving much as before.

## Postal survey sample: final criteria for points groups

Initial inspection of the survey data showed that the pattern of respondents' penalty points was considerably broader than had been expected using the criteria described earlier to specify the four targeted groups. After consultation with the Department for Transport, some changes were made and the final criteria were as follows:

- **'Brinkers'** – those on the brink of disqualification, having 6–11 penalty points.
- **'Returners'** – those who had returned from being at immediate risk from greater than six points in the last four years to less than six points now.
- **'Previously Disqualified'** – through 'totting-up', including for speeding. Licence returned in the last two years or if 'have ever been disqualified'.
- **'No Pointers'** – no points on licence in last four years.
- **'Low Pointers'** – a maximum of five points ever, and now 0–5 points.
- **'Eligible for Disqualification'** – currently 12 or more points, but claim never to have been disqualified.

First, the criterion for inclusion in the 'Brinkers' group was changed from 9 to 6–11 points. Returners remained as before. Respondents who replied in the affirmative to the question 'Have you ever been disqualified from driving?' were placed in the 'Previously Disqualified' group irrespective of the maximum number of penalty points they claimed they had ever held. 'No Pointers' remained as before. Lastly, two additional groups were created, defined as follows:

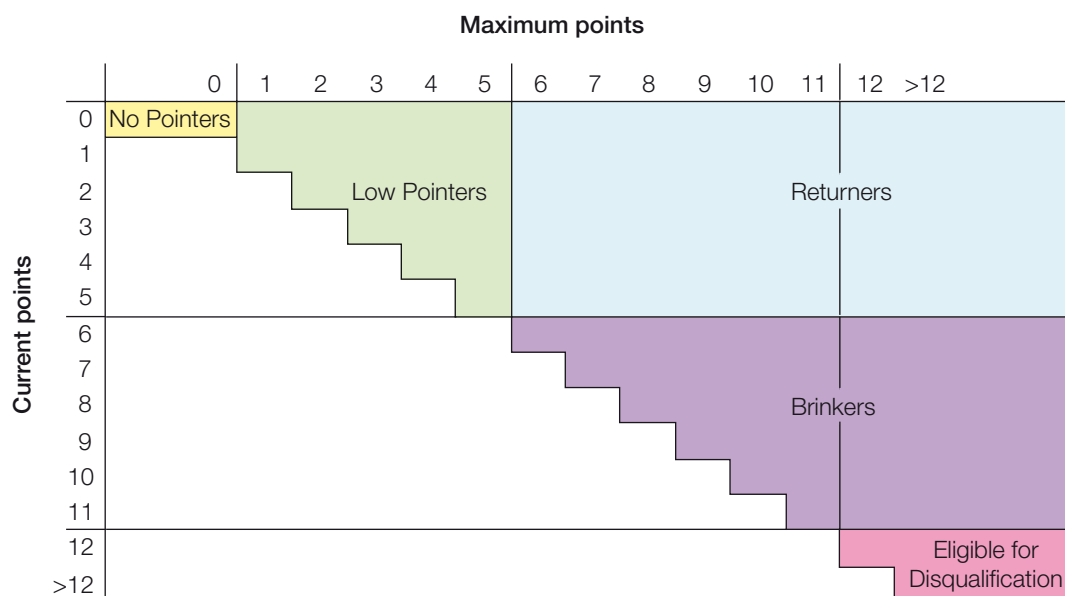
- those who had held a maximum of up to five points and currently had between no points and five points (**'Low Pointers'**); and
- those who currently had 12 points or more, but claimed never to have been disqualified (**'Eligible for Disqualification'**).



To establish the penalty points history of respondents, the questionnaire asked two questions: ‘How many penalty points do you currently have on your licence?’ and ‘What is the maximum number of points you have ever had on your licence (this may be more than you have now, as points are “wiped off” after four years)?’.

Figure 2 shows how the groups were formed by comparing the responses to these two questions. It should be noted, however, that those in the ‘Previously Disqualified’ group had a wide range of current and maximum points, and might also have included some drivers who were still disqualified. Accordingly, they are excluded from the figure.

Figure 2: **Points groups**



Several comments can be made in regard to the configuration of the points groups. First, the wide range of ‘current points’ might partly reflect the time-lag between confirmation of an endorsement and the appearance of penalty points on a driver’s licence, causing some inaccuracy. Second, it is possible that drivers do not bother to have points removed from their licences on their expiry as this involves expense and form-filling, which could lead to uncertainty as to how many points are still ‘live’. Indeed, the qualitative study found that some drivers were confused about how long points remain on their licence, since points are ‘live’ for three years, but must remain on the licence for four years. Third, drivers who get disqualified either through ‘totting-up’ or by outright disqualification may be unclear whether the slate is wiped clean once their disqualification period is over, and may have been unsure how to express the ‘maximum points total ever held’ requested in our survey, especially if outright disqualification had ever been awarded. Lastly, as Figure 2 shows, the ‘Eligible for Disqualification’ group claimed to have had 12 or more points ‘ever’ or currently on their licence, yet had never been disqualified. Enquiries made for this research indicated that a considerable proportion of ‘totters’ may escape disqualification for a range of reasons, and further research is recommended.

# Driver characteristics by points status

Since there was no intention to draw a representative sample of drivers with or without points, there is little purpose in discussing the characteristics of the whole sample combined, but a few points are noteworthy given that they were selected randomly from those who met the different selection criteria.

**Table 2: Driver characteristics by points status**

		No pointers			All other groups combined			
		Male (%)	Female (%)	Total (%)	Male (%)	Female (%)	Total (%)	Total (%)
Age	Under 25	6	8	7	1	1	1	2
	25–34	2	25	15	12	14	13	13
	35–44	22	18	20	22	36	26	25
	45–54	30	18	23	26	32	28	27
	55–64	19	18	19	26	13	23	22
	65+	22	12	16	12	5	10	11
	Base	54	76	130	707	274	985	1,115
Annual mileage	Less than 5,000	19	26	23	5	11	7	9
	5,001–15,000	61	69	66	39	63	45	48
	Over 15,000	21	4	11	56	25	48	43
	Base	53	73	126	705	267	972	1,098
Vehicles driven	Car	85	96	92	71	96	78	80
	Van/HGV	4	0	2	5	0	3	3
	Bus/coach/taxi	0	0	0	1	0	1	1
	Car plus other(s)	11	4	7	23	3	17	16
	Base	54	76	130	710	274	984	1,115
Accidents in past 3 years	None	92	71	79	77	74	76	76
	1 or 2	8	29	20	22	25	23	23
	3 or more	0	0	0	2	1	1	1
	Base	50	75	125	690	262	952	1,077
Drive to/for work	Do not drive to/for work	40	37	38	13	18	14	17
	Drive to work	21	45	35	18	30	21	23
	Drive for work	38	18	27	69	52	64	60
	Base	52	71	123	695	271	966	1,089

Table 2 shows that with regard to **age**, both our ‘No Pointers’ group and ‘All other points groups combined’ tended to be older than found in the fully licensed driving population. So only 2% of the total sample were aged under 25 years old, and 93% of ‘No Pointers’ and 99% of the combined points groups were aged over 25 years old. This could partly have been a consequence of our sampling criteria. On average,

male respondents in both the combined points group and the ‘No Pointers’ group were older than their female counterparts.

Comparing those with and without points, Table 2 shows that ‘No Pointers’ were more likely to have a low **annual mileage**, with 89% driving less than 15,000 miles a year compared with 52% of the other groups combined.

With regard to **vehicles driven**, respondents who had never had penalty points were much more likely to drive only a car than those with points (92% and 78%, respectively). Those with points were more likely to drive a car plus one or more other types of vehicle (17% versus 7%). Females were more likely than males to drive only a car, regardless of points status.

Overall, 21% of ‘No Pointers’ and 24% of those with points had been **accident involved** in the last three years. However, male ‘No Pointers’ were much **less** likely than males with points to have been accident-involved (8% and 23%, respectively). There was no noticeable difference between females in the two groups.

As shown in Table 2, respondents in the ‘No Pointers’ group were almost three times **less** likely than the other respondents to **drive to or for work** (14% and 38%, respectively). Similarly, those with points were more than twice as likely as ‘No Pointers’ to drive **for** their work (27% and 62%, respectively). In general, males were more likely to drive **for** work than females, while females were more likely to drive **to** work than males.

## Profiles of the points groups

When all points groups, defined by their current and maximum number of penalty points, are broken down by sex, age and ethnicity, as seen in Table 3, there are few big contrasts between them other than the differences in base numbers, and the main demographic distinctions are between those with and without points.

Thus, there is a preponderance of male respondents in all of the different points groups, with the highest proportion among the ‘Previously Disqualified’ (89%). Overall, 58% of ‘No Pointers’ were female, compared with 28% of all other groups combined, indicating that men were over-represented among drivers with penalty points. Of all full licence-holders in the driving population, 56% were male in 2006 (DVLA, 2007).

All of the points groups have a lower proportion aged under 25 than the ‘No Pointers’ group, and a generally older profile than the ‘No Pointers’ groups. For instance, the ‘Previously Disqualified’ and ‘Eligible for Disqualification’ groups had no member aged under 25. All groups are under-represented by minority ethnic members compared with their proportion in the national population (ONS, 2001). There were no substantial ethnic differences between the different points groups.

Table 3: Profile of the points groups

		No Pointers (%)	Low Pointers (%)	Returners (%)	Brinkers (%)	Eligible for Disqualification (%)	Previously Disqualified (%)	Total (%)
Gender	Male	42	73	69	70	71	89	69
	Female	58	27	31	30	29	11	31
	Base	130	56	149	517	157	106	1,115
Age	Under 25	7	2	1	1	0	0	2
	25–34	15	5	15	14	14	8	13
	35–44	20	18	23	25	30	31	25
	45–54	23	30	28	28	27	27	27
	55–64	18	20	25	22	20	28	22
	65+	16	25	8	10	8	6	11
	Base	130	56	149	517	157	106	1,115
Ethnicity	White	97	96	96	96	97	98	97
	Black	2	0	0	0	1	1	1
	Asian	2	0	3	2	1	1	2
	Other	0	4	1	1	1	0	1
	Base	126	55	141	498	150	102	1,069

## Knowledge of speed-related facts

Respondents were asked to indicate to what extent they agreed with the following four statements – which are all true, on a scale from strongly agree to strongly disagree:

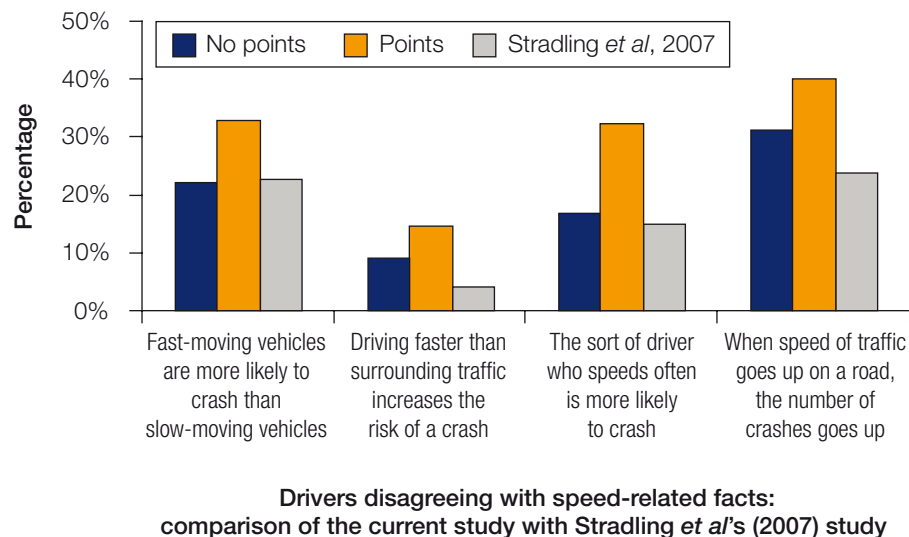
1. Fast-moving vehicles are more likely to crash than slow-moving vehicles.
2. Driving faster than the surrounding traffic increases the risk of a crash.
3. The sort of driver who speeds often is more likely to crash.
4. When the speed of traffic goes up on a road, the number of crashes goes up.

Stradling *et al.* (2007) gave the same four statements to a sample of 928 drivers who had driven at least 500 miles in the previous 12 months, whose points status is unknown. Figure 3 shows the proportion of respondents in the current study (with and without points) and the proportion of respondents in the Stradling *et al.* (2007) study who disagreed with these statements, i.e. those who held incorrect views on these speed-related facts.

It is clearly seen that drivers with penalty points are more likely than those without, and more likely than a general sample of drivers, to hold inaccurate views. This difference is most pronounced for responses to ‘the sort of driver who speeds often is more likely to crash’. It could be, therefore, that drivers with points for speeding are less willing to accept that increased speed leads to an increased risk of crashing.

Not shown in Figure 3 is the finding that, overall, female respondents had more accurate knowledge than males, with 'Previously Disqualified' males being least inclined to agree with the four statements overall and 'No Pointers' (with a majority of female respondents) being most inclined to agree. The results indicate that those with the worst penalty point records may have the most inaccurate knowledge on speed-related facts, indicating the challenge ahead.

Figure 3: Knowledge of speed-related facts

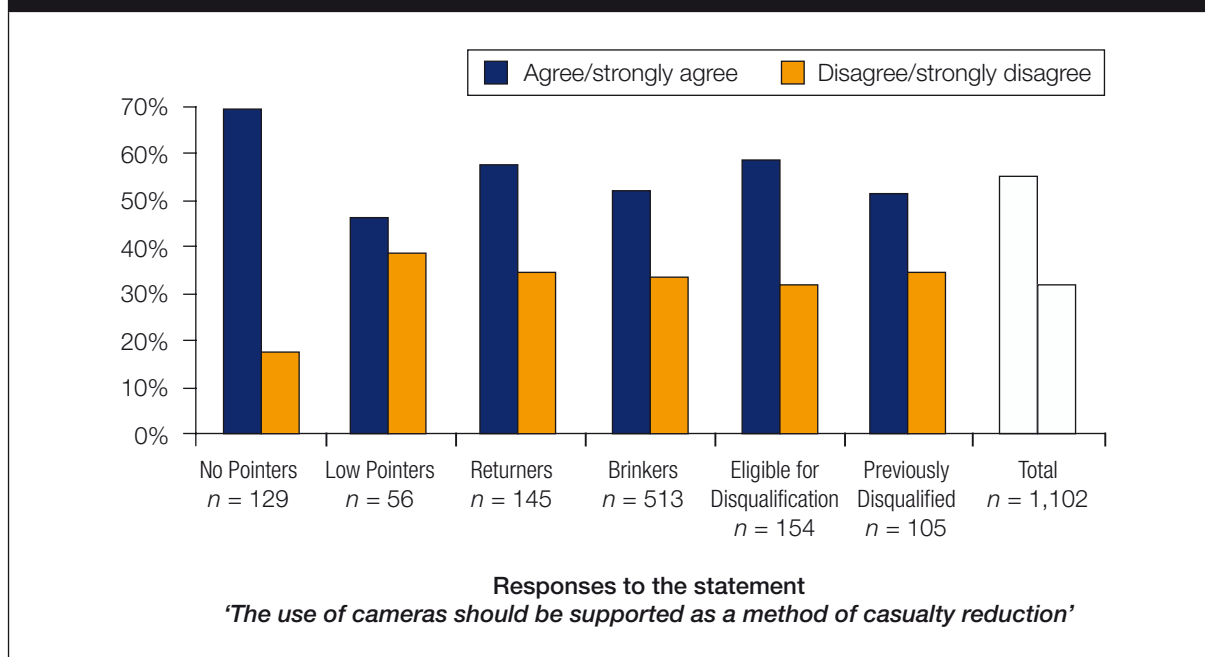


## Views on the use of speed cameras by points groups

In regard to respondents' views on cameras, a statement very similar to that used in previous studies (e.g. Gains *et al.*, 2005) was used to measure favourability. Respondents were asked to indicate their level of agreement on a five-point scale to the statement: 'the use of speed cameras should be supported as a method of casualty reduction'.

Figure 4 shows the results, whereby 55% of all respondents agreed with the statement, while 32% disagreed. The remainder were 'neutral'. Overall, 'No Pointers' were most likely to agree with the statement (69%), while 'Low Pointers' were least likely to agree (46%). Just over half of each of the 'high points' groups agreed with the statement. Agreement was slightly influenced by previous experience of accumulating points (see also Corbett and Simon, 1999; p. 55). Females were, overall, slightly more likely to agree than males, but interestingly there was no consistent gender difference across the points groups.

Figure 4: Views on the use of speed cameras



## Behavioural responses to cameras by points groups – camera type

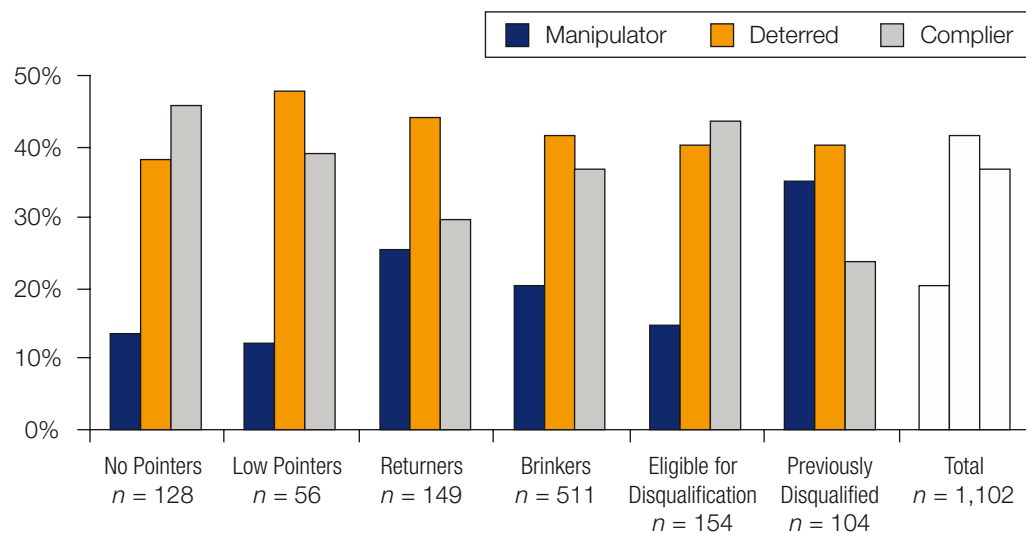
Respondents were categorised into one of the four main styles of response to cameras, as defined by Corbett (1995). The questionnaire asked drivers how they would describe their general style of driving in relation to speed cameras by selecting one of the following options:

- I tend to drive above the speed limit all along roads where I think there are cameras and I do not slow down even where I know there are cameras (**'defier'**).
- I tend to drive above the speed limit all along roads where I think there are cameras and only slow down where I know there are cameras (**'manipulator'**).
- I tend to drive close to or under the speed limit all along roads where I think there are cameras because I have slowed down to avoid being caught by them (**'deterred'**).
- I tend to drive below or within the speed limit regardless of speed cameras (**'complier'**).

There were only five 'defiers' in the whole sample and so these were excluded from further analysis. Interestingly, over time the proportion of defiers appears to have reduced (c.f. Corbett, 1995; Corbett and Simon, 1999), suggesting that sooner or later most drivers are deterred from the high detection risk of 'defying' the cameras.

Figure 5 shows the proportion of ‘manipulators’, the ‘deterred’ and ‘compliers’ in each of the points groups. Those in the ‘Previously Disqualified’ group were most likely to be ‘manipulators’ and least likely to be ‘compliers’. ‘Low Pointers’ were least likely to be ‘manipulators’ and most likely to be ‘deterred’. ‘No Pointers’ were least likely to be ‘deterred’, probably because they had experienced least need to slow down (although the proportion ‘deterred’ had a small range between groups of 39% to 48%). Somewhat curiously, those ‘Eligible for Disqualification’ were most likely to be ‘compliers’. As found in previous research (Corbett and Caramlau, 2006), overall, males were more likely to be ‘manipulators’ and females more likely to be ‘compliers’, though in this study this pattern was not completely consistent across all points groups.

Figure 5: Behavioural responses to speed cameras



## Risks that deter drivers from speeding

Respondents were asked to indicate their agreement with six statements about exceeding speed limits on 30 mph roads, on a five-point scale from ‘strongly agree’ to ‘strongly disagree’. Three of these concerned the perceived risks that might deter drivers from speeding:

1. The risk of being caught is not high enough to stop me speeding.
2. The risk of having an accident is not high enough to stop me speeding.
3. The likely penalty I would get is not high enough to stop me speeding.

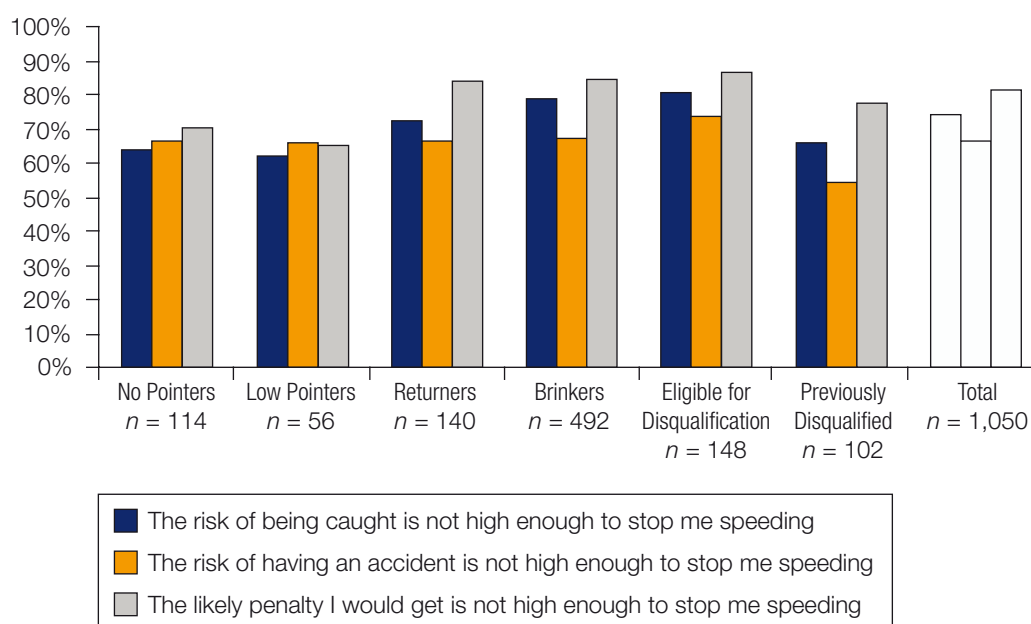
Figure 6 shows the responses of each points group to these statements and it is seen that, overall, at least two-thirds of each group **disagreed** with each statement. If this finding is generalised, it would suggest that the big majority of drivers with and



without points are deterred from speeding by the risk of detection, risk of accident and the likely penalty if caught.

In general, the full pattern of responses to these three statements suggested that the 'Previously Disqualified' were, overall, least deterred by these things, while the 'Eligibles' were, on balance, most deterred, suggesting that the threat of disqualification may be more effective than the experience itself.

Figure 6: Risks that deter drivers from speeding



## 'Inadvertent' speeding by points groups

Respondents were asked to indicate their level of agreement to a range of statements to explain the last time they were prosecuted for speeding. Three of them related to inadvertent speeding, which is a phenomenon noted in earlier research (e.g. Corbett and Simon, 1999; pp. 50–51):

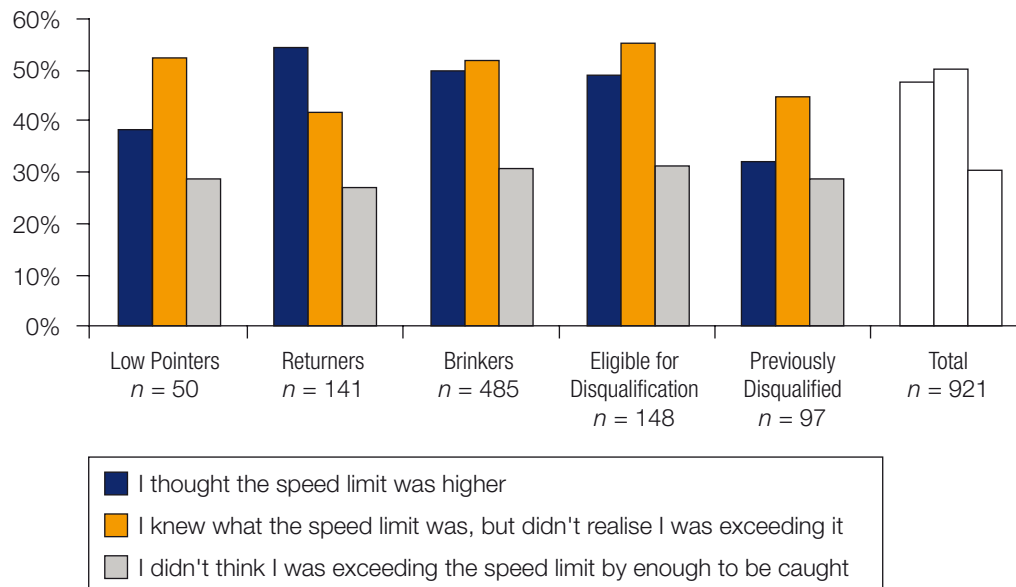
1. I thought the speed limit was higher.
2. I knew what the speed limit was, but didn't realise I was exceeding it.
3. I didn't think I was exceeding the speed limit by enough to be caught.

Figure 7 shows responses to these statements. 'No Pointers' were excluded, as by definition they had not been prosecuted for speeding.

These statements are mutually exclusive, so endorsing one should preclude endorsing either of the other two. Yet of those who gave an answer to all three, 6%

agreed or strongly agreed with all three, and 29% agreed or strongly agreed with two of the statements, therefore over a third of respondents were inconsistent in their explanations for speeding. However, perhaps of most interest is that at least several reasons accounted for ‘inadvertent’ speeding, and this affected roughly half of those with points.

Figure 7: ‘Inadvertent’ speeding by Points Groups

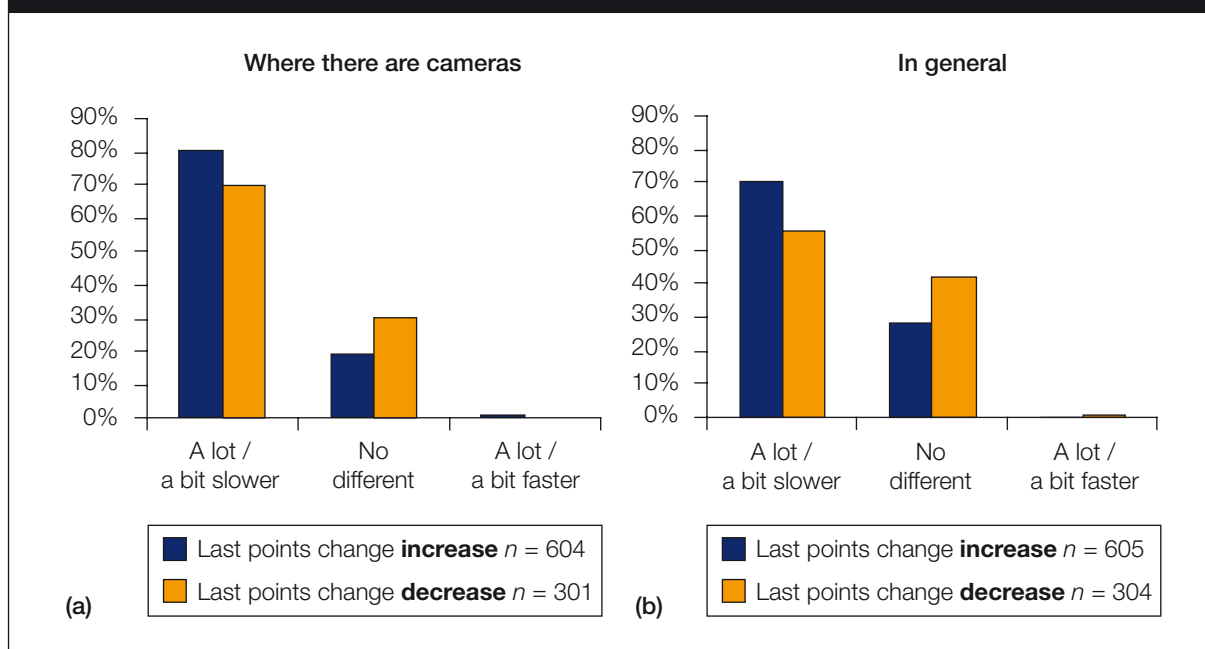


## Driving style since last change to penalty points total

Respondents were asked to indicate how they had driven in general and where there were cameras since their last change in penalty points, on a five-point scale from ‘a lot slower’ to ‘a lot faster’. Figure 8 illustrates that those whose points **increased** at the last change were more likely to have reduced their speeds around cameras (81% did) than those whose points had **decreased** (70% did). Similarly, 71% and 56%, respectively, had reduced their speeds in general. Respondents were more likely to have slowed down in places where they thought there was a camera than when driving in general. Females were more likely to have reduced their speeds than males.

Interestingly, the likelihood of driving slower increased with points severity both in general and around cameras, with the exception of the ‘Previously Disqualified’, who were less likely than the ‘Eligibles’ to have cut their speeds.

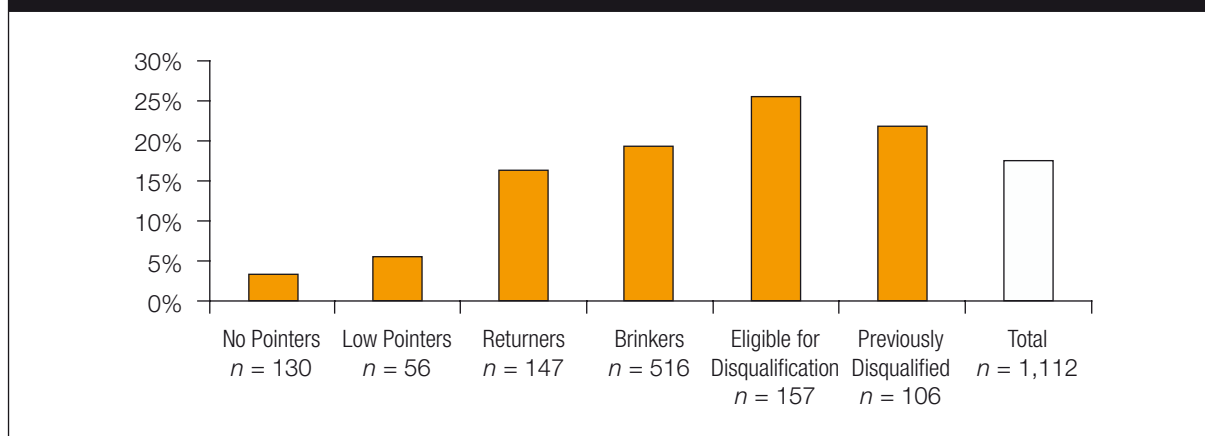
Figure 8: Driving style since last change to penalty points total: (a) where there are cameras; and (b) in general



## Ownership of radar detection equipment by points groups

So do those with points have radar detection equipment to warn of speed camera devices, and, if so, have they purchased it after being caught for speeding to avoid more penalty points? Perhaps unsurprisingly, the answers, as seen in Figure 9, are that the higher points groups were considerably more likely than the 'No Pointers' (3%) or 'Low Pointers' (5%) to own such equipment – compared with, for example, 25% of 'Eligibles'. And over three-quarters of those who owned radar detection equipment had bought it after being caught for speeding, in order to avoid more penalty points. Males in all groups, except 'Low Pointers', were more likely than females to own radar detection equipment.

Figure 9: Ownership of radar detection equipment



# Encouraging compliance by points groups

Respondents were presented with eight suggestions for encouraging compliance and were asked to indicate to what extent each would encourage them to keep to the speed limits. These items comprised the threats and incentives (or ‘sticks’ and ‘carrots’) of ‘all hidden cameras’, ‘halved insurance bills for no penalty points for a year’, ‘doubled fixed penalty fines’, ‘having to attend a speed awareness course instead of points’, ‘average speed cameras’, ‘a higher risk of detection’, ‘graduated penalties’, and ‘most drivers keeping to limits’. The proportions agreeing with each item are shown in Figure 10.

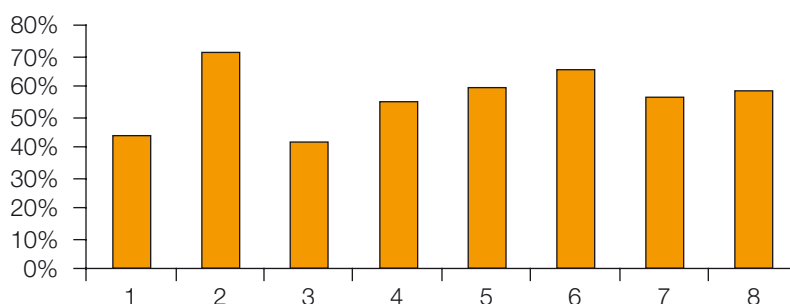
Of the ‘threats’, ‘average speed cameras’ (whereby cameras would be able to calculate average speeds rather than just speeds at camera boxes) seem to hold out the greatest hope for encouraging compliance overall and among the four higher points groups, with between 59% and 70% reporting that this would encourage compliance (the ‘Returners’ would be most encouraged).

Of the ‘incentives’, ‘a halved vehicle insurance bill for having no points on the licence for a year’ was the most popular option overall among all groups, especially among the ‘No Pointers’ and ‘Low Pointers’ (86% and 82%, respectively).

The least popular option overall was ‘hiding speed cameras’ – 34% of respondents said that this would not encourage them, followed closely by ‘doubling fixed penalty notice fines’.

Ironically, ‘No Pointers’ were the group most likely to be encouraged to comply by the different methods, with the exception of ‘attending speed awareness courses’ and ‘average speed cameras’.

Figure 10: Encouraging compliance



In general, I would keep to speed limits if ...

1. All speed cameras were hidden
2. My insurance bill was reduced for having no penalty points on my licence for a year
3. Fixed penalty notice fines were doubled
4. Most people kept to the speed limits
5. Instead of getting any more points on my licence I had to attend a speed awareness course
6. Speed cameras were able to calculate my average speed
7. There was a higher risk of getting caught
8. Higher levels of excess speed attracted higher penalties than now

# Avoiding disqualification by points groups

As shown on Table 4, respondents were asked to indicate which, if any, of four statements they agreed with about how to avoid disqualification. These statements were:

1. I would change the way I drive if I thought it would result in disqualification.
2. I don't think there is anything I could do to avoid being disqualified.
3. My style of driving is unlikely ever to lead to disqualification.
4. I would get someone else to take the points.

The lower level of agreement among 'No Pointers' and 'Low Pointers' for statement one is presumably due to members of these groups not perceiving their driving style as likely to lead to disqualification. The majority of the other groups agreed with the statement, but agreement was highest among the 'Eligibles', suggesting that they were least likely to think their current driving style would result in disqualification.

Statement two drew little consensus, though most notable are the 21% of 'Previously Disqualified' drivers holding the view that 'there is nothing [they] can do to avoid disqualification', compared with 2% of 'Low Pointers'. It would tend to suggest that the 'Previously Disqualified' would not be surprised if disqualification befell them again.

**Table 4: Avoiding disqualification**

	No Pointers (%)	Low Pointers (%)	Returners (%)	Brinkers (%)	Eligible for Disqualification (%)	Previously Disqualified (%)	Total (%)
I would change the way I drive if I thought it would result in disqualification	47	55	75	72	80	72	70
I don't think there is anything I could do to avoid being disqualified	6	2	10	15	12	21	13
My style of driving is unlikely ever to lead to disqualification	75	59	24	15	5	8	23
I would get someone else to take the points	1	2	9	11	5	3	7
Base	130	56	149	517	157	106	1,115

Statement three generated the biggest disparity between the points groups. Seventy-five per cent of 'No Pointers' and 59% of 'Low Pointers' respectively agreed with the statement, compared with only 5% and 8% of 'Eligibles' and 'Previously Disqualified' respectively. Clearly, 'No Pointers' and 'Low Pointers' were very confident that their driving style would not lead to disqualification.

'Brinkers' and 'Returners' were the most likely to consider giving their points to someone else, and (barring 'Low Pointers' and 'No Pointers') 'Previously Disqualified' drivers were the least likely. While this was not a popular option, with only 8% of all points groups combined (and 7% of all respondents overall) claiming that they would do this to avoid disqualification, as a proportion of all drivers with points in the full UK driver licence population such a minority group would comprise a large number of drivers.

## Some key conclusions from the project overall

There was evidence from both the quantitative and qualitative studies to support each of the main conclusions of the project that follow. First, a reminder is necessary that those who provided information for the project were not representative of the driving licence population as a whole, in that all but the control sample had penalty points currently or previously endorsed on their licences. Those with penalty points, however, are important in road safety terms:

1. The key conclusion is that threat of disqualification **does** work, as evidenced by the fact that the reconviction rate is low. Moreover, there was evidence for the threat of disqualification appearing a more effective deterrent than having been previously disqualified.
2. There seemed to be confusion about the processing of drivers eligible for disqualification. The study identified a large group of such eligible drivers who had not been disqualified. The practice of pleading exceptional hardship in court could account for some of these, yet there were other indications that some drivers may be 'slipping through' the system and avoiding disqualification.
3. Most of those surveyed said that they were deterred from speeding by the risk of detection, risk of an accident and the likely penalty if caught. Yet there was evidence of a small 'hardcore' of drivers who are not deterred by any of these factors, who tend to have positive attitudes to speeding, and are more likely to 'manipulate' cameras – just slowing down to pass them.
4. Drivers who had been previously disqualified were most likely to 'manipulate' cameras and least likely to comply with them.
5. Drivers with points were more likely to be male, middle aged (35–64), have high annual mileage, and drive for work and drive a vehicle other than a car, compared with drivers without points on their licences. Those with points had worse knowledge of speed-related facts than those without.

6. The survey results found that more than half of the sample reported that their speeding was inadvertent when last caught.
7. Speeding was generally perceived as ‘non-dangerous’ and ‘not serious’ among those with points for speeding, and many did not accept that they were ‘speeders’. A fair number of drivers thought it reasonable just to slow down when passing cameras or to use radar equipment devices to warn of camera sites.
8. There was considerable ‘folk law’ about how other drivers avoided speeding convictions. Many interviewees thought that passing penalty points to others was commonly done, a third of them were able to identify groups who could be asked to take points, and some were able to quote the going rate for paying other drivers to take their points. One respondent admitted to having passed points to others more than once.
9. It was concluded that not only are drivers deterred from further offending by the threat of disqualification, but some avoid disqualification in other ways.

## Some key recommendations from the project overall

The following recommendations are proposed:

1. Sentencing guidelines on the issue of ‘totting-up’ disqualifications could usefully be reviewed, since consistency appears to be lacking when 12 points may or may not result in the withdrawal of the licence at court.
2. Better publicity explaining why cameras are needed at particular locations is recommended, along with the better signing of posted limits near to cameras.
3. The illegal passing on of points to others was thought to be a common (and, to some, acceptable) practice. This issue deserves further investigation.
4. The fact that many speeding breaches occur in the context of work indicates possible avenues for intervention. High-mileage older males should be seen as a major target group.
5. Resources should be directed at ensuring that the enforcement system is administered consistently, efficiently and in a manner that maintains public support. Deterring the small hardcore who seem resistant to efforts to get them to reduce their speeds is likely to be a long and difficult task.



# References

- Broughton, J. (2008) *Recent Trends for Speeding Convictions and Totting-up Disqualifications*. Project Report No. PR181. Crowthorne: TRL.
- Corbett, C. (1995) Road traffic offending and the introduction of speed cameras in England: the first self-report survey. *Accident Analysis and Prevention*, 27, 345–354.
- Corbett, C. and Simon, F. (1999) *The Effects of Speed Cameras: How Drivers Respond*. DETR Road Safety Research Report No.11. London: DETR. [www.dft.gov.uk/pgr/roadsafety/research/rsrr/theme4/theeffectsofspeedcamerashowd4779](http://www.dft.gov.uk/pgr/roadsafety/research/rsrr/theme4/theeffectsofspeedcamerashowd4779) (accessed on 21 April 2009).
- Corbett, C. and Caramlau, I. (2006) Gender differences in responses to speed cameras: typology findings and implications for road safety. *Criminology and Criminal Justice: An International Journal*, 6(4), 411–433.
- Corbett, C., Delmonte, E., Quimby, A. and Grayson, G. (2008) *Does the Threat of Disqualification Deter Drivers from Speeding?* London: DfT. [www.dft.gov.uk/pgr/roadsafety/research/rsrr/theme2/threat.pdf](http://www.dft.gov.uk/pgr/roadsafety/research/rsrr/theme2/threat.pdf) (accessed on 21 April 2009).
- Drive and Vehicle Licensing Agency (DVLA) (2009). *DVLA Driver and Vehicle Statistics: Drivers Statistics at a Glance*. [www.dvla.gov.uk/pressoffice/stats.aspx](http://www.dvla.gov.uk/pressoffice/stats.aspx) (accessed on 21 April 2009)
- Gains, A., Nordstrom, M., Heydecker, B. and Shrewsbury, J. (2005) *The National Safety Camera Programme: Four Year Evaluation Report*. London: PA Consulting Group.
- Ministry of Justice (2007). *Statistical Bulletin: Motoring Offences and Breath Test Statistics, England and Wales 2005*. [www.justice.gov.uk/docs/motoring-offencesandbreath-stats2005.pdf](http://www.justice.gov.uk/docs/motoring-offencesandbreath-stats2005.pdf) (accessed on 21 April 2009).
- Office of National Statistics (2001) *Population Size by Ethnicity*. [www.statistics.gov.uk/cci/nugget.asp?id=273](http://www.statistics.gov.uk/cci/nugget.asp?id=273) (accessed on 21 April 2009).
- Stradling S., Gormley, M., Fuller, R., Broughton, P., Kinnear, N., O'Dolan, C. and Hannigan, B. (2007) A typology of speeding drivers: extent of and motives for exceeding the speed limit. *Behavioural Research in Road Safety, Seventeenth Seminar*. London: Department for Transport.

# 14

## Low-cost engineering measures for speed management

Samantha L. Jamson, Frank C. H. Lai and Oliver M. J. Carsten  
Institute for Transport Studies  
University of Leeds  
Leeds LS2 9JT

### Introduction

This project aimed to identify the most effective, low-cost speed-reducing measures for a selection of urban and rural environments. This was achieved by furthering our understanding of how drivers choose their speed (consciously or not) and what sensory cues we might use to alter this. The overall project approach consisted of three sequential phases:

- Phase 1 – a review of previous experience with speed-reduction treatments;
- Phase 2 – applying expert judgement to the information gathered in Phase 1 to design a range of treatments for each of the problem areas and road types; and
- Phase 3 – simulator experiments to identify the most promising treatments.

The review guided the experimental work in Phase 2 of the project by considering the relationship between speed indices and accident rates at both the individual driver level and the collective (road) level (Fildes *et al.*, 1991; Maycock *et al.*, 1998; Quimby *et al.*, 1999; Kloeden *et al.*, 2001). In addition, the review outlined the state-of-the-art speed-reducing measures, concentrating on engineering design. This involved consultation of the current research literature, analysis of existing data and a survey of local authorities in the UK. The results can be found in Jamson and Lai (2008). This paper, however, provides an overview of the behavioural study carried out in Phase 3 of the project.

Road safety treatments act as cues to the driver stimulating them to reassess the environment and the appropriateness of their current speed. In general, there are two broad categories of treatments:

- Illusory treatments – this type of treatment aims to influence the driver’s speed perception. As a driver’s perception of their own speed is altered, the driver’s perceived safety is amended, which may therefore result in a reduction of travel speed due to **intrinsic** motivation. For example, narrowing the road by hatching the centre or sides of the carriageway creates an illusory effect of narrowed lanes, although the physical width of the carriageway remains unchanged.
- Alerting treatments – this type of treatment aims to attract a driver’s attention and advise them about potential hazards. Although the driver’s perceived safety may not be altered (because the presence of the carriageway and adjacent environment is not changed), they may still reduce travel speed as a result of **extrinsic** motivation. For example, vehicle-activated signs or rumble strips with a raised profile draw a driver’s attention through different perception channels but they both deliver a message to the driver that there is a need to slow down.

Within these two broad categories, three types of treatment were used in this trial: narrowing, surface marking and signage. As the objective of the experimental work was to identify effective treatments with low capital and maintenance costs, as well as low risk of injury in the event of collision, treatments with narrowing were primarily focused on virtual narrowing (e.g. using paint). In addition, there is little doubt about the effectiveness of physical measures, and hence physical narrowing was included on some sections of roads as a benchmark (e.g. pedestrian refuges).

Since a driver can be selectively attentive, colouring was introduced to some treatments, such as signs on a yellow backing board or hatching with gaps filled with a coloured surface. The effect of sensory feedback on speed reductions was also investigated by comparing rumble strips with or without a raised profile.

## Method

The study was performed using the University of Leeds’ driving simulator, see Figure 1. The simulator’s vehicle cab is based around a 2005 Jaguar S-type, with all of its driver controls fully operational. The vehicle’s internal Control Area Network (CAN) is used to transmit driver control information between the Jaguar and one of the network of seven Linux-based PCs that manage the overall simulation. This ‘cab control’ PC receives data over Ethernet and transmits it to the ‘vehicle dynamics’ PC, which runs the vehicle model. The vehicle model returns data via cab control to command feedback so that the driver seated in the cab feels (steering torque and brake pedal), sees (dashboard instrumentation) and hears (80W 4.1 sound system provides audio cues of engine, transmission and environmental noise).

The Jaguar is housed within a 4 m diameter, spherical projection dome. Six visual channels are rendered at 60 frames per second and at a resolution of  $1024 \times 768$ . The forward channels provide a near seamless field of view of  $250^\circ$ , and the rear view channel ( $40^\circ$ ) is viewed through the vehicle’s rear and side view mirrors. The simulator incorporates a large amplitude, eight degree of freedom motion system using a railed gantry and electrically-driven hexapod. The motion-base enhances the

fidelity of the simulator by providing realistic inertial forces to the driver during braking and cornering. It also provides lifelike high-frequency heave, allowing the simulation of road roughness and bumps.

Figure 1: University of Leeds' driving simulator



## Road scenarios

Seven road scenarios were modelled, each according to Volumes 6 and 8 of the *Design Manual for Roads and Bridges* (Highways Agency, 2005):

1. Urban straight.
2. Urban junction.
3. Rural straight.
4. Rural junction.
5. Rural bend.
6. Village entry.
7. Rural lane.

Since a very long stretch of road would be needed to accommodate the required number of sections (44 treatment sections and seven baseline sections), there were concerns about possible driver fatigue, which could jeopardise the validity of the data. Hence, these 51 sections of road were spread across three routes, and each route took no more than 25 minutes to drive. Each route contained all of the seven road layouts. A completely within-subject design was used, allowing direct comparison between a driver's baseline speed and the speed when they encountered the treatments. Each participant drove all three routes, but the order in which they encountered the three routes was counterbalanced.

## Treatments

Following the results of the literature review and the survey data received from local authorities, a total of 44 treatments were developed, representing various types of treatment suitable for implementation on each road layout.

## Participants

Speeding countermeasures are implemented to reduce the average speed of drivers. In order to achieve this without increasing speed variation, it is necessary to reduce the speed of the fastest drivers. It is therefore logical to recruit drivers who either have a history of, or a propensity to, speed. This is most easily achieved by using a sample that is skewed towards speeding propensity. Using incentives to drive quickly on the simulator is not appropriate here, as 'speed choice' will be heavily influenced. Much research has concentrated on answering the question: 'Which drivers speed?' Most studies have concluded that speeding is predominantly a male pastime (e.g. French *et al.*, 1993; Shinar *et al.*, 2001). With regard to age, speeding is associated with young drivers (e.g. Parker *et al.*, 1992; Stradling *et al.*, 2000). In order to truly study the effectiveness of speeding countermeasures, young (under 25) male drivers were recruited for the simulator study.

Forty male drivers were recruited for this study. Their age ranged between 19 and 25 years, with a mean age of 22 years. Annual mileage ranged between 100 and 20,000, with the average being approximately 7,000 miles. On average they had obtained their driving licence 3.78 years previously. They reported that they drove, on average, three times a week, mostly on urban roads. Their experience on rural roads was limited. Of the 40 participants, 39 either owned or had access to a car. Four drivers currently had points on their licence.

## Data analysis

As the treatments ranged from signage to road markings to physical objects, they were different in length and therefore impact. For example, a sign is located at a particular spot, but is clearly visible from some distance beforehand. Conversely, central hatching is longer in length but may not be seen until relatively close to the start of the treatment. From plotting the speed profiles for each of the treatments, it was clear that treatments had different 'impact zones' and that simply recording mean speed at the start and end of the treatment did not take account of all the impacts of the treatment. An impact zone was therefore defined for each treatment.

The impact zone starts at the approximate point on the route when the driver is likely to perceive the first visual cue relevant to the road layout that he is about to negotiate. The impact zone ends at the point on the route when the target point is reached. Each treatment was compared against the baseline condition to evaluate its effectiveness with respect to mean speed as well as the 85th percentile speed. Owing to the different lengths of the treatments, each had a corresponding length of baseline road.

Following inspection of the speed profiles, a number of measures of speed were developed which allowed comparison across the treatment types:

1. Speed change within the impact zone ( $\Delta$ ).
2.  $\Delta$  per metre of treatment ( $\Delta/m$ ) – this standardises the  $\Delta$ , enabling comparison across treatments.
3. Speed at Maximum  $\Delta$  ( $v@max\Delta$ ) – this refers to vehicle speed at the point at which the change in speed is greatest.
4. Speed at target point ( $v_2$ ) – this refers to speed at the end of the impact zone ( $v_2$ ) as opposed to speed at the beginning of the impact zone ( $v_1$ ).
5. Percentage of speed change:  $(v_2 - v_1)/v_1$ . A negative percentage indicates speed reduction.

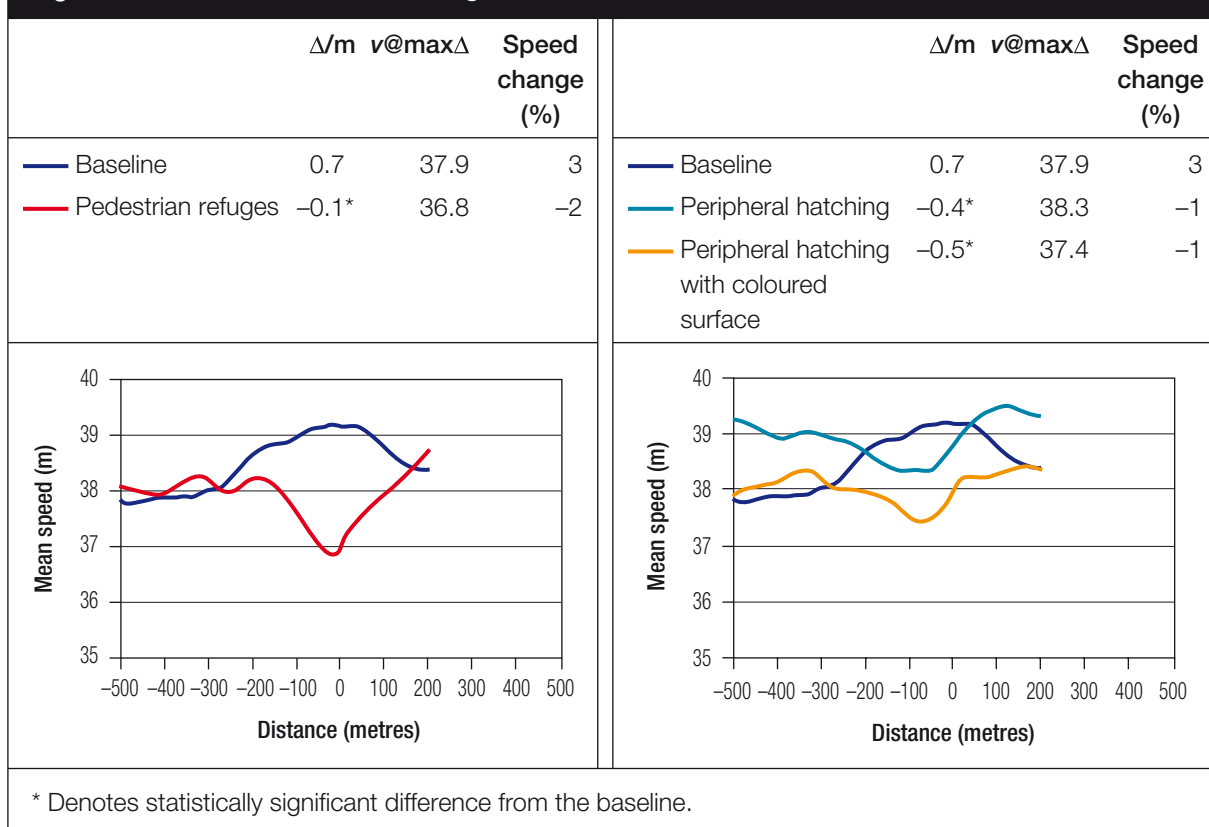
## Results

The following sections summarise the effect of each of the treatments on speed behaviour. For clarity we present the results by road type.

## Urban straight

The central hatching treatments were not successful in lowering speeds on straight sections of urban road. Peripheral hatching, on the other hand, was more successful (see Figure 2). This presumably is due to drivers feeling more exposed as they travel nearer the centre line. The physical presence of pedestrian refuges also reduced driver's speed significantly, suggesting that physical objects are more effective in these situations. It is worth noting that pedestrian refuges reduced spot speed, as indicated by a lower  $v@max\Delta$  in comparison with peripheral hatching. On the other hand, peripheral hatching achieved better results over distance, as indicated by  $\Delta/m$ .

Figure 2: Results of the urban straight scenario



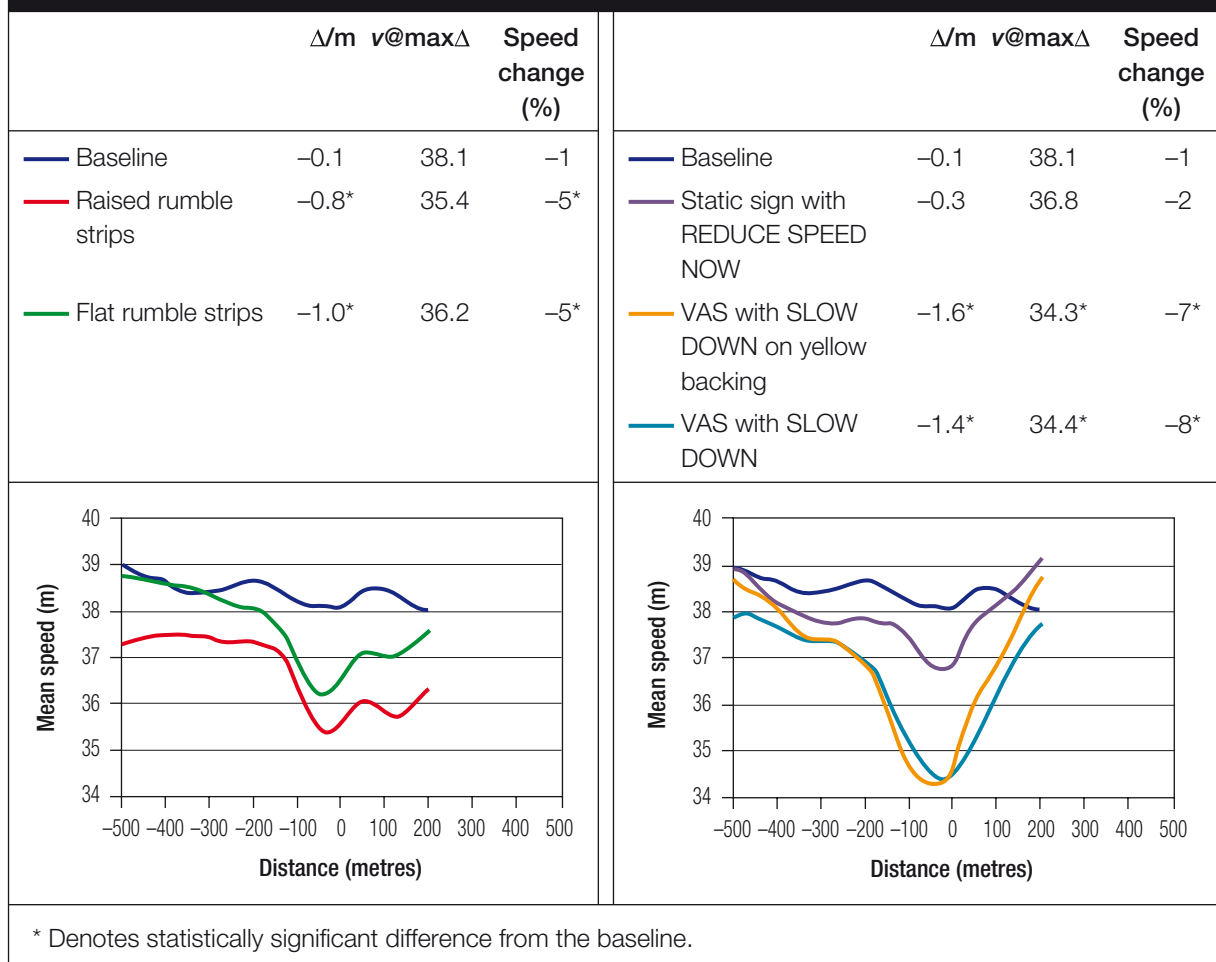
Noticeably, the coloured surface achieved better results than the non-coloured surface (i.e. with respect to peripheral hatching), which is perhaps attributable to a higher degree of contrast, reinforcing the effect of the hatching treatment. However, the effect size of treatments for the urban straight section is generally small, presumably due to the fact that vehicle speed is relatively low in comparison with the rural environment.



## Urban junction

Rumble strips and vehicle-activated signs (VAS) are effective at reducing speeds when approaching an urban junction, as evidenced by statistical significance (see Figure 3). The effect of VAS is more prominent than rumble strips, as revealed by all three performance indicators. Static signs appear to be effective to some extent, although not statistically different from the baseline.

Figure 3: Results of the urban junction scenario

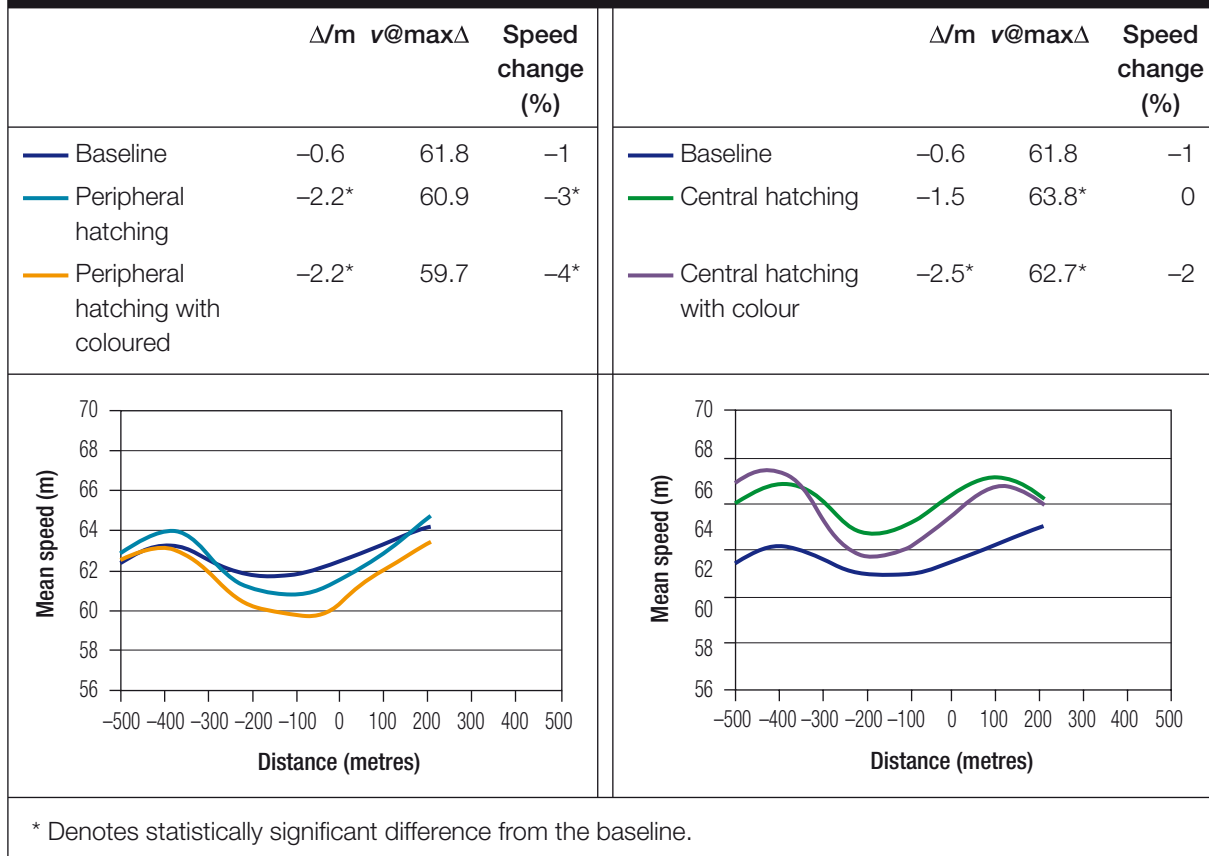


With respect to rumble strips, there is little difference between the two variants (raised and flat profiles), with the speed profiles showing very similar shape. In addition, there appears to be no advantage of the yellow background to the VAS. This is perhaps due to the cluttered background of the urban environment and hence the effect of contrast was not prominent.

## Rural straight

With respect to absolute speed, peripheral hatching was the most effective treatment, as indicated by  $v@max\Delta$ , which also achieved the greatest speed reduction in percentage (see Figure 4).

Figure 4: Results of the rural straight scenario

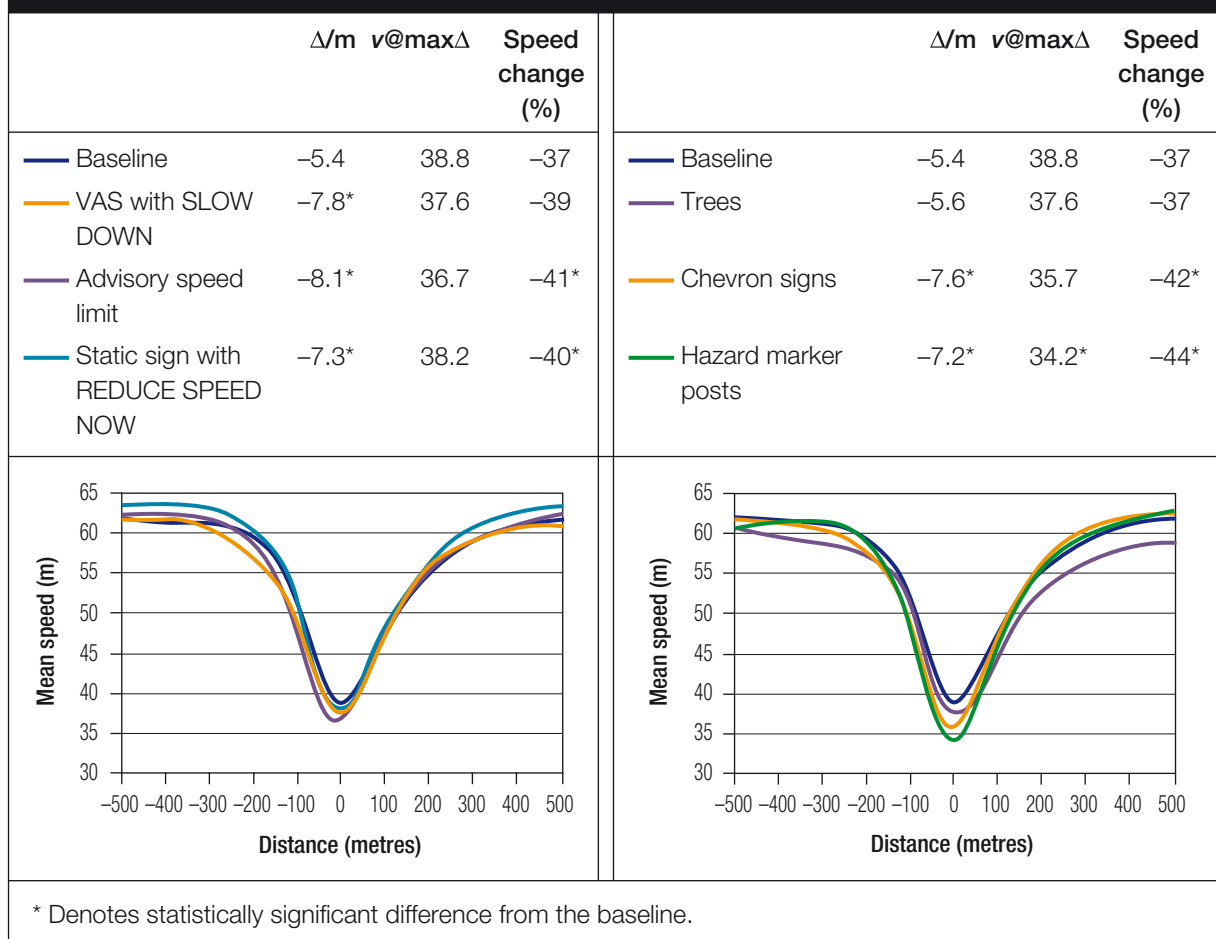


However, in terms of the shape of the speed profile, central hatching with coloured surface also achieved great results in speed reduction, i.e. the value of  $\Delta/m$  being -2.5, which is the best result among all treatments tested for rural straight sections. Overall, hatchings appeared to be more effective than trees, suggesting that horizontal narrowing outperforms vertical narrowing.

## Rural bend

Of the treatments tested on the rural bend scenario (Figure 5), two types demonstrated the best results in speed reduction. One of them was the treatments that highlight the position of the apex, i.e. chevron signs and hazard marker posts, which guide the drivers through the point along the bend where loss of control is most likely to happen. These two treatments, unsurprisingly, achieved the lowest  $v@max\Delta$ .

Figure 5: Results of the rural bend scenario

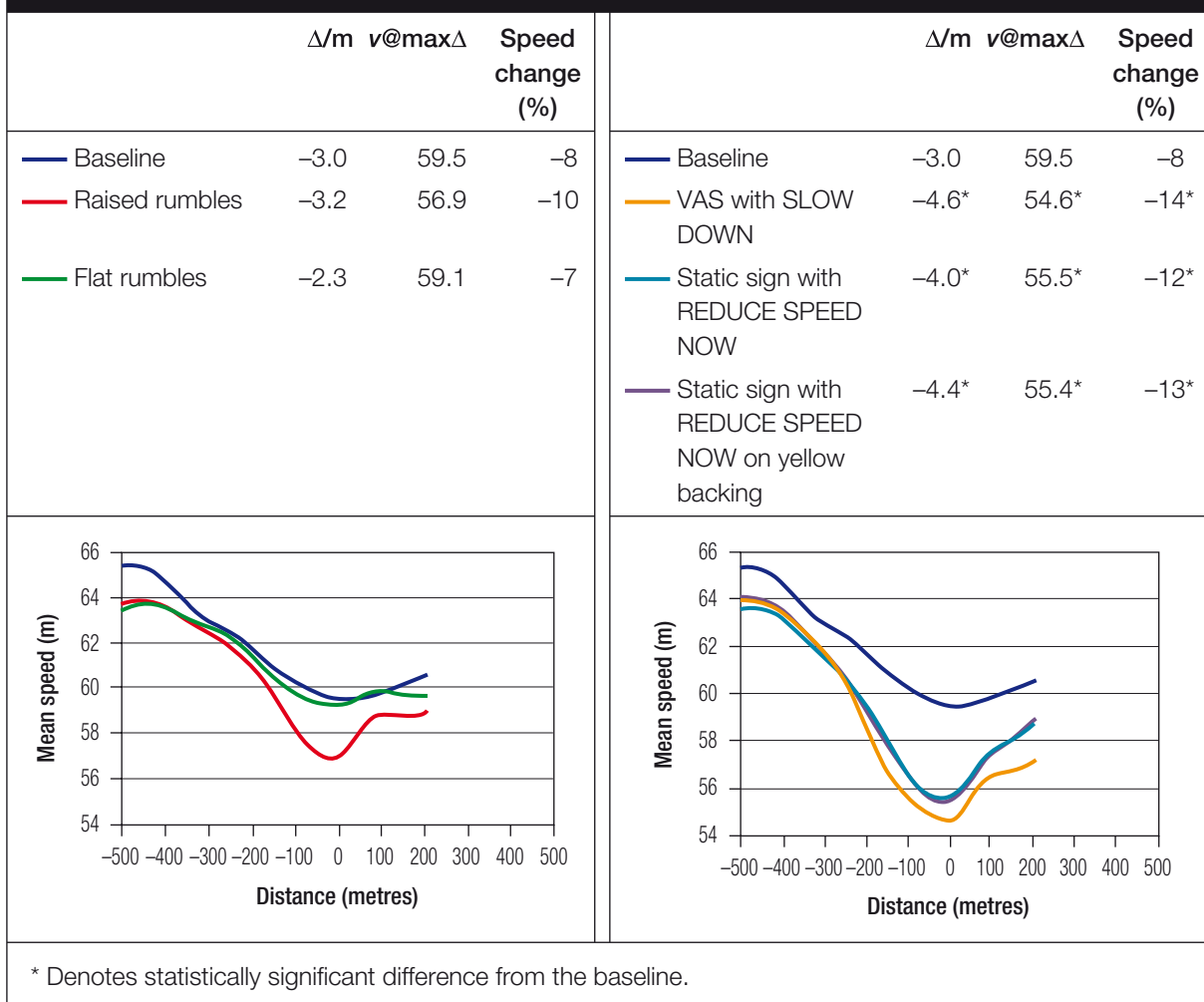


The other type of most effective treatment was signs, which provide advanced warning over an ample distance ahead of the apex, as demonstrated by  $\Delta/m$ . It is worth noting that a static sign with an advisory speed performed better than a VAS consistently across all three performance indicators, which suggests that a clearly defined advisory speed-limit gives a more effective warning than a standard phrase such 'Slow Down' or 'Reduce Speed Now'.

## Rural junction

Rumble strips with a raised profile appeared to have an impact on vehicle speed approaching a rural junction (Figure 6), although the reduction was not statistically different from the baseline condition. Somewhat surprisingly, rumble strips with a flat profile were not effective, and performed slightly worse than the baseline condition, although the difference was not statistically significant. The two variants of rumble strips resulted in a similar shape in the speed profile up to the beginning of the first set of rumble strips. The raised rumble strips then brought the speed down at a greater rate, while the flat rumble strips merely mirrored the reduction rate achieved in the baseline condition. This suggests that tactile feedback played a role in speed reduction.

Figure 6: Results of the rural junction scenario

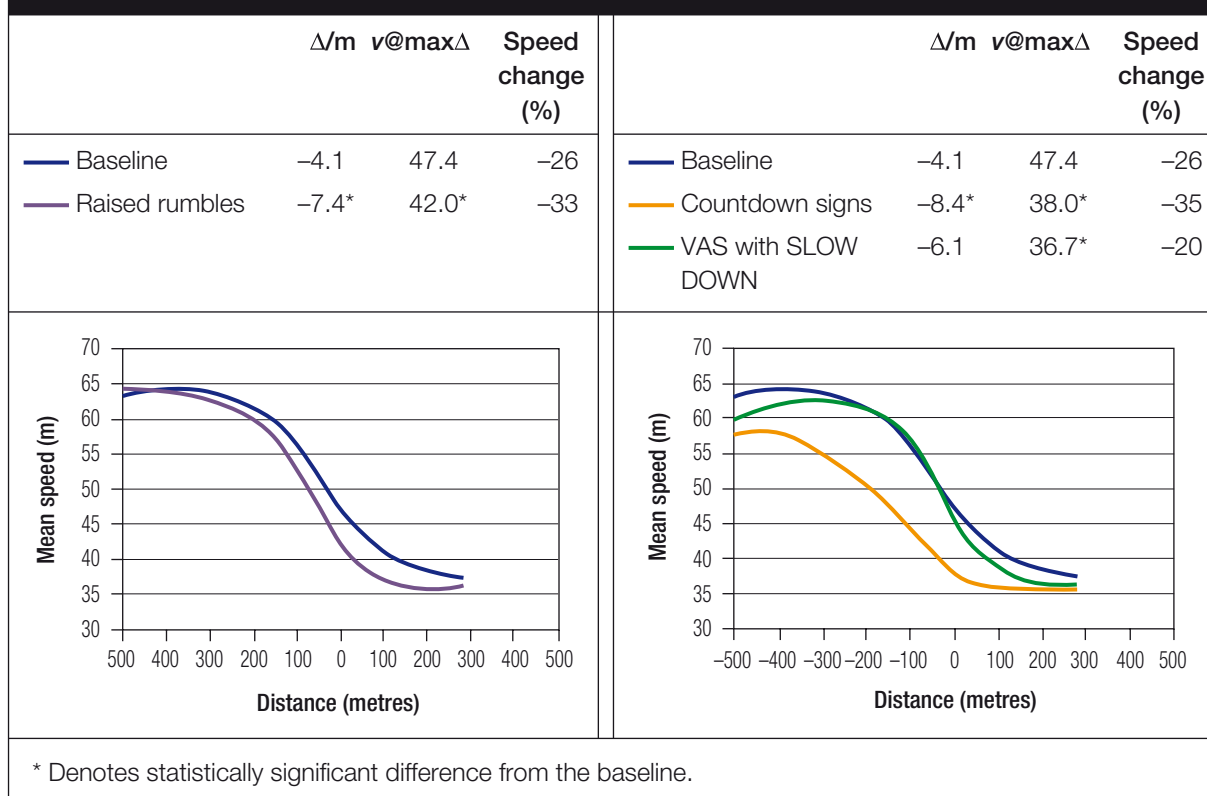


The other group of treatment applied to urban junctions, signs, performed significantly better than rumble strips. Of the three signage treatments, VAS achieved the best results in speed reduction. It is also worth noting that signs with a yellow background performed marginally better than signs without, which suggests that contrast helps the perception of the visual cue.

## Village entry

Most of the treatments tested for village entry appear to be effective (Figure 7). It should be noted that the VAS was placed behind the village entry (where the 30 mph speed limit signs were located) to comply with the legal requirement and hence its effectiveness is not comparable with all other treatments for this layout, which were placed ahead of, or at, the village entry. However, the VAS was effective in speed reduction in comparison with its own baseline condition.

Figure 7: Results of the village entry scenario



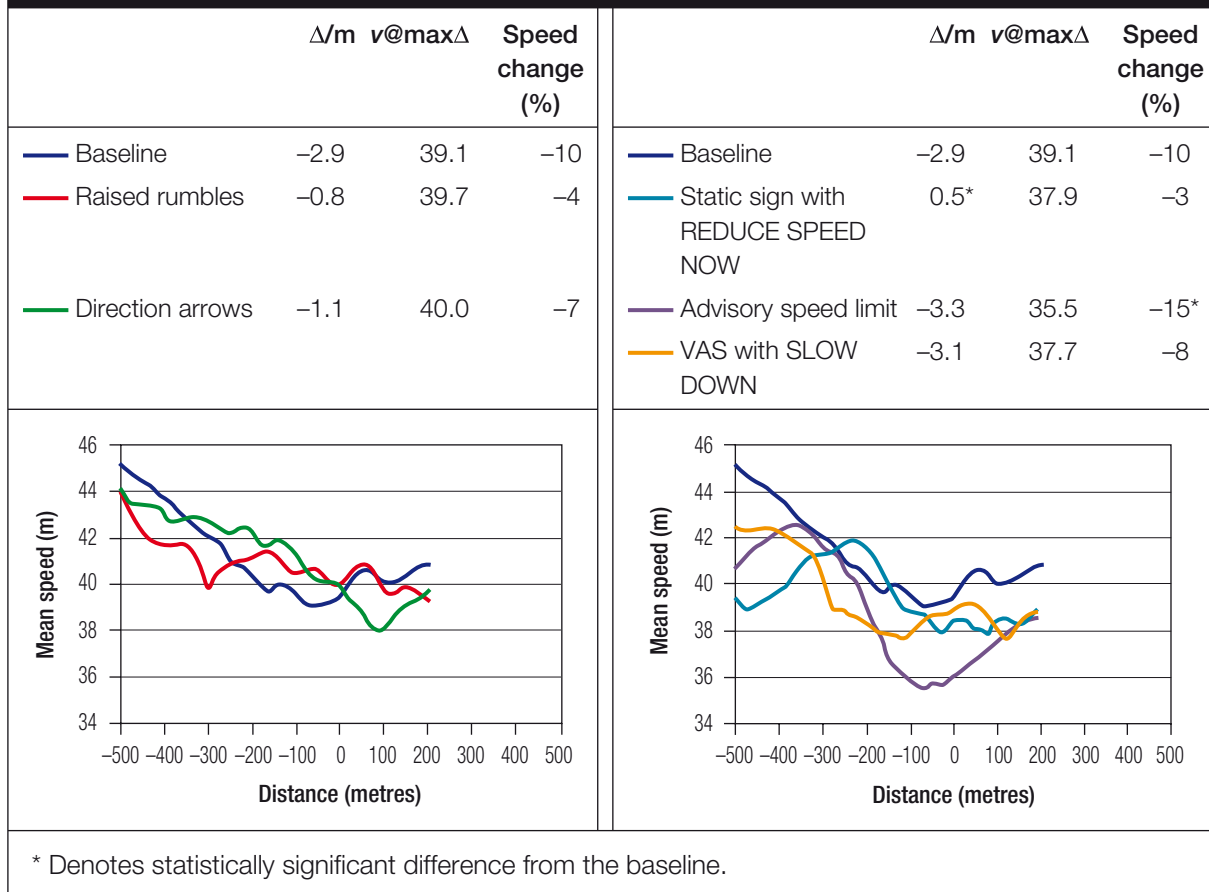
Among the rest of the treatments, countdown signs were consistently the best-performing treatment across all three performance indicators. The speed profile of the countdown signs is also evidently different from other treatments. This suggests that progressive warning (i.e. 300, 200, 100 yards to the change of speed limit) achieves better results in speed reduction than other types of treatment.

It is worth noting that rumble strips with a raised profile is the second best-performing treatment for village entry. Although the location and duration of rumble strips are similar to other surface treatments, such as dragon's teeth or combs with chevrons, the unique tactile feedback seems to reinforce the warning in addition to the visual presentation.

## Rural lanes

The results for the rural lane scenario are affected by the presence of oncoming traffic, as can be seen by the variation in the speed profile as drivers slowed down to let others pass (Figure 8).

Figure 8: Results of the rural bend scenario



The treatments had limited success, with only the two static signs affecting speeds significantly. The sign showing the advisory speed limit was the best performer, inducing an additional 5% speed reduction over the baseline measurements.

## Perceived speeds

At the end of the study, drivers were shown a selection of the treatments using still photographs. They were asked:

- ‘At what speed would you travel along this stretch of road?’; and
- ‘At what speed do you think other drivers would travel along this road?’

By comparing their responses with their actual speed, as measured in the simulator trials at those particular locations, we were able to correlate drivers’ self-reported speed against their actual speed. Secondly, by correlating drivers’ self-reported speed with the speed they reported for ‘others’, we were able to judge whether young males consider themselves different to other drivers.

In the urban environment, drivers' actual and reported speeds showed close correlation (Table 1). Only a divergence in speeds was noted for raised rumble strips.

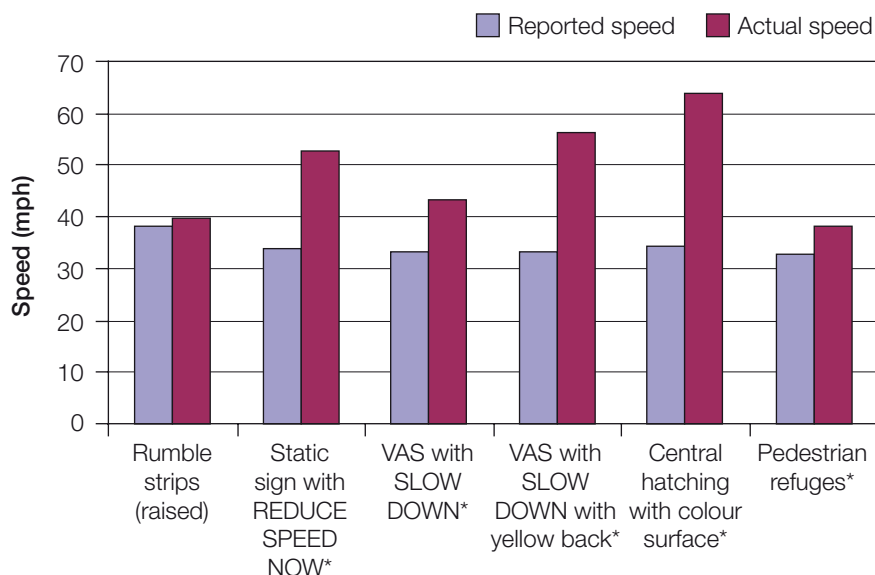
**Table 1: Correlation between drivers' reported and actual speed in urban scenarios**

Treatment	Correlation between actual and reported speed	Correlation between own and others' speeds
Rumble strips (raised)	0.161	0.807*
Static sign with REDUCE SPEED NOW	0.337*	0.517*
VAS with SLOW DOWN	0.486*	0.415*
VAS with SLOW DOWN with yellow back	0.431*	0.242
Central hatching with coloured surface	0.461*	0.589*
Pedestrian refuges	0.624*	0.492*

\* Denotes statistically significant correlation.

However, when we compare the mean speeds using paired t-tests for each of the treatments, it can be seen that, while the speeds may correlate, actual speeds are almost always significantly higher than reported speeds (Figure 9). There were no statistically significant differences between a driver's reported own speed and the speed of others.

**Figure 9: Differences between reported and actual speeds in urban scenarios**



\* Denotes that the differences are significant at the 0.05 level.

For rural treatments there was less concordance between actual and reported speeds compared with the urban treatments (Table 2).

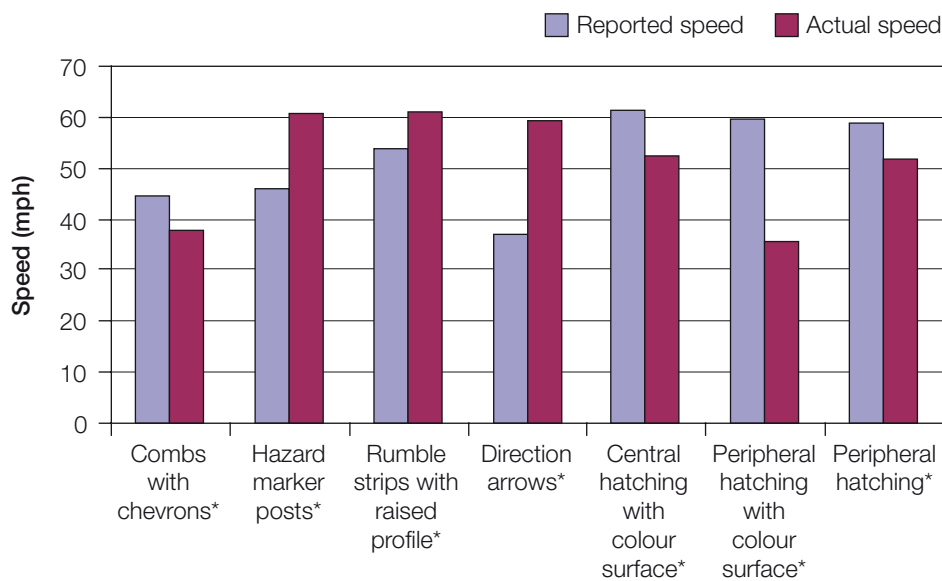


**Table 2: Correlation between drivers' reported and actual speed in rural scenarios**

Treatment	Correlation between actual and reported speed	Correlation between own and others' speeds
Combs with chevrons	-0.009	0.728*
Hazard marker posts	0.267	0.791*
Rumble strips with raised profile	0.489*	0.736*
Direction arrows	0.359*	0.600*
Central hatching with coloured surface	0.615*	0.707*
Peripheral hatching with coloured surface	0.291	0.452*
Peripheral hatching	0.307	0.574*

\* Denotes statistically significant correlation.

However, as in the urban environment, there were differences in mean actual and reported speeds across the treatments. This time the pattern is not as clear cut, with some reported speeds being higher than actual speeds and some vice versa. In general, the actual effect of hatching treatments was larger than the drivers imagined it would be (Figure 10).

**Figure 10: Differences between reported and actual speeds in rural scenarios**

\* Denotes that the differences are significant at the 0.05 level.

Again, there were no statistically significant differences between drivers' reported own speed and the speed of others.

There was a general lack of correlation between drivers' reported and actual speeds in village transitions, see Table 3.

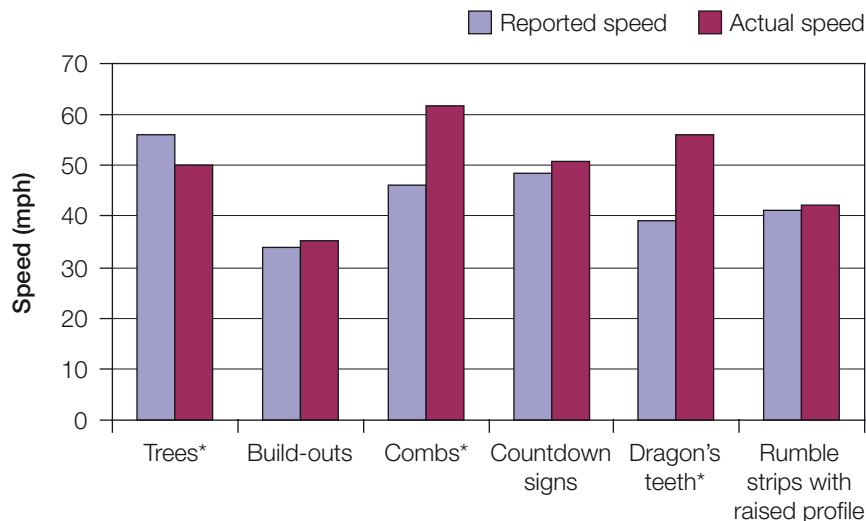
Table 3: Correlation between drivers' reported and actual speed in village transitions

Treatment	Correlation between actual and reported speed	Correlation between self and others' speeds
Trees	0.307*	0.734*
Build-outs	0.216	0.749*
Combs	0.331*	0.749*
Countdown signs	-0.009	0.751*
Dragon's teeth	0.039	0.722*
Rumble strips with raised profile	0.117	0.746*

\* Denotes statistically significant correlation.

Paired t-tests revealed few differences between reported and actual speeds, with trees having a greater effect on driver speed than they imagined (Figure 11).

Figure 11: Differences between reported and actual speeds in village transitions



\* Denotes that the differences are significant at the 0.05 level.

## Conclusions

In the **straight, urban** sections of road, narrowing of the road was achieved either by using physical means (pedestrian refuges) or using surface paint treatments. Overall, it proved difficult to induce significant reductions in speed. This may have been partly due to the fact that there was no obvious reason for a speed reduction. Pedestrian refuges achieved the best results in terms of lowest actual speed, implying that physical obstacles affect drivers' speed choice. Central hatching was not as effective as peripheral hatching, and the coloured surface of the peripheral hatching was beneficial.

In the **straight, rural** sections of road, narrowing was achieved either by horizontal or vertical means. Hatching, particularly in the periphery, was effective in lowering speed; again the coloured surface proved beneficial. Vertical narrowing, using trees, was not successful.

At **urban junctions** static signs were the least effective treatment, perhaps due to the complexity of the external environment. VAS and rumble strips were both effective – the raised rumble appeared to have additional benefits.

At **rural junctions** raised rumble strips demonstrated an impact on speed reduction; flat rumble strips, however, were not effective. This highlights the added benefit of tactile feedback to speed perception in addition to visual presentation. The VAS was the clear winner in this scenario.

At **rural bends** treatments that highlight the apex area of the curve seem to be more effective than just providing an advance warning only. These treatments guide drivers through the bend rather than leaving the judgement to the drivers. Advisory speed limits appear to work well, suggesting that drivers appreciated targeted information (rather than a standard warning of ‘Slow Down’ or ‘Reduce Speed Now’). Trees were not successful at this location.

At **village entry** raised rumbles alerted the driver and reduced speed, as did VAS. Countdown signs worked well, suggesting that early, as well as continual, warning is necessary. This theme of alerting the driver was also evident in that treatments with more paint were more effective. Trees were not an effective treatment.

In **rural lanes**, the advisory speed limit sign was the best performer, with VAS also effective.

## References

- Fildes, B. N., Rumbold, G. and Leening, A. (1991) *Speed Behaviour and Drivers' Attitude to Speeding*. General Report No. 16. Hawthorn, Victoria: VIC Roads.
- French, D., West, R., Elander, J. and Wilding, J. (1993) Decision-making style, driving style and self-reported involvement in road traffic accidents. *Ergonomics*, 36(6), 627–644.
- Highways Agency (2005) *Design Manual for Roads and Bridges* Volumes 6 and 8. London: HMSO.
- Jamson, S. L. and Lai, F. C. H. (2008) *Interaction Between Speed Choice and Road Environment*. Road Safety Research Report No. 100. London: Department for Transport.
- Kloeden, C. N., Ponte, G. and McLean, A. J. (2001) *Travelling Speed and the Rate of Crash Involvement on Rural Roads*. Report No. CR204. Canberra: Australian Transport Safety Bureau.

Maycock, G., Brocklebank, P. J. and Hall, R. D. (1998) *Road Layout Design Standards and Driver Behaviour*. TRL Report No. 332. Crowthorne: Transport Research Laboratory.

Parker, D., Manstead, A. S. R., Stradling, S. G., Reason, J. T. and Baxter, J. S. (1992) Intention to commit driving violations: an application of the Theory of Planned Behaviour. *Journal of Applied Psychology*, 77(1), 94–101.

Quimby, A., Maycock, G., Palmer, C. and Buttress, S. (1999) *The Factors that Influence a Driver's Choice of Speed: A Questionnaire Study*. TRL Report No. 325. Crowthorne: Transport Research Laboratory.

Shinar, D., Schechtman, E. and Compton, R. (2001) Self-reports of safe driving behaviours in relationship to sex, age, education and income in the US driving population. *Accident Analysis and Prevention*, 33(1), 111–116.

Stradling, S., Meadows, M. and Beatty, S. (2000) *Characteristics of Speeding, Violating and Thrill-seeking Drivers*. Paper presented at the International Conference on Traffic and Transport Psychology, Bern.

# The psychology of speeding

Frank P. McKenna  
Department of Psychology  
University of Reading  
Reading RG6 6AH

## Introduction

The relationship between speed choice and casualties has been well documented (Aarts and van Schagen, 2006; Finch *et al.*, 1994; Richter *et al.*, 2006) and is relatively uncontroversial within professional circles. The extent to which the connection between speed and casualties is accepted outside of professional circles is less clear. It is certainly possible to encounter opposition to the connection between speed and casualties. This opposition takes many forms. Indeed, Delaney *et al.* (2005) have noted that opposition within sections of the public can, and has, led to the collapse of speed enforcement campaigns. Even within driver-training circles it is common to deny a simple connection between speed and casualties. Here the emphasis is on inappropriate speed for the conditions as opposed to speed per se. While this position seems uncontentious, one potential difficulty with this argument is the implication that if you have the appropriate skill to determine the appropriate speed then all will be well. At an empirical level, if it were the case that drivers were determining the appropriate speed, then we should not observe the relationship between speed and casualties. The fact that we do observe this relationship means that something is wrong. What might that be? One potential difficulty might be in determining level of skill. Most people will estimate their own degree of skill. If this estimate is inaccurate, then drivers may find that their estimate of personal skill influences their speed, but their estimate of their personal skill may not be accurate. In a survey of over 10,000 drivers, McKenna (2007) reports that only 4% of drivers judged that they were less skilful than average. This then leaves open the argument that, while drivers may perceive that they have the skill to judge the appropriate speed for the conditions, this may not be the case.

The fact that so few drivers have a low estimate of their skill may also be consistent with the fact that, historically, so many drivers have broken the speed limit. In one survey it was found that 69% of drivers broke the speed limit (DETR, 2000). If we consider speed as the output of the combined effects of the driver, the vehicle and the road, then the sheer number of people breaking the speed limit represents a massive system failure. Clearly we could examine such a system failure from a number of different perspectives. For the present, the aim is to examine the potential role of enforcement. If a substantial number of drivers break the law, then a number of barriers to the enforcement of speed limits occur.

# Barriers to obeying speed limits

Authorities around the world face a number of dilemmas over enforcement as a function of the large number of potential barriers to obeying speed limits. For those who wish the law to be obeyed, it is worth understanding these issues. Some of these barriers stem directly from the sheer frequency of law breaking. (There is a chicken and egg problem here that will not be considered in any depth. Should we start from the position of the large number of people who break the law or try to explain why that has come to be the case?)

## Social pressure

People are very sensitive to the behaviour of others. For example, in a classic study Asch (1956) demonstrated that when people are faced with social pressure to provide a clearly incorrect answer, then many people will conform by providing that incorrect answer. When a substantial number break the speed limit, drivers may experience social pressure to break the speed limit as opposed to conform to the speed limit. A number of studies have demonstrated that perceived social pressure is a determinant of speeding intention.

## Deterrence

The fact that so many drivers have been breaking the speed limit brings with it particular problems for enforcement. One specific problem is the mandate for enforcement. In a democratic society what mandate do authorities have to prosecute the majority of the people that they represent? In addition, Nagin (1998) has argued that the key feature of the deterrent effect of sanctions arises from social stigma. He also notes that a punishment cannot be socially isolating if it is commonplace. Herein, lies a difficulty. As long as speeding is commonplace, any punishment will not be socially isolating.

The key principles of deterrence have remained relatively unchanged since Beccaria and Bentham. The proposal is that deterrence increases as the certainty, severity and celerity (imminence) of punishment increases. Although there has been little research on the role of celerity (though see Nagin and Pogarsky, 2001) considerable attention has been paid to the relative merits of the certainty versus severity of punishment. The general consensus has supported Bentham's position that the certainty of punishment is more important than severity. Although there are some who point to the importance of severity (Mendes, 2004; Mendes and McDonald, 2001), in one extensive review Doob and Webster (2003) came to the strong conclusion that there is no relationship between severity and deterrence. Herein lies another difficulty for enforcement. While the severity of punishment is relatively easy to manipulate, this is not so for the certainty of detection. Indeed, Robinson and Darley (2004) have criticised all deterrence theories on the basis that the probability of detection is too low to prompt a change in behaviour. Put simply, they argue that deterrence does not work. In the case of speeding, the argument would be that if the probability of detection for a speeding offence is too low, then drivers will not change their behaviour.

## Perceived legitimacy

It has been argued that a key factor in gaining the acceptance of legal decisions is their perceived legitimacy (Tyler, 2003). A number of factors affect perceived legitimacy.

### MOTIVE-BASED TRUST

An important consideration is the inferences people make about the motives of the authority. Are the motives benevolent? Does the authority have my best interests at heart? Is the motive to reduce harm? What is the motive? Tyler and Huo (2002) have found that people are more willing to defer to an authority if they trust their motives. Indeed, they found that the best predictor of satisfaction with the authority was motive-based trust. In the case of speeding, a good deal of debate in the public media has concerned the motives of authorities. A particular focus has been placed on money as the motive. Clearly if people perceive that traffic enforcement is being used as a mechanism to acquire money as opposed to reduce harm, then trust in authority is likely to decline. As noted in one report, the public is less likely to be supportive if they believe that enforcement is 'being deployed as fund raising "speed traps"' (Transportation Research Board, 1998; p. 157).

### PROCEDURAL JUSTICE

Another important feature is whether the procedures that are employed are perceived as being fair. The fact that the term 'speed trap' is frequently used implies that there might be a question mark over the procedures that are employed in speed enforcement.

## Instrumental motives

In the catalogue of barriers to reducing speed we might add personal instrumental motives. When asked why drivers speed, Gabany *et al.* (1997) found that two key factors were thrill seeking and time pressure. If drivers perceive specific benefits such as using speeding as a method of thrill seeking, or consider themselves to be under time pressure, then clearly personal self-interest will be a barrier to obeying speed limits. People vary in their sensation seeking, with men higher in sensation seeking than women and younger higher than older (a pattern that parallels crash involvement). It has been known for some time (see Jonah, 1997) that those who are higher in sensation seeking have a greater tendency to express this in risky driving. Time pressure is often cited as a reason for speeding. Clearly, if people consider that they can meet their appointments if they speed, then an extra pressure arises.

## Perceptual factors

There are a number of perceptual factors that need to be considered. For example, speed adaptation has long been known (Schmidt and Tiffin, 1969). After travelling at speed for some time, the sensation of speed decreases and the perception is that we are travelling at slower speeds than is the case. It has also been found that, as



visibility decreases, our ability to determine speed also decreases and our actual speeds increase (Snowden *et al.*, 1989). So the point at which we have minimal cues available, for example fog, we are travelling faster than we think. Even simple factors, such as the presence of engine noise, have been shown to affect speed, such that the less noise from the engine, the faster the speed (Horswill and McKenna, 1999). With quieter cars we would then predict faster speeds. The presence of perceptual factors raises the prospect that all speeding may not be intentional.

## What can be done?

The potential barriers to a public health initiative via enforcement are therefore considerable. As we have seen, there may be suspicion about the motives of the authorities, there may be counterproductive self-interest motives towards thrill seeking and responding to time pressure, there may be problems in the perceived legitimacy of interventions, there may be problems in providing a detection level that is sufficiently high to deter, there may be perceptual factors making it difficult to determine speed, and there may be social pressure to conform to a deviant pattern of law breaking.

Let us consider what authorities might do. Authorities have two important methods of influencing public behaviour. One is through instrumental rewards and punishments, and the other is through legitimacy. Kelman and Hamilton (1989) argue that when authority is perceived as legitimate, obeying authority can even override personal morality in determining behaviour. One barrier that we identified for legitimacy was motive-based trust. It is clear that, to achieve legitimacy, authorities have to present transparent motives to reduce harm and be equally transparent that money is not the key factor. It is clear that many advertising campaigns are aimed directly at the connection between speed and harm, but leave the connection with enforcement as implied. Perhaps there is opportunity in campaigns to provide the direct link between enforcement and harm reduction. Providing a focused enforcement campaign at casualty sites is another method of providing a transparent harm-reduction motive. Where this is the policy there is a question as to how readily that is understood by the public. Clearly if the motive is harm reduction, then enforcement should be placed at those sites at which most harm can be reduced as opposed to most fines collected. The potential threat of a money-driven motive should be answered if the harm-reduction motive is sufficiently transparent. An additional approach is through the use of speed rehabilitation. If drivers are offered an education course instead of punishment, then it becomes transparent that the majority of the payment is directed towards their personal education course as opposed to generating finance. Indeed, McKenna and Poulter (in preparation) have shown that attendance at a speed awareness course produces a significant and sustained change in the perceived motives of authorities. That said, clearly authorities require some finance to install and maintain speed cameras, and the obvious solution is to retain some of the finance to achieve this.

If the motive is harm reduction then deterrence, rather than detection, may be the easier concept to put at the heart of enforcement. In other words, the aim could be to prevent the occurrence of speeding rather than detecting it once it has occurred. Having the police permanently and transparently present at casualty sites would be

one effective, if very expensive and impractical, method. Automatic speed detection via cameras can render the enforcement practical. Automatic speed detection at casualty sites can solve some other dilemmas. We have already noted that the certainty of detection provides a barrier to deterrence theory. If speed camera sites are provided with warning signs, then the certainty of detection can be solved. Under this system drivers are provided with clear evidence that they could be caught. The perceived probability of detection should then be high enough to prompt action. (Even where hidden cameras have been shown to be effective (Keall *et al.*, 2001), warning signs were presented on the specific road sections.) The fact that drivers do respond to the presence of cameras is evidence that deterrence can work.

One other problem that we identified in discussing problems of deterrence is the important role of social isolation, that there should be a stigma. We can see that this has happened in the case of drinking and driving, but it is less clear in the case of speeding. As noted above, it is difficult for a behaviour to be socially isolating if it is commonplace. Here it is possible that speed rehabilitation courses may serve the function of decreasing the number of people who are formally punished and hence provide the grounds for social isolation. There is a difficult balance here. It is clear that it would be useful to provide drivers with feedback if they are breaking the speed limit. However, if this feedback involves formal sanctions that become commonplace, then stigma will not be involved. Keall *et al.* (2002) noted that the hidden camera programme that they evaluated resulted in a four-fold increase in ticketing. If the long-term aim is to get to a position in which speeding is regarded as an alienating experience, then having large numbers punished is problematic. Link and Phelan (2001) propose that stigma exists when four specific components converge. The first component is that people perceive and label human differences. The second is that dominant cultural beliefs link labeled persons to undesirable characteristics. In the third component, labeled individuals are placed in a group that provides a disconnection between 'us' and 'them'. In the fourth component, labeled individuals experience status loss. The term stigma applies when these components occur in a power situation. In other words, it is only when these components occur in a situation in which there is a power differential that it allows negative consequences to follow.

We could speculate on how speeding might currently be viewed under Link and Phelan's system. First, it is easy to see that, since people vary in their propensity to speed, this is open to a labelling process. For young male drivers, the term 'boy racer' indicates that a labelling process is taking place. For those who break the speed limit *per se* it is less clear that a labelling process is currently in place, though informally people may label drivers who drive fast. For the second component to be operating, the dominant cultural beliefs would link labelled individuals to undesirable characteristics. In the motor racing world the dominant cultural belief links speed to desirable characteristics. The extent to which this extends to motoring in general, and the public at large, is more open. The fact that a review of anti-social concerns has speeding at the top of the list (Poulter and McKenna, 2007) would suggest that speeding is not universally considered as desirable. In the third component there is a disconnection between 'them' and 'us'. Speed choice, of course, is a continuous measure rather than a binary characteristic. However, it is possible that the offender/non-offender classification could provide a dichotomy. In the fourth component, individuals experience status loss. There is not much evidence of the presence of status loss in the case of speeding.

To get a rough appreciation of how a negative attribution process is working, one can compare attitudes over time or compare one activity with another. Those who have been around for long enough will have noticed the remarkable shift in the perception of one violation – drinking and driving. This has gone from being largely accepted to being socially unacceptable. Speeding may constitute a rather more difficult problem.

Another issue that we identified was whether the procedures employed seemed fair. The frequent image of the police lurking in the bushes waiting to catch unsuspecting drivers is powerful. However, by providing warning signs prior to the presence of camera sites should do much to increase the perceived fairness of the process. In terms of procedural justice, there are some clear advantages of an automated system. While a police officer could operate discretion in who to detect and hence could, in principle, be open to bias, the automated system is programmed to deal only with the objective offence. There is one area in which the police officer may have an advantage in terms of perceived fairness. This concerns the role of voice, of being heard, of being able to state your case to the authority (Tyler, 2003). Clearly the speed camera does not offer much opportunity to state your case. The dilemma between voice and discrimination is well presented in a communication in a car magazine ([www.autocar.co.uk/forums/t/1280.aspx?PageIndex=5](http://www.autocar.co.uk/forums/t/1280.aspx?PageIndex=5)) in which the writer praises the opportunity to have the discussion with the police over a speeding offence, but wonders whether he was stopped because of a bias against the type of car that was being driven.

A rather different approach to the role of voice concerns the opportunity to express concern about speeding. Clearly those who have experienced the negative effects of speeding have a legitimate case to be heard. What then of members of the public. Perhaps, surprisingly, when we analysed concerns over general anti-social behaviour, such as drugs, drunks and noisy neighbours, we found that the greatest concern was over speeding in their local neighbourhood (Poulter and McKenna, 2007). Perhaps importantly authorities could, under these circumstances, quite legitimately note that their enforcement actions were in response to a public concern. This could go some way to counter any view that authorities were inflicting their views on an unsuspecting public. The sheer magnitude of the public concern over speeding would suggest that there is an untapped social pressure that could be brought to bear. It was noted earlier that, historically, a high proportion of drivers have broken the speed limit. That position has been changing with reductions in the percentage that break the speed limit. The fact that the number of people who break the speed limit is decreasing could lead to a decrease in the social pressure to speed, though it is not clear how the frequency of law breaking would translate into social pressure. Perhaps by highlighting the public concern over speeding, the social pressure to conform to the speed limit can be increased.

Let us consider some of the other barriers to obeying speed limits. We noted that there may be instrumental motives, such as thrill seeking and responding to time pressure, that may be important. The vast majority of drivers who break the speed limit do not do so by a large margin. We can assess the extent to which these motives are present by asking them directly whether enjoying speed or time pressure is important in their personal speeding offence. In a survey of 9,196 drivers caught for speeding, 96% indicated that enjoying speed was of little importance in their speeding offence and 67% reported that time pressure was of little importance in

their offence (McKenna, 2005). For the majority of offenders these potential barriers are not substantial.

It would appear, therefore, that the formidable barriers to speed enforcement are not insurmountable. We need mechanisms to increase the certainty of detection to a high enough level to prompt action and speed cameras can provide this function. With warning signs the emphasis is on deterrence rather than detection. We need a balance between feedback and punishment such that sufficiently few are formally punished to provide the grounds for stigma to develop. A combination of the use of speed indication devices and speed rehabilitation courses can provide feedback while decreasing the numbers who are formally sanctioned.

## References

- Aarts, L. and van Schagen, I. (2006) Driving speed and the risk of road crashes: a review. *Accident Analysis and Prevention*, 38, 215–224.
- Asch, S. E. (1956) Studies of independence and conformity: a minority of one against a unanimous majority. *Psychological Monographs*, 70 (Whole no. 416).
- Delaney, A., Ward, H. and Cameron, M. (2005) *The History and Development of Speed Camera Use*. Report No. 242. Victoria, Australia: Monash University Accident Research Centre.
- Department of the Environment, Transport and the Regions (2000) *New Directions in Speed Management: A Review of Policy*. London: DETR.
- Doob, A. N. and Webster, C. M. (2003) Sentence severity and crime: accepting the null hypothesis. In M. Tonry (ed.), *Crime and Justice: A Review of Research*, volume 25. Chicago: University of Chicago Press. pp. 143–195.
- Finch, D. J., Kompfner, P., Lockwood, C. R. and Maycock, G. (1994) *Speed, Speed Limits and Crashes*. Project Record S211G/RB/Project Report PR 58. Crowthorne: Transport Research Laboratory.
- Gabany, S. G., Plummer, P. and Grigg, P. (1997) Why drivers speed: the speeding perception inventory. *Journal of Safety Research*, 28, 29–36.
- Horswill, M. S. and McKenna, F. P. (1999) The development, validation, and application of a video-based technique for measuring an everyday risk-taking behavior: drivers' speed choice. *Journal of Applied Psychology*, 84, 977–985.
- Jonah, B. A. (1997) Sensation seeking and risky driving: a review and synthesis of the literature. *Accident Analysis and Prevention*, 29, 651–665.
- Keall, M. D., Povey, L. J. and Frith, W. J. (2001) The relative effectiveness of a hidden versus a visible speed camera programme. *Accident Analysis and Prevention*, 33, 277–284.

- Keall, M. D., Povey, L. J. and Frith, W. J. (2002) Further results from a trial comparing a hidden speed camera programme with a visible camera operation. *Accident Analysis and Prevention*, 34, 773–777.
- Kelman, H. C. and Hamilton, V. L. (1989) *Crimes of Obedience: Towards a Social Psychology of Authority and Responsibility*. New Haven, CT: Yale University Press.
- Link, B. G. and Phelan, J. C. (2001) Conceptualizing stigma. *Annual Review of Sociology*, 27, 363–385.
- McKenna, F.P. (2005). Why do drivers break the speed limit? In *Behavioural Research in Road Safety*, 15. London: Department for Transport.
- McKenna, F. P. (2007) Road traffic accidents: human factors. In S. Ayers, A. Baum, C. McManus, S. Newman, K. Wallston, J. Weinman and R. West (eds), *Cambridge Handbook of Psychology Health and Medicine*. Cambridge: Cambridge University Press.
- McKenna, F. P. and Poulter, D (in preparation). Speed awareness: the effect of education versus punishment on driver attitudes.
- Mendes, S. M (2004) Certainty, severity, and their relative deterrent effects: questioning the implications of the role of risk in criminal deterrence policy. *Policy Studies Journal*, 32, 59–74.
- Mendes, S. M. and McDonald, M. D. (2001) Putting severity of punishment back in the deterrence package. *Policy Studies Journal*, 29, 588–610.
- Nagin, D. S. (1998) Criminal deterrence research at the outset of the twenty-first century. *Crime and Justice*, 23, 1–42.
- Nagin, D. S. and Pogarsky, G. (2001) Integrating celerity, impulsivity and extralegal sanction threats into a model of general deterrence: theory and evidence. *Criminology*, 39, 404–430.
- Poulter, D. and McKenna, F. P. (2007) Is speeding a ‘real’ antisocial behavior? A comparison with other antisocial behavior. *Accident Analysis and Prevention*, 39, 384–389.
- Richter, E. D., Berman, T., Friedman, L. and Ben-David, G. (2006) Speed, road injury, and public health. *Annual Review of Public Health*, 27, 125–152.
- Robinson, P. H. and Darley, J. M. (2004) Does criminal law deter? A behavioural science investigation. *Oxford Journal of Legal Studies*, 24, 173–205.
- Schmidt, F. and Tiffin, J. (1969) Distortion of drivers’ estimates of automobile speed as a function of speed adaptation. *Journal of Applied Psychology*, 53, 536–539.
- Snowden, R. J., Stimpson, N. and Ruddle, R. A. (1998) Speed perception fogs up as visibility drops. *Nature*, 392, 450.

Transportation Research Board (1998) *Managing Speed: Review of Current Practices for Setting and Enforcing Speed Limits*. Special Report 254. Washington, DC: National Academy Press.

Tyler, T. R. (2003) Procedural justice, legitimacy, and the effective rule of law. In M. Tonry (ed.), *Crime and Justice: A Review*, volume 25. Chicago: University of Chicago Press.

Tyler, T. R. and Huo, Y. J. (2002) *Trust in the Law: Encouraging Public Cooperation with the Police and the Courts*. New York: Russell-Sage Foundation.



# Risk and the driving of emergency vehicles

Tomás Walsh, Barbara Hannigan and Ray Fuller  
School of Psychology  
Trinity College Dublin  
Dublin 2, Ireland

## Introduction

The Dublin Fire, Rescue and Emergency Ambulance Service (hereafter DFB – Dublin Fire Brigade) serves 1.2 million people in the Greater Dublin area and handles about 100,000 calls per annum, operating from 15 stations with over 900 front-line personnel. These are trained both as fire-fighters and paramedics, rotating between fire and ambulance duties. Approximately 84% of calls-outs are emergency ambulance incidents, 14% are fire service incidents and 2% road traffic accidents. The annual cost of the service is about €110 million.

The study reported here was initiated at the invitation of the DFB in the context of a growing concern regarding the number of collisions involving DFB emergency service vehicles (ESVs). In 2006 and 2007 there were 179 recorded collisions. In 2006, about 60% involved a collision with a private vehicle. Twenty per cent of these occurred at a junction, and in half of them the ESV was passing through the junction against a red light. Another 20% occurred when the vehicle was reversing. Fifteen collisions resulted in personal injury to DFB personnel (Dublin Fire Brigade, 2006).

The study is preliminary in nature and comprised three elements: an initial analysis of all DFB vehicle accident report forms for 2006 and 2007, a focus group of front-line personnel regarding their experiences of driving for the service, and a questionnaire survey of personnel to generate a more quantitative description of the frequency and severity of the problems identified in the first two elements. This paper will present the results of the focus group study. However, it may be noted that the analysis of vehicle accident report forms revealed that, for both ambulances and fire appliances, there were significantly more collisions reported under blue light conditions than non-blue light conditions, with a ratio of three blue light collisions for every one non-blue light collision. The ‘blue light’ condition refers to responding to an emergency situation with blue lights on and usually also with an accompanying siren. This contrast is powerful in the sense that ESVs provide their own controls for a comparison of driving under time pressure in one direction and without that pressure in the other (albeit confounded by condition order). For



ambulances this blue light effect occurred independently of type of manoeuvre, but was particularly evident for manoeuvring in traffic and crossing road junctions. For fire appliances the effect was clearly present for manoeuvring in traffic and crossing road junctions, but less prevalent for overtaking manoeuvres.

## Focus group of front-line emergency service personnel

In order to help understand the blue light effect and explore the experience of service vehicle driving, a focus group of front-line staff was arranged. It consisted of eight males aged 32 to 59 years ( $m = 42.7$ ,  $sd = 9.7$ ), with service experience from 7 to 34 years ( $m = 14.9$ ,  $sd = 10.0$ ), working from an urban fire station in Dublin. All had driver status and could be rostered to driving an ambulance or fire appliance as well as to non-driving paramedic or fire-fighting duties. None of the participants had reported a collision in the previous 12 months.

The focus group, all of whom volunteered to participate, was held during a working shift (indeed, three participants were called to an incident shortly before the end of the session). The process was facilitated by a counselling psychologist with extensive experience of focus group work. All comments were recorded and subsequently transcribed, excepting a brief discussion relating to fatigue and shift work, which one participant requested that he be excluded from the record.

Thematic analysis of the transcribed discussion was conducted independently by two of the authors and a third independent assessor to ensure reliability of coding. Details of the coding procedure may be found in Braun and Clarke (2006). The main themes which emerged related principally to blue light driving conditions, driver training, and accidents and near misses.

## Conditions of blue light driving

Seven conditions of blue light driving were highlighted by participants:

- stress;
- time pressure;
- speed-humps;
- personal accountability;
- vehicle design;
- secondary task load; and
- poor situation awareness (by other road users).

In the quoted statements below, words in bold highlight the emphasis made by the speaker and words in square brackets have been added where it helps to make the meaning clearer.

## Stress

The experience of stress when driving to an emergency is reflected in this exchange between five of the participants:

*P3: Your first responsibility is to get there safely, you know, you can't forget about the fact that you have to drive safely, that's the bottom line, you know what I mean?*

*P2: ... and as quickly as possible.*

*P3: But you have to be switched on the whole time, like, everyone says that.*

*P7: Yeah, there's no relaxing or stuff like that in those situations.*

*P2: It's been proven that anxiety levels just go sky high, depending, say you can get a house fire, you get confirmed house fire with people reported.*

*P3: ... confirmed people.*

*P1: It's [relevant to] the information you receive in your docket going out, or over the radio.*

*P2: That's the time you kind of start nudging people out of the way, not literally nudging now, but, you know, Move Out! Move Out!*

*P8: Maybe **forcing** the issue, then.*

*P2: Yeah.*

*P3: You're not going to sit behind a car at a red light if you're going to a fire with three kids in it, you're not going to hang around 'cause someone's blocking you. You will get them to move.*

## Time pressure

Apart from the obvious functional advantages of arriving at incidents as quickly as possible, there are also organizational targets which may create additional time pressure on drivers:

*P3: I think it's eight minutes for ambulance calls, 90% or something like that within eight minutes – I think that's what it was in the business plan ...*

*P1: So ... [we] have to meet, eh well, [we] don't really have to meet a time limit, but time limits are there. If they're not met, then there's questions asked ...*

## Road humps

Speed humps and other road features designed to restrain speed, such as speed tables and cushions, are recognised to cause delay, but the trade-off in reductions in road accidents is also admitted:

*P3: [Speed bumps and ramps] Yeah, they're everywhere.*

*P1: They might reduce accidents, but they might increase fatalities if you can't get to the incident ...*

*P3: They are delaying us.*

*P1: But there again, they're making places safer, so which do you want?*

It might be noted that there does not appear to have been any analysis published which attempts to estimate the size of this possible trade-off.

## Personal accountability

Drivers, in achieving a rapid response, are expected to exploit the fact that they do not have to comply with local authority bye-laws with regard to roadway use (e.g. crossing a light-controlled junction on red). Nevertheless, they have to make each risk judgement when violating such laws: if their action leads to a collision and it is subsequently deemed unsafe, they are held personally responsible and are vulnerable to penalties under the various road traffic acts:

*P2: There's something else that kind of weighs heavy on people's minds as well now – the licence that you'd, that you drive on is your own licence ... if you were involved in an accident 'cause you went through a red light – **why** did you go through a red light?*

*F (facilitator): So you would lose your own personal driver's ... points on your own personal driver's ...*

*P3/5: Yes ... you could go to jail – forget about points.*

*P3: You're exempt from bye-laws, as in you can break red lights, you can park illegally. But the way the law stands is: when it is safe to do so – and it's always safe to do it until something happens. So if I cause a pile-up down here today after going through a red light, our understanding of the law is that, say somebody gets killed after we go through a red light, we're not charged, we can't be charged for going through a red light. We're exempt – but we can be charged with dangerous driving or manslaughter, whatever the charge is, you know, because it wasn't safe to do so at the time, and that's the reality of the situation you're driving. You're driving off, off your own back.*

*P8: It ties in with whatever situation you're going to, like. If you're going to, as I say, a bin on fire, you know, you can ... well it's your licence at the end of the day so ...*

*P3: You can justify driving at a certain speed when its three kids in a house, if you're standing in front of a judge. You can't justify that kind of driving if it's a bin on fire.*

## Vehicle design

One of the older designs in the ambulance fleet (based on a Ford Voyager) came in for criticism because it was alleged to have no special tyres, suspension or engine to take account of the requirements of high-speed driving and, in addition, it tended to lean over to the side on which the rear ramp was mounted (... *if you're taking a sharp corner, you have to be very careful, you have to really slow down, otherwise she'll, she'll go on ya, like, she'll turn*). Reversing an ambulance was also highlighted because there are usually only two personnel, a driver and an assistant, and typically the assistant goes to the patient while the driver reverses the vehicle so as to be pointing in the exit direction:

*P3: It's the easiest thing in the world to tip a pole. I'm not saying it's right, I'm not saying we should be doing it, but it's going to happen.*

*P7: ... but regards, say, if someone's driving [the] ambulance and the other guy is in the back, eh, you're kind of on your own, 'cause there's just you ... people out there – you just couldn't trust 'em. They'd back you into a pole or turn out to be a lunatic or something. Back you straight into a wall or something, so you are kind of on your own to that degree. The newer ambulances, for example, – they have a cam, a reversing camera, you know, and that's a big help [all agree].*

## Secondary task load

Driving a large vehicle such as a fire appliance, and especially reversing it where there are children around, is a challenging hazard, not just because of the obvious danger to the children, but also because they may be engaged in hostile acts such as throwing stones or attempting to ride on the appliance or steal equipment from it:

*P1: The other thing with driving is the, eh, abuse you take ... in certain areas you could be stoned when you're driving ... it puts more pressure [on] you when you're driving in certain areas ... You have to understand, you slow down if you're going into, say, for want of a word, an ambush – that's part of your driving as well ... You don't drive down a street you have to reverse back out [of] – you have to reverse down, so you can drive straight out, so you can get out quickly ... and you're all the time watchin' them where yer ... with children around, especially kids – you're watchin' them – you don't want, you obviously don't want, none of us want to harm anybody ... that you just have to keep an eye out. But there again sometimes the people you're trying to help are tryin' to harm you. So it puts more pressure onto you when you're driving.*

*P3: The kids are a big problem for us around certain areas. Massive problem when we go into flat complexes. Em, you'd have 20, 30, 40 kids appearing. And it gets to the stage when we're trying to get, leave the area afterwards. We have to walk alongside the fire engine and nearly run alongside it to get it fast*

*enough to keep them off. First of all off the back of the fire engine. Secondly from robbin' stuff from the lockers ... obviously you don't want to run, run them over is the main thing we're worried about.*

*P7: Sometimes it takes ya 20, 25 minutes.*

*P3: Just to get out 'cause you'd be stopping ... get all the kids off. Remember the driver cannot see directly behind him in a fire engine so he doesn't know what's ...*

*P8: ... at the back*

*P2: Some of the newer ones have a rear camera.*

*P1: ... but he has to drive, at the same time look at the camera, but it's very hard to do that as well [agreement from P2, 3, 7] ... so you just might have to turn ... somebody just turns off the camera – can't watch everything – and get on with it.*

Radio communication in ambulances was also seen as an important secondary task load which was largely avoided while driving:

*P1: ... yes ... operating the sys ... operating your radio when you're driving, it's practically impossible ... it does affect your driving – you just leave it there and ignore it.*

*P3: You're not going to use the radio if you're not in a position to use it like. Generally you, most of us would give a message to the hospital before we pull away. If you're driving, you know, if you're on your own in the ambulance, if you're going to send a message in, you'll do it while you're ... before you pull off ... you'll wait 'till you're going slow – you're not going to do it driving through red lights or something like that, you know.*

## Poor situation awareness (by other road users)

Complete oblivion to what is happening around them does not appear to be an unknown feature of other road users:

*P7: It's funny, like sometimes you'd be driving behind em, driving behind a car with sirens on and blue lights on and you can actually see them, they wo, they wouldn't notice ya, you know ... and you can see em in the mirror. Next of all, you can see the shock on their face. Like you could be sittin' behind them for like two minutes or something like that, which is a long time for something that size to be behind ya, and, em, they're the ones that usually jam on the brakes then. So, but again, that's down to experience – you kind of have to read them a small, to a small degree. Sometimes you nearly predict what they're going to do.*

*P3: You have to maybe assume everybody else on the road is going to do [the] stupidest thing in the world.*

Emergency service vehicles travelling in convoy also appear to surprise some drivers:

*P1: Em, driving in convoys. People don't realise that there is a couple of [fire] trucks coming. One truck goes through, next thing yer man thinks that's one fire engine gone. Next thing there's another one. Then that's gone, then there's a little fire engine ... So they don't anticipate there's a convoy coming through [all agree].*

A particular problem is other drivers stopping dead (say from 40 or 50 mph) when it would be better if they just slowed down a little to let the ESV past. The group showed stolid resignation to just putting up with other people's unhelpful driving of this type.

## Driver training

The following narrative exchange between two of the participants underlines their perception that the basic training for driving fire appliances is unsatisfactory. In the light of the collision evidence that in 2006 20% of collisions occurred while reversing, it is of interest to note the comment that there was no assessment of reversing in the fire appliance driving test.

*P7: Well, basic.*

*P8: It's not ... it's not good enough, no, not good enough ... Well, the way it works is, you have to be 'light' driving, well, the ambulance driving for two years. And then you go driving the appliance then, if you want to go driving after the two-year period, and then you have to do a certain amount of, before you actually go out on, basically, with blue lights going, you have to do a couple of drives back to the station. So, it's meant to be 50 drive backs, but that's a bit unclear at the moment ... em, you do your drive backs ... It goes on the experience you have outside the job – before you came in like, as well [all agree].*

*So you do your, your drive backs and then the driving school come out, the fire brigade driving school come out and they take you out on a, a blue light run, as they call it ... and they show you ... well it's a few snapshots of accidents that have happened with fire engines, that type of thing. He basically has a little chat with ya, now ... do a little spiel with ya, take you out on a blue, a blue light run, em, for a couple of minutes and then he signs you off basically. You're allowed to ...*

*P7: You're out on our own then ...*

*P8: Out on your own ... Even the spin, the spin wouldn't bring you on the likes of motorways, anything like that. You're just literally going up around the block type of thing and back. You wouldn't even do what's involved in say your normal driving test – reversing or anything like that, like you know.*



## Accidents and near misses

Manoeuvring a fire appliance through very narrow gaps appears to be a common experience:

*P5: You have things where side mirrors are caught. Taps. A lot of that. Tight areas [all agree].*

*P3: Tight areas.*

*P6: We'd be going through tight areas constantly.*

*P2: Parked cars ... where we kind of squeeze down the road with cars either side. Sometimes you just can't get down.*

Also, drivers' attitudes reflect an acceptance of the inevitability of minor scrapes and knocks:

*P3: Reducing accidents is one thing, how do you reduce **serious** accidents? Minor tips to me are acceptable – not if you're having one every day of the week. Major crashes, where people are getting, er, injured, are obviously not acceptable and that to me should be what ... well, that's what you don't want. Let's be honest about it. You just don't want anybody hurt. If you have a minor tip, or you're tipping a mirror 'cause it's a narrow street, or you reverse into a pole, me, as a driver, sorry, I'm, quite happy to accept that.*

However, the main problem highlighted by participants was that of light-controlled junctions where an ESV crossing through a red light is not apparent to another driver, where a driver sees the ESV, brakes abruptly and is then rear-ended, and where drivers panic in the presence of the ESV and react dangerously.

## Concealed ESV

*P3: [Crashes involving us] ... Most of em are going through lights.*

*P7: Yes, going through like, em ...*

*P8: A blind junction, more so.*

*P3: The main one where everyone stops.*

*P7: Bar one.*

*P3: ... We have very few wipe-out smacks 'cause lads are conscious – like we're not going to just drive straight through a red light. OK, we know we're on blues. If the light's red, all our drivers will actually come up to the red light and slow up and stop and wait 'til it's clear. So if there is a tip, generally nine out of ten they're small. There's not a fella straight through a light at 50 mph and ploughin' someone else.*

*F: Has that ever happened, big whammys like that?*



*P2: Well ... there was a few times where ambulances have been turned over, like. Thinkin' that a junction would be fairly safe to go through, albeit at a red light. As you say, five will stop, but the sixth one coming through ...*

*P3: The ambulance might only be doing 5 mph, but the car could be doing ...*

*P2: It has been people get injured, and they're out a long time injured.*

*P1: There was two of them killed, there was two of them killed, two separate accidents.*

*P7: Cars coming from the blind side of a vehicle that's after stopping to allow us out, they're the worst.*

## Rear-end shunts

*P2: What happens when we come up to the lights, somebody will jam on ... and somebody would come up behind him and rear-end him, although we're not involved in it. I mean he just sees us and jams on, and he gets rear-ended.*

*P5: If you drive an ambulance ... I'd say there'd probably be five near misses nearly every day where the likes of that could possibly happen.*

## Panic and dangerous reaction

*P3: We'd never force anyone out into a junction. If we can't see ourselves what's coming ... you're not going to force someone out through a red light ... But people don't realise that and they panic and they start going through, doing stupid things.*

*P5: And then you have other people blowin' horns and everything else. 'Ah! There's an ambulance behind me! Get out of me way!' Like sometimes you just can't go anywhere.*

*P6: Sometimes you're better off knockin' the sirens off.*

*P5: You could turn off the sirens but there's a brigade audit that says once we have a patient there, we can't turn off the blue lights. So even if we stop at a junction we have to leave the lights on and then people assume you're trying to get through and then try to move out of the way [all agree].*

## Discussion

Driving an ESV under blue lights is significantly more likely to result in a collision. If we were searching for a human factors variable that might be operating to undermine driver capability in an emergency response, these results highlight the

prominent role of stress. Drivers' accounts make clear where the sources of stress lie:

- the tension between wanting to get to the emergency location as rapidly as possible and features of road-user behaviour, road design, vehicle design and traffic conditions which hold them up;
- additional demands from communications system use and from the behaviour of children around fire appliances;
- personal vulnerability in terms of licence penalties if they are deemed to have acted in an unsafe manner; and
- all this in the context of feeling that their initial fire appliance driver training is inadequate.

The service delivery system frees drivers from the constraints of normal traffic rules in support of a fast response, but at the same time drivers have to make each risk-related decision and have to carry the blame if their judgement is subsequently deemed faulty. This problem is particularly exacerbated at junctions where conflicts may arise because, for non-ESV drivers, the rules of driving may briefly change and their response may be panicked, inappropriate and dangerous.

What suggestions emerge from these rich personal accounts of experiences of driving ambulances and fire appliances that might contribute to reducing the particular problem of elevated collisions under blue light conditions? One basic principle would be to reduce exposure by eliminating unnecessary and bogus calls out. As one participant remarked in relation to unnecessary calls: '*Could he go to the doctor, could you go out and put the grass out with a cup of water?*' Another pointed to the role of children in bogus calls: '*It's kids, and, like, a lot of the time you get a bogey, say at night, and there's a gang of kids on the corner. You know well, you know that they're after ringing in ... there's nothing you can do about it.*' A second fundamental change would be to develop driver training, especially for fire appliance driving, as well as to introduce a more comprehensive form of driver testing.

A third would be to develop more explicit procedures for other drivers when responding to the approach of an ESV. In Ireland, the *Rules of the Road* (Road Safety Authority, 2007) simply advise drivers to be cautious and give way if it safe to do so. Thus we get these comments from two of the participants:

*P5: I think a lot of it has to do with a lack of driver training – for other people. Like there's nothin' in the Rules of the Road say, when you see or hear a fire engine behind ya, ya indicate to the left and pull into the left when it's clear and safe to do so. So there's like you have one fella stopping on the left and another fella's stopping on the right – and you have nowhere to go then, so you're just caught there. There's no set procedure for what happens if you do hear blue lights or sirens, and nobody knows what to do, and you get panic then.*

*P3: ... Some people actually freeze and just do nothin', other people do stupid things like driving up footpaths and everything ... they are actually dangerously getting out of your way.*

*The Highway Code* (Department for Transport, 2005) has this to say about how to respond to ESVs:

‘Emergency and Incident Support vehicles. You should look and listen for ambulances, fire engines, police, doctors or other emergency vehicles using flashing blue, red or green lights and sirens or flashing headlights, or Highways Agency Traffic Officer and Incident Support vehicles using flashing amber lights. When one approaches do not panic. Consider the route of such a vehicle and take appropriate action to let it pass, while complying with all traffic signs. If necessary, pull to the side of the road and stop, but try to avoid stopping before the brow of a hill, a bend or narrow section of road. Do not endanger yourself, other road users or pedestrians and avoid mounting the kerb. Do not brake harshly on approach to a junction or roundabout, as a following vehicle may not have the same view as you.’ (Section 219)

Although this represents a fairly comprehensive set of instructions, warning against a panic response, emphasising the goal of letting the ESV pass safely, and dealing with the dangers of pavement mounting and rear-end shunts, what ‘appropriate’ action should be at a light-controlled junction remains unclear, and this is where the main problem has been identified by the focus group participants. To address the problems of colliding with an ESV which is crossing through a red light, or causing a rear-end shunt through sudden, severe braking, the following additions to *The Highway Code* might be proposed:

Approaching a green traffic light:

If you become aware of an emergency vehicle using flashing lights or a siren that is **not** coming up behind you, treat the junction as an uncontrolled crossing, slow down gradually as you approach. Do not brake harshly and cross only if it is clear.

To address the problem of panic violation of traffic rules and other unsafe responses to an ESV approaching from behind:

Approaching a red traffic light:

If you become aware of an emergency vehicle using flashing lights or a siren coming up behind you, don’t panic. It will wait if necessary. Do not move into the junction to allow the vehicle to pass if at all dangerous. If moving out of the way means passing the red light, only consider this action if all crossing traffic has stopped.

Be aware that more than one emergency vehicle may be coming through.

## Conclusions

Emergency driving under blue lights is stressful for ESV drivers and creates problems of how to get out of their way for other drivers. This situation is exacerbated by the exemption of ESV drivers from normal traffic rules and a lack of

clear procedures for other drivers, particularly at light-controlled junctions. Thus, it is hardly surprising that ESVs are involved in more collisions going to a case than returning from it. It is proposed that this situation might be addressed by improving ESV driver training and testing (especially for fire appliances), making ESV design more compatible with the functional requirements and conditions of emergency driving (handling and performance, rear-view provision), and providing clearer procedures for non-ESV drivers as to how to respond to ESVs under various critical circumstances.

## References

Braun, V. and Clarke, V. (2006) Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3, 77–101.

Department for Transport (2005) *The Highway Code*. London: Department for Transport. [www.dft.gov.uk/pgr/roadsafety/drs/highwaycode](http://www.dft.gov.uk/pgr/roadsafety/drs/highwaycode) (accessed on 16 May 2008).

Dublin Fire Brigade (2006) *Dublin Fire Brigade Health and Safety Unit Annual Report 2006*. Dublin: Dublin Fire Brigade.

Road Safety Authority (2007) *Rules of the Road, March 2007*. Ballina: Road Safety Authority, Government Offices.

# Driver behaviour on rural roads in Scotland

Stephen Stradling,<sup>1</sup> Emma Collins,<sup>2</sup> Chris Eynon<sup>2</sup> and Pat McLeod<sup>2</sup>

<sup>1</sup> Transport Research Institute

Napier University

Edinburgh EH10 5DT

<sup>2</sup> TNS System Three

Edinburgh EH3 8HQ

## Rural road accidents in Scotland

In March 2000 the UK Government, the Scottish Executive and the National Assembly for Wales announced new national road safety strategy and casualty reduction targets for 2010 (DTLR *et al.*, 2000). The targets required a reduction in people killed or seriously injured of 40% when measured against a baseline of the average recorded between 1994 and 1998.

Current knowledge about road accidents in rural areas in Scotland arises from Transport Statistics Scotland (Scottish Executive, 2005), a Rural Road Safety Literature Review (Hamilton and Kennedy, 2005) which scanned this and other publications published in Scotland and elsewhere, and a recent study published by the IAM Motoring Trust (Hopkin and Morris, 2007). These all show that a greater proportion of all types of road user, except pedestrians, are killed on roads in non-built-up areas and, with the exception of pedestrians and pedal cyclists, a greater proportion are killed or seriously injured on these roads. Car users account for over 70% of all killed or seriously injured casualties on roads in non-built-up areas, and most car occupant fatalities occur on such roads.

Police accident report STATS 19 data for Scotland show that the number of people killed or seriously injured in road accidents in 2005 was 39% below the average between 1994 and 1998, so the 2010 target had almost been achieved. However, the fall was greater for roads in built-up areas and the number of fatalities has declined at a much slower rate on roads in non-built-up areas. Presently there are fewer casualties on the latter (42% of casualties in 2005), but a higher proportion of people that are killed (72% of total fatalities in 2005) and a majority of people killed or seriously injured (53%) are involved in accidents on roads in non-built-up areas.

Locally managed B and A class roads in non-built-up areas have the highest accident rate per vehicle kilometre in Scotland, while motorways have markedly lower rates. Most rural accidents on single carriageways occur on A roads in 60 mph speed limit

areas away from junctions. Single-vehicle accidents account for a third of all rural single-carriageway accidents. These are most likely to occur on bends at night on B or C class roads and involve young drivers. In Scotland, 31% of serious and fatal injuries with car accidents on rural roads involve drivers under the age of 26 and a further 27% involve drivers aged 26 to 39. Additionally, 72% of such accidents involve men (Hopkin and Morris, 2007).

The Scottish Government and Road Safety Scotland commissioned research from TNS System Three, the Transport Research Laboratory (TRL Ltd) and the Transport Research Institute at Napier University to examine rural road accidents, driving behaviour on such roads and attitudes to driving on rural roads in Scotland (Collins *et al.*, 2008). This multi-stage project included an analysis of STATS 19 data for recent rural road accidents in Scotland; an item on the omnibus Scottish Opinion Survey (SOS) about the frequency of driving on rural roads, here defined as ‘A road that is outside of towns and has a speed limit of 50 miles an hour or more, but is not a motorway or dual carriageway’; a large survey of Scottish car drivers’ behaviours and attitudes; and focus groups with young, male, rurally-resident car drivers.

Initial analysis of the STATS 19 data showed that speed was an important factor in rural road accidents, particularly when associated with loss of control. Loss of control was the factor recorded most often, in 32% of serious and 45% of fatal rural road accidents. There are two speed-related items in the STATS 19 list of factors: travelling too fast for the conditions and exceeding the speed limit. As one of the focus group respondents noted:

*‘Sometimes on the country roads you can’t get up above 60 so you’re still below the speed limit, it just depends on what kind of road you’re on. If it’s on the back roads with the farmers, most of the time you’re under 60 but you’re still driving fast going round the corner so sometimes you find it hard to speed on some of the back roads. You’re ... not breaking the speed limit but you are going fast.’*  
(Male; age group 21–25 years)

When accidents where both speed codes were recorded are combined, excessive speed, though not necessarily above the speed limit, was a factor in 22% of serious and 33% of fatal accidents. Both loss of control and travelling too fast for the conditions were recorded more often in accidents on rural than urban roads.

## Who drives on rural roads in Scotland?

As the population profile of rural road drivers was unknown, an initial investigation was undertaken to establish this using the SOS.

The SOS is an omnibus survey for which around 1,000 adults are interviewed face-to-face in-home each month using computer-aided personal interviewing (CAPI). Interviewing is carried out at 42 sampling points throughout Scotland, including the

Highland and Islands, using a random route<sup>1</sup> methodology. The sample is designed and the data weighted to be representative of the adult population of Scotland in terms of age, sex within working status, and socio-economic grade (SEG).

The fieldwork for this wave of the survey took place from 22 to 27 February 2007 and 1,000 adults aged 17 years and over were asked whether they had driven and which types of road they had driven on in the last 12 months. Of the respondents resident in rural areas ( $n = 296$ ), 73% had driven in the last 12 months and were classed as current drivers. Of the respondents residing in urban areas ( $n = 696$ ), 59% were current drivers. These figures are consistent with the differences in household access to a car or van between urban and rural areas of Scotland (Stradling 2005, 2006; Stradling *et al.*, 2005).

The results, Table 1, showed that most current drivers drive on most types of road whether they reside in an urban or rural area. Indeed, around 19 out of 20 drivers resident in either type of area had driven on rural roads in the past year.

**Table 1: Per cent of urban and rural drivers who had driven on four road types in the previous 12 months, from SOS, February 2007**

	Urban drivers (%)	Rural drivers (%)
Rural roads	95	94
Roads in villages/rural towns	92	98
Roads in a city/urban area	97	86
Motorway/dual carriageway	95	88

## Scottish rural driver survey

Survey fieldwork took place between 8 June and 9 August 2007, and 1,020 rural road drivers, that is adults aged 17 or over who had driven a car on a rural road in the past 12 months, were interviewed face-to-face in their own homes. Interviews were conducted using a random location methodology throughout Scotland, including the Highlands and Islands.

The survey was conducted using CAPI for the interviewer-administered section of the questionnaire and computer-assisted self-interviewing (CASI) for the self-completion section. Fifty per cent of the interviews took place in urban areas and 50% in rural areas.<sup>2</sup>

- 1 When using a random route methodology, interviewers are given a starting address within a randomly selected location. They make their way along the random route, calling at every fourth house. They are allowed to interview anyone in the household that falls into the correct quota. In the case of the SOS, quotas are set on age, sex and working status.
- 2 Urban/rural in this project was calculated using the Scottish Government six-fold urban rural classification. The respondents' census Output Area was mapped on to one of six classifications – large urban areas, other urban areas, accessible small towns, remote small towns, accessible rural areas and remote rural areas. This was then aggregated so data were classified as belonging to a respondent resident in either an urban or rural area. Thirty per cent of Scotland's population reside in rural areas, 70% in urban areas.

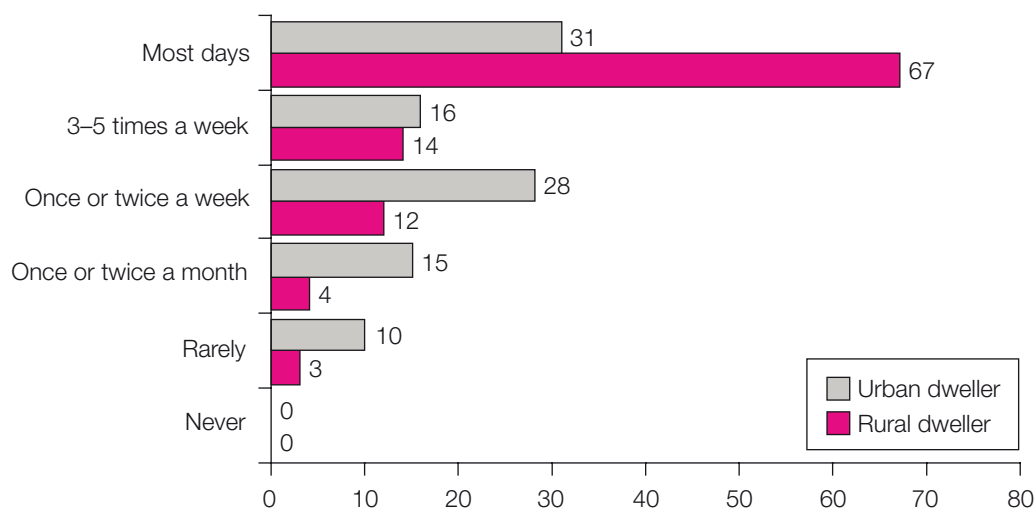


The majority of respondents held a full clean driving licence (87%), with 12% holding a licence with penalty points on it and 1% holding a provisional licence. The majority of drivers were relatively experienced, with 92% having held their licence for five years or more and 82% having more than four years' no claims bonus. Fifty-two per cent were male.

The majority of drivers had used rural roads either every day, or once or twice a week in the previous 12 months. Frequencies of driving on roads in cities or other urban areas, and in rural towns or villages, were similar. Around four in ten respondents had driven on these roads every day, and around one in eight had driven on these roads three to five times a week, or once or twice a week. Motorway and dual carriageways were driven on with slightly lesser frequency, with 13% of the sample reporting that they never drove on motorways or dual carriageways. However, 60% said they drove on motorways or dual carriageways once a week or more often.

Figure 1, though, shows that **frequency** of driving on rural roads varied more substantially between urban and rural dwellers, with two-thirds (67%) of rural dwellers reporting driving on rural roads 'most days'. Even so, a third (31%) of Scottish urban dwelling car drivers reported driving on rural roads 'most days' and three-quarters (77%) did so once a week or more often.

Figure 1: Frequency of driving on rural roads in the previous 12 months for urban and rural dwellers in Scotland



## Risky behaviours on Scottish rural and urban roads

Respondents were asked which of a number of risky behaviours they had undertaken in the previous 12 months while driving on rural and on urban roads in Scotland, and whether they had been flashed by a safety camera or stopped by the police for speeding on rural or urban roads in the previous three years. Table 2 shows the

reported incidence of risky behaviours to be effectively indistinguishable on the two road types.

**Table 2: Frequency of risky driving behaviours on rural and urban roads**

	On rural roads	On urban roads
<b>In the past 12 months, I have driven:</b>		
When very tired	32	35
While using a mobile phone	21	21
After drinking any alcohol	16	20
After taking drugs (inc. prescription drugs)	16	15
When not wearing a seat belt	10	11
When I thought I might be over the limit	1	2
<b>In the last three years I have been:</b>		
Flashed by a speed camera	6	9
Stopped by police for speeding	2	4

Speeding was more likely to be detected and enforced on urban than rural roads, albeit with both at low levels such that the differences were not statistically significant.

## Exceeding the speed limit on rural roads

Speeding behaviour on rural roads was compared with that on two other road types. Following work on the Department for Transport HUSSAR (High Unsafe Speed Accident Reduction) project on speeding drivers (Stradling *et al.*, 2007; Stradling *et al.*, 2008), respondents were asked how frequently, on a six-point scale, from most days to never, they had driven in the last three months on three types of road with different speed limits: a road in a built-up area with a 30 mph limit, a rural road with a 60 mph limit, and a dual carriageway with a 70 mph limit. They were then asked how often in the last three months they had breached the speed limit on each road type, by varying amounts. The responses of the 784 drivers (77% of respondents) who had driven on all three road types in the last three months are reported in Table 3.

Twice as many (79%) had driven ‘most days’ on a road in a built-up area with a 30 mph limit than had driven on a rural road with a 60 mph limit (39%). Just over a quarter (27%) had driven ‘most days’ on a dual carriageway. Two per cent reported rarely driving on a 30 mph road, 13% rarely driving on a rural road and 22% rarely driving on a dual carriageway. Of the larger sample, some of whom were not included here as they had not driven on all three road types within the previous three months, 1% had not driven at all on a road in a built-up area with a 30 mph limit, 8% had not driven on a rural road with a 60 mph limit, and 13% had not driven on a dual carriageway within the last three months.

**Table 3: Reported frequencies of driving on, and exceeding the speed limit on, three road types within the last three months**

How often have you ...	Most days (%)	3–5 times a week (%)	Once or twice a week (%)	Once or twice a month (%)	Rarely (%)	Never (%)
Driven in a built-up area where there is a 30 mph limit	79.1	10.7	6.0	2.0	2.2	(1)
Driven at 35 mph in a 30 mph limit	23.3	8.0	12.2	5.9	30.7	19.8
Driven at 40 mph in a 30 mph limit	7.5	2.9	5.4	3.8	30.0	50.4
Driven at 50 mph or more in a 30 mph limit	1.7	0.9	0.9	0.9	10.2	85.5
Driven on a single-carriageway road where there is a 60 mph limit	39.3	14.8	18.6	14.0	13.3	(8)
Driven at 70 mph on a single-carriageway road	5.7	4.1	7.3	6.9	28.8	47.2
Driven at 80 mph or more on a single-carriageway road	1.1	0.6	1.5	1.9	15.3	79.5
Driven on a dual carriageway where there is a 70 mph limit	26.5	9.9	19.3	22.2	22.1	(13)
Driven at 80 mph on a dual carriageway	4.0	2.4	7.3	9.1	28.7	48.6
Driven at 90 mph or more on a dual carriageway	0.6	0.3	1.3	1.8	16.3	79.7
Base: all who had driven at least rarely on all road types in the last three months (784). Figures in brackets give the percentage of the whole sample who had not driven at all on each road type in the previous three months.						

On 30 mph roads, 20% of respondents reported never driving at 35 mph, half never driving at 40 mph, and 86% never driving at 50 mph or more. On 60 mph rural roads, half (47%) reported never driving at 70 mph, and four in five (80%) never driving at 80 mph or more. On dual carriageways, half (49%) reported never driving at 80 mph and four in five (80%) never driving at 90 mph or more.

Univariate ANCOVA (Analysis of Covariance) analysis, with residence as factor, and age and gender as covariates, shows that drivers residing in urban areas tended to break the speed limit more in town; drivers residing in rural areas tended to break the speed limit more on dual carriageways; and there was no significant difference between urban and rural dwellers on single-carriageway rural A roads. Age and gender made a statistically significant difference in all comparisons, with male drivers and younger drivers being less compliant throughout.

Responses to these seven scenarios were cluster-analysed, using K-means clustering set to three clusters. Table 4 gives the per cent reporting each speed limit breach within each of the three clusters. The proportions reported here are in close agreement with those reported for the UK-wide HUSSAR project analysis (Stradling *et al.*, 2009, Table 3; Stradling *et al.*, 2008).

Table 4: Per cent within each cluster reporting breaking each speed limit more often than 'rarely' 'in the last three months'

'Within the last three months, how often have you ...' (per cent more often than 'rarely')	Cluster 1	Cluster 2	Cluster 3
	Compliants	Exceeders	Excessives
<b>n = 748</b>	<b>430</b>	<b>254</b>	<b>100</b>
<b>Per cent of sample</b>	<b>55%</b>	<b>32%</b>	<b>13%</b>
Driven at 35 mph in a 30 mph limit	8	100	97
Driven at 40 mph in a 30 mph limit	0.9	28	89
Driven at 50 mph or more in a 30 mph limit	0.2	2	29
Driven at 70 mph on a single-carriageway A road	10	22	83
Driven at 80 mph or more on a single-carriageway A road	0.7	1.5	33
Driven at 80 mph on a dual carriageway	10	22	71
Driven at 90 mph or more on a dual carriageway	0.5	1.5	23
Mean number of speed limit breaches, of 7 (with 95% confidence interval)	1.84 <sub>a</sub> * (1.68–1.99)	3.46 <sub>b</sub> * (3.28–3.65)	5.99 <sub>c</sub> * (5.79–6.19)
*Means with different subscripts (a, b or c) differ at $p < 0.05$ on Student-Neuman-Keuls post-hoc tests.			

Just above half (55%) of the sub-sample of respondents who had driven on all three road types within the previous three months fell in the largely compliant Cluster 1. On average, those in Cluster 1 had committed with some frequency, within the past three months, 1.84 of the seven speed limit breaches.

A third (32%) fell in Cluster 2, labelled here 'Exceeders': all reported they had done 35 mph in a 30 mph zone, and a quarter reported sometimes doing 40 mph in a 30 mph zone, but hardly any reported doing 50 mph or more in a 30 mph area. Similarly, some reported having done 70 mph on a 60 mph rural road but not 80 mph, and 80 mph on a dual carriageway but not 90 mph. On average, they had committed 3.46 of the seven speed limit breaches in the past three months.

Most Cluster 3 drivers had done 35 mph in a built-up area, many (89%) reported 40 mph and above a quarter (29%) reported having done 50 mph or more in a built-up area 'in the last three months'. Many (83%) reported 70 mph on a rural 60 mph road and a third (33%) reported 80 mph or more. Approaching three-quarters (71%) said they had done 80 mph on a dual carriageway and approaching a quarter (23%) admitted to 90 mph or more on a dual carriageway 'in the last three months'. On average they had committed 5.99 of the seven speed limit breaches within the past three months.

Table 5 gives demographic differences between the three clusters. There were statistically significant differences in cluster membership by area of residence, gender, age and experience of having a near miss on a rural road, but not rural road traffic accident involvement, in the last 12 months.

**Table 5: Demographic differences between clusters**

	Cluster 1	Cluster 2	Cluster 3
	Compliers (%)	Exceeders (%)	Excessives (%)
Per cent of sample <sup>†</sup>	55	32	13
Urban*	50	36	14
Rural	60	29	12
Male*	52	32	17
Female	58	33	9
17–24*	39	31	29
25–34	50	30	20
35–44	50	35	15
45–54	50	38	12
55–64	63	31	6
65–74	73	26	1
75+	70	30	0
Near miss on a rural road in last 12 months*	18	21	32
Accident on a rural road in last 12 months (ns)	3	1	4

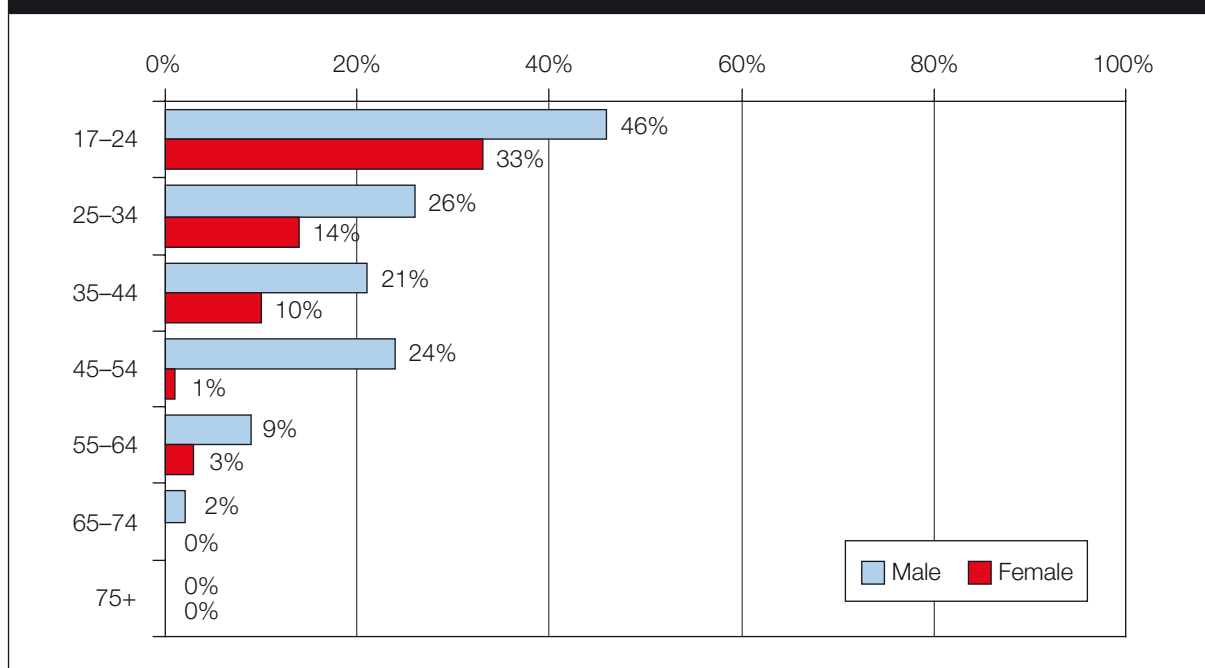
Base: all who had driven on all three road types in the past three months (784).  
 \* Statistically significant difference (at 95% level) – ns denotes a non-significant difference.  
<sup>†</sup>Numbers may not add up to 100 due to rounding.

Drivers residing in rural areas were more likely to belong to Cluster 1 (60% of rural dwelling compared with 50% of urban dwelling drivers). There were twice as many male (17%) as female (9%) drivers in Cluster 3, though the fact that 1 in 11 female drivers were excessive speeders should not be overlooked. Membership of Cluster 3 dropped sharply with age, from 29% of the 17–24-year-old group to none of the 75+ group. Again, though, it should not be overlooked that, while 70% of the oldest group (75+) are generally speed limit compliant, falling in Cluster 1, 30% are not.

Figure 2 shows the age and gender composition of Cluster 3. Approaching half (46%) of the young male drivers (17–24 years) fell in Cluster 3. The 24% of male drivers in the 45–54 years age group may merit further attention.

Cluster 3 drivers were also significantly more likely to report a near miss on a rural road within the last 12 months (32% compared with 21% of Cluster 2 and 18% of Cluster 1 drivers). Numbers for road traffic accidents on rural roads within the last 12 months were small for all groups and did not show statistical significance between clusters.

Figure 2: Proportion of each age group of male and female drivers in Cluster 3



## Speed selection on rural roads

Lee and Frowley (2006), in work for the then Scottish Executive, showed that a variety of road features, such as bends in the road or the road being visually ‘closed’ by features such as adjacent trees or walls, will cause drivers to slow down. With this in mind, respondents in the driver survey were shown a series of six photographs depicting the following rural road types:

- a straight open road in good weather;
- a straight open road in bad weather;
- a bendy open road in good weather;
- a bendy open road in bad weather;
- a straight road in the dark; and
- a bendy ‘closed’ road (i.e. with trees and hedges on either side of the road) in good weather.

For each picture, respondents were asked what speed, in miles per hour, they would normally drive at on that stretch of road and what speed they felt was the fastest they could go on that stretch of road that would put them right at the edge of their safety margins. Respondents were told prior to seeing the pictures that they would be asked both of these questions and it was intended that this would encourage them to differentiate between their ‘typical’ and ‘maximum’ speeds.

The mean typical and maximum speeds were calculated for each road type. These, along with 95% confidence intervals, are shown in mph in descending order of speed in Tables 6 and 7.

Across all road types, the average maximum speed was around 10% higher than the average typical speed. However, the overall pattern across the photographs was the same when considering both driving speeds. For both their typical and maximum speeds, drivers, on average, would drive fastest on a straight open road in good weather, followed by a straight open road in bad weather, a bendy open road, a bendy open road in bad weather, a straight open road in the dark and, finally, a closed bendy road.

**Table 6: Typical mean speeds (mph) for each road type**

		(mph)	
	Mean	95% confidence limits	
Straight open (1,019)	53.5	52.9	54.1
Straight bad weather (1,016)	45.6	45.0	46.2
Bendy open (1,019)	42.4	41.8	43.0
Bendy bad weather (1,018)	42.0	41.4	42.6
Straight dark (1,015)	39.4	39.4	38.8
Bendy closed (1,018)	37.4	36.8	38.0

Base: all responding to each picture in the main survey (see brackets for number).

**Table 7: Maximum mean speeds (mph) for each road type Typesetter: Add commas to thousands and set 'confidence limits' in lower-case. Add (mph) to cross-heads above the last three columns]**

		(mph)	
	Mean	95% confidence limits	
Straight open (1,019)	59.1	58.5	59.8
Straight bad weather (1,019)	50.4	49.7	51.0
Bendy open (1,019)	47.1	46.5	47.8
Bendy bad weather (1,019)	46.3	45.7	47.0
Straight dark (1,017)	43.6	42.9	44.2
Bendy closed (1,019)	41.8	41.2	42.5

Base: all responding to each picture in the main survey (see brackets for number).

Repeated measures tests revealed that when considering driving at their normal speed, respondents said they would drive at a significantly different speed on every road type, with the exception of bendy open roads and bendy roads in bad weather, where mean stated speeds did not significantly differ. It may be that bad weather does not appear to lead to additional speed reduction on a bendy, open road, in the same way as it does on an open, straight road, or that the extent of the 'badness' of the weather differed appreciably between the two bad weather photographs. When considering driving at their maximum possible speed, respondents said they would drive at significantly different speeds on every road type.



Further comparisons (Collins et al, 2008; Collins and Stradling, 2008) showed that:

- on the straight open road both typical and maximum speeds reduced by 36% from daylight conditions to darkness;
- on the straight open road both typical and maximum speeds reduced by 14% from good weather conditions to bad weather conditions;
- under good weather conditions both typical and maximum speeds were 25% slower on the open bendy road than the open straight road;
- under bad weather conditions both typical and maximum speeds were 8% slower on the open bendy road than on the open straight road; and
- on bendy roads, in daylight and with good weather conditions, both typical and maximum speeds were 13% lower for the closed bend than the open bend.

Figures 3–8 show the photographs used, together with the mean typical speed in mph for male and female drivers in seven age groups, plus an apposite quotation from the young rural driver focus groups. It may be seen that across all six rural road types mean indicated typical speeds reduce with age, and that for each age group mean indicated typical speeds were higher for male than for female drivers. This pattern holds for mean maximum speeds (Collins *et al.*, 2008; Collins and Stradling, 2008).

**Figure 3: Straight, open rural road in daylight with good weather (source: Scottish Government)**

'I took it easy the first couple of weeks I passed my test, so I got used to everything first, and then I just went wild ... I would do 60 [at first], but now I do whatever I want. I know I can drive now. I'm confident in myself.' (M 17–21)



mph	F	M
17–24	59	63
25–34	55	61
35–44	54	56
45–54	51	58
55–64	52	53
65–74	50	52
75+	49	49
Mean	53	55

STRAIGHT  
OPEN  
DAY  
GOOD WEATHER

Figure 4: **Straight, open rural road in daylight with poor weather (source: Scottish Government)**

‘It depends on the weather for me, if it’s a sunny evening or something like that it’s really enjoyable. If its pouring with rain and its six in the morning and you’re heading towards work its totally different, you just can’t be bothered but if it’s an evening and it’s sunny and get the windows open and music on and stuff, if your going to do something nice, its nice to have a blast through the nice roads, its enjoyable.’ (M 21–25)



mph	F	M
17–24	49	52
25–34	45	53
35–44	44	48
45–54	43	51
55–64	45	47
65–74	43	47
75+	44	44
Mean	44	49

STRAIGHT  
OPEN  
DAY  
BAD WEATHER

Figure 5: **Bendy, open rural road in daylight with good weather (source: Scottish Government)**

‘There needs to be corners. It’s no fun if it’s straight.’ (M 21–25)



mph	F	M
17–24	45	49
25–34	42	49
35–44	42	46
45–54	41	48
55–64	42	44
65–74	39	42
75+	39	41
Mean	41	45

BENDY  
OPEN  
DAY  
GOOD WEATHER

Figure 6: **Bendy, open rural road in daylight with poor weather (source: Scottish Government)**

‘I just basically ignore the speed limit ... The only way you can actually get up to real speeds is on the straight bits, and not look at the speedo ... just look at the corner coming up.’ (M 17–21)



mph	F	M
17–24	43	47
25–34	43	49
35–44	41	45
45–54	39	47
55–64	41	43
65–74	39	42
75+	38	40
Mean	41	45

BENDY  
OPEN  
DAY  
BAD WEATHER

Figure 7: **Straight, open rural road at night with good weather (source: Scottish Government)**

‘My sister when she just passed her test because I’d been past my test for a while and going out with her at night was a bit scary because she’d never done it before, never had before doing her test. She was how do I put my lights on?’ (M 21–25)



mph	F	M
17–24	43	48
25–34	39	50
35–44	38	45
45–54	36	43
55–64	36	39
65–74	32	38
75+	34	37
Mean	37	42

STRAIGHT  
OPEN  
NIGHT  
GOOD WEATHER

**Figure 8: Bendy, closed rural road in daylight with good weather (source: Scottish Government)**

'If you don't know [the roads], you're a wee bit more aware. But once you know them, you just think, right, let's see how quick I can get round this corner, or how quick I can go on this straight.' (M 17–21)



mph	F	M
17–24	40	45
25–34	38	44
35–44	35	40
45–54	36	43
55–64	36	39
65–74	35	38
75+	33	38
Mean	36	40

BENDY  
CLOSED  
DAY  
GOOD WEATHER

Drivers from the three clusters were compared on the typical and maximum speeds they nominated for the six photographs. Table 8 gives the figures for typical speeds and Table 9 for maximum speeds.

**Table 8: Typical speeds on six road types by cluster membership**

Bendy/straight	Closed/open	Good/bad weather	Day/night	Cluster 1	Cluster 2	Cluster 3
Straight	Open	Good	Day	52.25 <sub>a</sub> *	54.99 <sub>b</sub> *	62.17 <sub>c</sub> *
Straight	Open	Bad	Day	44.59 <sub>a</sub>	46.31 <sub>a</sub>	52.97 <sub>b</sub>
Bendy	Open	Good	Day	42.15 <sub>a</sub>	43.59 <sub>a</sub>	48.71 <sub>b</sub>
Bendy	Open	Bad	Day	41.39 <sub>a</sub>	43.21 <sub>a</sub>	47.53 <sub>b</sub>
Straight	Open	Good	Night	38.55 <sub>a</sub>	40.71 <sub>a</sub>	46.68 <sub>b</sub>
Bendy	Closed	Good	Day	37.37 <sub>a</sub>	38.30 <sub>a</sub>	43.00 <sub>b</sub>
			Average	42.72	44.52	50.18

Base: all who had driven (more often than 'never') on all three road types (784).

\* Means with different subscripts (a, b, c) differ at  $p < 0.05$  on Student-Neuman-Keuls post-hoc tests.

For typical speeds, post-hoc statistical tests showed that Cluster 1 drivers nominated the lowest typical speeds on all road types and Cluster 3 drivers the highest typical speeds on all road types. The Cluster 2 drivers' typical speeds were indistinguishable from those of Cluster 1, except on the straight open road, where they were statistically elevated.

Table 9: Maximum speeds on six road types by cluster membership

Bendy/straight	Closed/open	Good/bad weather	Day/night	Cluster 1	Cluster 2	Cluster 3
Straight	Open	Good	Day	56.67 <sub>a</sub> *	62.33 <sub>b</sub> *	69.90 <sub>c</sub> *
Straight	Open	Bad	Day	48.35 <sub>a</sub>	52.35 <sub>b</sub>	59.13 <sub>c</sub>
Bendy	Open	Good	Day	45.96 <sub>a</sub>	49.15 <sub>b</sub>	55.25 <sub>c</sub>
Bendy	Open	Bad	Day	44.90 <sub>a</sub>	48.62 <sub>b</sub>	53.87 <sub>c</sub>
Straight	Open	Good	Night	41.93 <sub>a</sub>	45.93 <sub>b</sub>	52.18 <sub>c</sub>
Bendy	Closed	Good	Day	40.91 <sub>a</sub>	43.72 <sub>b</sub>	48.72 <sub>c</sub>
			Average	46.45	50.35	56.51

Base: all who had driven (at least rarely) on all three road types in the past three months (784).

\* Means with different subscripts (a, b or c) differ at  $p < 0.05$  on Student-Neuman-Keuls post-hoc tests.

For maximum speeds, post-hoc statistical tests showed that Cluster 1 drivers nominated the lowest and Cluster 3 the highest maximum speeds on all road types. However, the Cluster 2 drivers' maximum speeds were statistically higher than Cluster 1, and lower than Cluster 3 on all six road types. This suggests that when driving on rural roads (other than straight, open roads in daylight and in good weather conditions), Cluster 2 drivers differ in their belief about the maximum safe speed possible, though not in actual speed behaviour, from Cluster 1.

## Conclusions

In Scotland the number of fatalities has declined, but at a slower rate on rural roads than on urban roads. A large study was conducted for the Scottish Government to examine driving behaviour on rural roads, comprising an analysis of STATS 19 data for recent rural road accidents in Scotland; frequency of driving on rural roads; a large survey of Scottish car drivers' attitudes and behaviours; and focus groups with young, male, rurally-resident car drivers.

Analysis of the STATS 19 data (Collins *et al.*, 2008) showed that speed was an important factor in rural road accidents, particularly when associated with loss of control. Loss of control was the factor recorded most often, in 32% of serious and 45% of fatal rural road accidents. There are two speed-related factors in the STATS 19 list of factors: travelling too fast for the conditions and exceeding the speed limit. When accidents where both speed codes were recorded are combined, excessive speed, though not necessarily above the speed limit, was a factor in 22% of serious and 33% of fatal accidents. Both loss of control and travelling too fast for the conditions were recorded more often in accidents on rural than urban roads.

From the omnibus Scottish Opinion Survey it was shown that most current drivers had driven in the previous 12 months on most types of road whether they reside in an urban or rural area. Indeed, around 19 out of 20 drivers resident in either type of area had driven on rural roads in the past year. The survey of 1,020 Scottish drivers, though, showed that the **frequency** of driving on rural roads varied more substantially between urban and rural dwellers, with two-thirds (67%) of rural



dwelling car drivers reported driving on rural roads ‘most days’ and three-quarters (77%) did so once a week or more often.

Self-reported prevalence of risky behaviours, such as mobile phone use while driving, drink- and drug-driving, or driving when very tired, gauged as the proportions who owned up to having done such at least once in the previous 12 months, did not differ between urban and rural driving.

Examination of the frequency of exceeding the speed limit by varying amounts in built-up areas, single-carriageway rural roads and dual carriageway found that on 30 mph roads, 20% of respondents reported never driving at 35 mph, half (50%) never driving at 40 mph, and 86% never driving at 50 mph or more. On 60 mph rural roads, half (47%) reported never driving at 70 mph and four in five (80%) never driving at 80 mph or more. On 70 mph limit dual carriageways, half (49%) reported never driving at 80 mph and four in five (80%) never driving at 90 mph or more. Drivers residing in urban areas tended to break the speed limit more in town; drivers residing in rural areas tended to break the speed limit more on dual carriageways; and there was no significant difference between urban and rural dwellers on single-carriageway rural A roads. Age and gender made a statistically significant difference in all comparisons, with male drivers and younger drivers being less compliant throughout.

Cluster analysis of these responses showed three clusters and proportions in close agreement with those reported for the UK-wide HUSSAR project analysis (Stradling *et al.*, 2009, Table 3; Stradling *et al.*, 2008). Just over half (55%) of the sub-sample of respondents who had driven on all three road types within the previous three months fell in the largely compliant Cluster 1. A third (32%) fell in Cluster 2, who typically reported having sometimes done 10 mph over the speed limit on each road type, but not more. Thirteen per cent fell in Cluster 3. On average these had committed six of the seven speed limit breaches within the past three months. Approaching half (46%) of the young male drivers (17–24 years) fell in Cluster 3. While the numbers of reported rural road collisions in the previous 12 months were too low to show reliable differences between clusters, significantly more Cluster 3 drivers reported a near miss on a rural road in the last 12 months (32% versus 18% and 21%).

Shown six different still photographs of rural roads and asked to nominate their typical and maximum speeds, drivers, on average, would drive fastest on a straight open road, followed by a straight open road in bad weather, a bendy open road, a bendy open road in bad weather, a straight open road in the dark and, finally, a closed bendy road. Average nominated speeds varied with gender and age – in the expected directions.

For both typical and maximum speeds, Cluster 1 drivers nominated the lowest speeds on all road types and Cluster 3 drivers the highest. Intriguingly, Cluster 2 drivers’ typical speeds were indistinguishable from those of Cluster 1, except on the straight open road, and were lower than those of Cluster 3 on all roads, whereas their maximum speeds were statistically higher than Cluster 1, and lower than Cluster 3, on all six road types. Cluster 2 drivers would appear to differ in their belief about the maximum safe speed possible, though not in actual speed behaviour, from Cluster 1.

They reportedly do not drive any faster than Cluster 1 drivers, but believe they could before reaching the limit of their safety margins.

However, for a minority (13%) of drivers, those in Cluster 3, who post higher typical and maximum speeds, and more of whom report recent near misses on rural roads, urgent action is needed to ensure they cease and desist.

## References

Collins, E. and Stradling, S. (2008) Rural road safety – a question of speed? *Scottish Transport Applications Research (STAR) Conference*, Glasgow, 24 April 2008.

Collins, E., Eynon, C., MacLeod, P., Stradling, S., Crinson, L., Scoons, J. and Broughton, J. (2008) *Rural Road Safety: Drivers and Driving*. Edinburgh: Scottish Government and Road Safety Scotland.

Department for Transport, Local Government and the Regions; Scottish Executive; National Assembly for Wales (2000) *Tomorrow's Roads – Safer for Everyone*. London: DTLR

Hamilton, K. and Kennedy, J. (2005) *Rural Road Safety Literature Review*. Crowthorne: Transport Research Laboratory/Edinburgh: Scottish Executive.

Hopkin, J. and Morris, B. (2007) *Rural Roads – The Biggest Killer*. London: IAM Motoring Trust. [www.iam.org.uk/NR/exeres/96063558-E01F-4095-AB52-EE7518033377](http://www.iam.org.uk/NR/exeres/96063558-E01F-4095-AB52-EE7518033377) (accessed on 9 April 2009).

Lee, T. and Frowley, J. (2006) *Natural Traffic Calming; Some Effects of the Environment on Driving Speed*. Road Safety Scotland, Seminar Paper.

Scottish Executive (2005) *Road Accidents Scotland 2005. A Scottish Executive National Statistics Publication*. Edinburgh: Scottish Executive. [www.scotland.gov.uk/Resource/Doc/155345/0041727.pdf](http://www.scotland.gov.uk/Resource/Doc/155345/0041727.pdf) (accessed on 23 April 2009).

Stradling, S. G. (2005) Speeding behavior and collision involvement in Scottish car drivers. In D. A. Hennessy and D. L. Wiesenthal (eds), *Current Trends in Driver Behavior and Traffic Safety Research*. New York: Nova Science Publishers.

Stradling, S. G. (2006) Cutting down and slowing down: changes in car use and speeding on Scotland's roads. *Behavioural Research in Road Safety: Sixteenth Seminar*. London: Department for Transport.

Stradling, S. G., Carreno, M., Ferguson, N., Rye, T., Halden, D., Davidson, P., Anable, J., Hope, S., Alder, B., Ryley, T. and Wigan, M. (2005) *Scottish Household Survey Analytical Topic Report: Accessibility and Transport*. Edinburgh: Scottish



Executive. [www.scotland.gov.uk/Publications/2005/10/11131554/15544](http://www.scotland.gov.uk/Publications/2005/10/11131554/15544) (accessed on 23 April 2009).

Stradling, S., Gormley, M., Fuller, R., Broughton, P., Kinnear, N. and O'Dolan, C. (2009) A typology of speeding drivers: extent of and motives for exceeding the speed limit. *Behavioural Research in Road Safety, Seventeenth Seminar*. London: Department for Transport. [www.dft.gov.uk/pgr/roadsafety/research/behavioural/seventeenthseminar/](http://www.dft.gov.uk/pgr/roadsafety/research/behavioural/seventeenthseminar/) (accessed on 23 April 2009)

Stradling, S., Broughton, P., Kinnear, N., O'Dolan, C., Fuller, R., Bates, H., Gormley, M. and Hannigan, B. (2008) *Understanding Inappropriate High Speed: A Quantitative Analysis*. Road Safety Research Report No. 93. London: Department for Transport.

This is the eighteenth in a series reporting the findings of the annual behavioural research seminar in road safety. The seminar, organised by the Road Safety Division of the Department for Transport, provides a forum for the discussion of current research as well as the exchange of ideas in this area of behavioural research.

Price £33.00

ISBN 978-1-84864-010-8



9 781848 640108 >