These proceedings are the twelfth in a series reporting on an annual seminar on behavioural research in road safety organised by the Road Safety Division of the Department for Transport (DfT). These seminars have the aim of providing a forum for the discussion of current research and the exchange of ideas in this area of behavioural research. The proceedings of seminars one to nine were published by the Transport Research Laboratory, and the tenth and eleventh seminars by DfT’s predecessor departments; these reports are still available.
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Twelfth Seminar
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# CONTENTS

1  Estimating the effects of age and experience on accident liability using STATS19 data
   G Maycock

2  Sequential case-study of police road accident files involving young drivers, motorcycles, or work-related accidents
   DD Clarke, P Ward, W Truman and C Bartle

3  EU-project ‘ANDREA’: analysis of driver rehabilitation programmes
   G Bart, J-P Assailly, F Chatenet, M Hatakka, E Keskinen and G Willmes-Lenz

4  Multiphase driver education in Austria
   G Bartl

5  A laboratory comparison of two steering techniques
   ID Brown

6  Police drivers’ visual search in hazardous situations
   P Chapman, D Crundall, N Phelps and G Underwood

7  Antilock braking systems: do they reduce accidents?
   CJ Baughan, J Broughton and L Smith

8  The effect of new technologies on speed distributions
   OMJ Carsten, FN Tate and F Lai

9  The impact of speeding tickets on speeding behaviour
   M Campbell and SG Stradling

10 International review of Driver Improvement Schemes
    DJ Knox and BM Turner
11  Reaching a consensus: using the Delphi method to assess expert opinion on countermeasures against unlicensed driving
    DJ Knox and BM Turner

12  Safe mobility for older people
    D O’Neill

13  Medical aspects of fitness to drive
    T Carter

14  Prevalence of licit and illicit drugs on EU roads: legislation and policy implications
    J-P Assaily

15  Driver sleepiness: can devices based on reaction time help?
    SD Baulk, LA Reyner and JA Horne

16  The accidents and behaviours of bus drivers
    L Dorn, L Garwood and H Muncie

17  DBQ in disguise: confirmatory factor analysis on a four-factor model
    P-A Rimmo

18  Combating car dependence
    SG Stradling

19  Attitudes to driving in pre-17-year-olds
    A Waylen and P McKenna

20  Evaluation of the effectiveness of a dramatic presentation on attitudes to road safety
    G O’Brien, F Rooney, C Carey and R Fuller

21  Fools speed: evaluation of a national theory-based advertising campaign to reduce speeding
    M Stead, S Tagg, AM MacKintosh and D Eadie
Changing drivers’ attitudes: is there potential for changing drivers’ behaviour?
MA Elliott, CJ Armitage and CJ Baughan

Drivers’ illusions of superiority for hazard perception and vehicle control skill
MS Horswill, AE Waylen and MI Tofield
1 Estimating the effects of age and experience on accident liability using STATS19 data

G Maycock, Scientific & Allied Services, Bracknell, RG12 9YH

Introduction

It is well known that the accident liabilities of drivers fall with age and with increasing driving experience. However, quantifying the changes in accident liabilities as a result of maturation (the age effect) as distinct from that of increasing driving experience (defined here as the number of years a driver has been driving since passing the test) has always been difficult. In statistical terms, the difficulty arises from the fact that in any large random sample of drivers, age and experience are highly correlated and therefore difficult to disaggregate. Estimating these effects from national accident statistics is difficult for the practical reason that, whereas a driver’s age is usually collected with the official statistics, driving experience is not. However, if it is required to make estimates of the accident consequences of a range of policy options which might influence the age at which young drivers start driving, the quantification of the effects of age and experience on injury accidents is essential.

This paper describes an attempt to calibrate an age-experience relationship obtained from a statistical accident liability study carried out some years ago, making use of nationally reported STATS19 injury accident data, driver licensing data from the Driver Vehicle Licensing Agency (DVLA), data on driving test passes from the Driving Standards Agency (DSA) and data on annual mileages from the National Travel Survey (NTS).

Self-report accident liability studies

Figure 1 shows the modelled results of an accident liability survey (Maycock, Lockwood and Lester, 1991) based on accidents reported by a sample of about 13,500 drivers split roughly equally between the sexes. The accidents were self-reported accidents on public roads, and were mainly damage only; most drivers reported the number of accidents in which they had been involved during a three-year period. The study was a cross-sectional study using a structured sample in which older and younger drivers, and drivers with limited driving experience, were deliberately over-sampled.

The upper broken lines in Figure 1 show how the accident liability of male and female drivers in their first year of driving falls with increasing age. For both sexes, accident liabilities fall by about a factor of two between the liabilities of drivers passing the test at age 17/18 and those who are over 60 when they pass the test. In their first year of driving, male drivers have an accident liability that is just over one-third higher than that of female drivers adjusted to the same level of annual mileage. The lower solid curves in Figure 1 show how the accident...
liabilities of drivers who start driving at 17 change as they get older and gain in experience; clearly there is a rapid fall in accident liability in the first few years of driving due to increasing experience.

The best fit equation for the age-experience effects illustrated in Figure 1 for both sexes combined was:

\[
AL = 0.00212 M^{0.38} \exp\{(20/Ag) + 2.5/(X+2.2)}
\] (1)

where \(AL\) is accident liability (accidents per year), \(M\) is annual mileage, \(Ag\) is age (at the mid-point of the accident period) and \(X\) is driving experience expressed as the number of years since passing the test.

A further study which also involved the collection and modelling of accident liability data was the Cohort Study (Forsyth, Maycock and Sexton, 1995). An analysis of these data confirmed the findings of the earlier accident liability study in showing that a rapid decrease in accidents occurs in the first three years of driving.

Calibrating age and experience effects using STATS19 data

This section describes the calibration of an age-experience relation of the form given by equation (1) above, using STATS19 accident data and data on the age-experience structure and annual mileages of the driving population obtained from a variety of sources.

ACCIDENT DATA

STATS19 provides information about personal injury accidents occurring on public roads in which at least one vehicle is involved, and which becomes known to the police within 30 days of its occurrence. The fact that in most cases the ages of the drivers involved in each accident are recorded in the STATS19 database
enables the number of casualties arising from accidents involving a driver of a particular age to be determined. The number of KSI (killed and seriously injured) casualties and ‘all severity’ casualties for the three years 1996–98 were obtained from the STATS19 database. The average number of these accidents for the years 1996–1998 is shown for male and female drivers aged from 17–39 in Table 1; columns 2, 4, 6 and 8 present the average values as provided by STATS19 and columns 3, 5, 7 and 9 are ‘adjusted’ versions of these averages, required for the reasons given below.

Two rather different aspects of the accident data shown in Table 1 need further comment. The first relates to ‘double counting’ of accidents, and the other to the fact that the ages of drivers as recorded are sometimes ‘rounded’ to the nearest 5- or 10-year value.

The raw STATS19 data shown in Table 1 are the total number of casualties associated with drivers of a given age in the yearly age bands from 17–39. Since a driver of a given age, say 17, will have some accidents which involve another driver of a different age within the 17–39 age range, some casualties will appear twice in the table. If the purpose of any calculations based on accident data disaggregated by age is to estimate absolute accident numbers or changes in the numbers of accidents due to some intervention, then the effect of double counting has to be allowed for. In the present study, however, we are concerned only with the relationship between the accident liability of an individual driver and the age and driving experience of that driver. In this case it is unnecessary to correct for double counting, though if the resulting accident liabilities are to be used in a way which aggregates expected accident numbers across ages a correction for double counting will be needed.
The other issue illustrated by the data in Table 1 is that in reporting drivers’ ages, there is a tendency to report some ages to the nearest ‘rounded’ age. Figure 2 shows, by way of example, the average number (1996–98) of accidents of all severities for male drivers (column 4 of Table 1) plotted against age – the ‘hollow’ triangles. It will be seen that the numbers of accidents assigned to ages 20, 25, 30 and 35 are considerably higher than the trend indicated by the accident numbers for the intermediate ages. The solid triangles show the ‘adjusted’ values. The adjustment process consisted of replacing the discrepant values by the average of the number of accidents corresponding to the ages either side of them. The resulting set of ‘smoothed’ accident numbers have then been scaled so that the total number of accidents is restored to the total number observed. This adjustment process was carried out separately for the age groups 17–22 and 23–39, with the result shown in Figure 2 (the solid triangles). The same adjustment process has been repeated for all accident categories and the results are shown in Table 1 as ‘adjusted’ accident numbers.

**NUMBERS OF LICENSED DRIVERS**

The numbers of licensed drivers by age and sex were supplied by the DVLA for two months in each of the three years 1996, 1997 and 1998. Table 2 shows the average number of licensed drivers for male and female drivers over this period (columns 2 and 5). The table (columns 3 and 6) also shows the number resulting from the simulation to be described in the next section and a ‘correction factor’ (columns 4 and 7), the purpose of which will be clarified when the calculations are described.
Two points are worth making about driver numbers. The first is that some drivers may relinquish their licences without notifying the DVLA. The second point is that not all licensed drivers are regular drivers. In the present case, we shall be using DVLA licensed driver numbers as the basis of the calculations, so the resulting absolute accident liabilities may not accurately represent those of active drivers.

**SIMULATING THE AGE AND EXPERIENCE DISTRIBUTION IN THE DRIVER POPULATION**

The first step in being able to estimate the total number of accidents a particular age-group of drivers will have is to estimate the structure of this group in terms of driving experience. To do this an estimate of the distribution of ages at which drivers enter the driving population is required.

The Transport Research Laboratory (TRL) archives a section of the DVLA driver file each year for research purposes. A sample of about 100,000 drivers from this archive for the years 1993 and 1998 has been extracted to establish the distribution of the ages at which these drivers passed the test. There was little practical difference between the distributions for these two years, so the assumption has been made that, although the number of drivers will change from year to year, the age distribution at which they pass the test has remained the same as the 1993/1998 average. The distribution is tabulated in Appendix 1 for the age range used in these calculations (17–39) and the first five years of this distribution for both male and female drivers is illustrated in Figure 3. The points in the figures are the actual values obtained from the analysis of the DVLA data, though the values used in the calculations were based on a smoothed version of these data.
Using these distributions, Table 3 illustrates, for male drivers, the procedure used in the estimating of the numbers of drivers by age and experience. The table represents a ‘snapshot’ of the driver age/experience distribution for drivers aged from 17–39 – though for space reasons the full matrix cannot be reproduced. The columns of the Table represent the ages of drivers in 0.1 year steps from 17–39, the actual values given at the head of each column being the mid-point of these 0.1 year age bands. The rows of the table (headed by ‘X’) represent driver experience values increasing in 0.1 year steps. Since the object of the exercise is to reconstruct the pattern of the age/experience structure in the ‘target’ year (that which corresponds to the 1996–98 average), the successive rows of the table should be thought of as drivers entering the driving population progressively earlier in time. Thus, the top row of the table represents the most recent entries to the driving population (experience 0.05 years) and the bottom row of the table corresponds to drivers entering the driving population 22 years before the ‘target’ year (22 corresponding to the difference between 17 and 39).

The row labeled ‘%’ shows the proportions of drivers in a given year entering the driving population at various ages – values taken from Appendix 1 and illustrated in Figure 3. The figures in brackets just below the ‘Intake year’, shown in the first column of the table, represent the numbers of drivers passing the test in that year expressed as thousands (how these numbers were obtained will be described shortly).

The second row in the table is the same as the first shifted one column to the right – so, for example, the column headed 17.15 now contains two numbers, the first (530) representing the new group of drivers entering the population at age 17.15 and the other (205) the drivers who had entered the driving population 0.1 year earlier, and who now have 0.15 years’ experience. And so on throughout the table. Each year, the number of drivers entering the driving population in the year is allowed to change to reflect the changing numbers of drivers passing the test over the past 22 years.

The total numbers of drivers in each year of age is shown in the bottom row of the table – four years are illustrated. These figures can be compared to the number of licensed drivers provided by the DVLA and shown in Table 2. The connection between the numbers shown in the age/experience distribution shown in Table 3 and the DVLA numbers is the pattern of test pass rates over the last 24 years (the figures in the ‘Intake year’ column of Table 3). Actual data for the full 24 years (from 1974–98) was not available, but Figure 4 illustrates the number of passes for male and female drivers for the eight years from 1991 to 1998 presented in the form of three-year averages. It will be seen from Figure 4 that over the 1991–98 period there has been a more or less
Table 3: Illustrating the distribution of age/experience for male drivers

<table>
<thead>
<tr>
<th>Intake year (n)</th>
<th>Age</th>
<th>17th year</th>
<th>18th year</th>
<th>...33rd year</th>
<th>...39th year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>0.05</td>
<td>0.15</td>
<td>0.25</td>
<td>0.35</td>
</tr>
<tr>
<td>1996/8 (390.6)</td>
<td>X</td>
<td>205 530 977 1340 1473 1427 1252 1112 992 919</td>
<td>790 700 651</td>
<td>48 48 48</td>
<td>24 24 24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.05 205 530 977 1340 1473 1427 1252 1112 992</td>
<td>919 790 700</td>
<td>48 48 48</td>
<td>24 24 24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.25 205 530 977 1340 1473 1427 1252 1112 992</td>
<td>992 919 790</td>
<td>48 48 48</td>
<td>24 24 24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.35 205 530 977 1340 1473 1427 1252</td>
<td>1112 992 919</td>
<td>48 48 48</td>
<td>24 24 24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.45 205 530 977 1340 1473 1427</td>
<td>1252 1112 992</td>
<td>48 48 48</td>
<td>24 24 24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.55 205 530 977 1340 1473</td>
<td>1427 1252 1112</td>
<td>48 48 48</td>
<td>24 24 24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.65 205 530 977 1340</td>
<td>1473 1427 1252</td>
<td>48 48 48</td>
<td>24 24 24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.75 205 530 977</td>
<td>1340 1473 1427</td>
<td>48 48 48</td>
<td>24 24 24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.85 205 530</td>
<td>977 1340 1473</td>
<td>54 48 48</td>
<td>26 24 24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.95 205</td>
<td>530 977 1340</td>
<td>54 54 48</td>
<td>26 24 24</td>
</tr>
<tr>
<td>1995/7 (401.0)</td>
<td>1.05</td>
<td></td>
<td>211 545 1003</td>
<td>55 55 55</td>
<td>27 27 27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.15</td>
<td>211 545</td>
<td>55 55 55</td>
<td>27 27 27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.25</td>
<td>211</td>
<td>55 55 55</td>
<td>27 27 27</td>
</tr>
<tr>
<td>1994/6 (411.4)</td>
<td>2.75</td>
<td></td>
<td>64 64 64</td>
<td>31 31 31</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.85</td>
<td></td>
<td>72 64 64</td>
<td>35 31 31</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.95</td>
<td></td>
<td>72 72 64</td>
<td>35 35 31</td>
<td></td>
</tr>
<tr>
<td>1984/6 (492.6)</td>
<td>12.75</td>
<td></td>
<td>122 122 122</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.85</td>
<td></td>
<td>129 122 122</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.95</td>
<td></td>
<td>129 129 122</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1974/6 (368.6)</td>
<td>22.75</td>
<td></td>
<td>194 501 922</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>22.85</td>
<td></td>
<td>194 501</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>22.95</td>
<td></td>
<td>194</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>51,236</td>
<td>138,246</td>
<td>414,463</td>
<td>394,144</td>
<td></td>
</tr>
</tbody>
</table>
linear decline in the number of both male and female drivers entering the driving population each year. The DVLA data (Table 2) show that the number of 39-year-old drivers (of both sexes) is lower than the number of drivers in their early 30s. This suggests that the number of drivers entering the driving population ‘peaked’ at some point during this 22-year period and is now falling.

In the present calculations it has been assumed that the number of drivers (male and female) entering the driving population increased linearly from the early 70s to a maximum in 1985/87 and thereafter declined linearly also. The parameters of these ‘intake year’ models were obtained by adjusting the parameters of the models in order to minimise the errors (squared) between the simulated numbers of license holders and the DVLA values. The fit is not exact, and Table 2 shows the simulated numbers by age and the factor needed to correct these simulated values to the actual values obtained from the DVLA. These correction factors are used in the estimation of accidents.

ANNUAL MILEAGE BY AGE

The predictive equation for accidents includes a mileage term. In the present exercise, the patterns of mileages driven by males and females by year of age have been extracted from estimates provided by drivers in two surveys – a survey of trunk road drivers (Maycock, Brocklebank and Hall, 1998) and a speed choice survey (Quimby, Maycock, Palmer and Butress, 1999). These estimated mileages have been scaled to match the mileages reported by the NTS for all license holders for the years 1995–97. The results are illustrated in Figure 5.

The accident calculations

For each cell of Table 3 (the numbers of drivers by age and experience), the number of accidents generated by the drivers in the cell are estimated using an equation of the form:

\[ A = A_c \times N \times M^* \times f(Age) \times f(Experience) \]  

(2)
where \( A \) is the number of accidents (KSI or total injury accidents), \( A_0 \) is a constant, \( N \) is the number of drivers, \( k \) is the correction factor (Table 2), \( M \) is the annual mileage (for the particular age and sex of the driver – Figure 5), \( \alpha \) is the mileage exponent, and \( f(Age) \) and \( f(Experience) \) are functions of age and experience respectively. Since in most of the studies carried out of accidents in relation to mileage to the present time the exponent \( \alpha \) has been between 0.2 and 0.4, a value of 0.3 has been used as a realistic representation of the mileage exponent.

Two age functions were tried – the reciprocal exponential function shown in equation (1), ie \( \exp\left\{b_1/Age\right\} \), and the simpler negative exponential function which has proved adequate in some studies, ie \( \exp\left\{-b_2Age\right\} \) where \( b_1 \) and \( b_2 \) are coefficients. The experience function used is a more general form of that shown in equation (1), ie \( \exp\left\{b_3/(X^{b_4} + b_4)\right\} \) in which \( X \) is experience (the number of years since passing the test), \( b_3 \) and \( b_4 \) are constants, and \( b \) is either 1 (as in equation (1)) or 0.5 – ie a square root effect.

Having used the above equations to estimate the number of accidents in each cell of Table 3, the accident totals were formed for each year of age and compared to the adjusted STATS19 data shown in Table 1. The age and experience constants in equation (2) are then iteratively adjusted to optimise the fit between the observed and simulated number of accidents. Because the absolute number of accidents in each age group varies considerably (in particular, the number of accidents involving 17-year-old drivers is less than one fifth of the number for 18-year-olds) the objective function used in the optimisation was the square of the percentage error between observed and simulated numbers.

Three models were fitted:

Model 1: \[ A = A_0 N k M^{0.3} \exp\left\{(b_1/Age) + b_3/(X + b_4)\right\} \]
Model 2: \[ A = A_0 N k M^{0.3} \exp\left\{(b_1/Age) + b_3/(X0.5 + b_4)\right\} \]
Model 3: \[ A = A_0 N k M^{0.3} \exp\left\{(b_2*Age) + b_3/(X + b_4)\right\} \]
The best fit models for all injury accidents for both male and female drivers are shown in Table 4.

### Table 4: Accident models fitted to all injury accidents

<table>
<thead>
<tr>
<th></th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
</tr>
<tr>
<td>Constant $A_0$</td>
<td>0.000308</td>
<td>0.000192</td>
</tr>
<tr>
<td>Age constant $b_1 (\text{+ve})$</td>
<td>19</td>
<td>11</td>
</tr>
<tr>
<td>Age constant $b_1 (-\text{ve})$</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>Experience power $b$</td>
<td>3.3</td>
<td>4.2</td>
</tr>
<tr>
<td>Experience constant $b_3$</td>
<td>1.5</td>
<td>1</td>
</tr>
<tr>
<td>Experience constant $b_4$</td>
<td>4.0</td>
<td>2.4</td>
</tr>
<tr>
<td>Overall fit (root mean square %)</td>
<td>4.0</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Table 4 shows that all the models are reasonable overall fits to the data. The key issue in relation to the age/experience effect is what is the best representation for predicting the accidents in which the young drivers are involved? An examination of the age-related residuals indicated that, for both sexes, the best compromise was Model 3.

Table 5 illustrates the model predictions for male and female drivers respectively using Model 3, and compares these predictions with the ‘raw’ STATS19 accident liabilities.

### Table 5: All accident predictions (Model 3) showing the effect of age only, of age and experience combined and the ‘raw’ STATS19 accident liabilities per 1000 drivers

<table>
<thead>
<tr>
<th>Age</th>
<th>Male drivers</th>
<th>Female drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Age only</td>
<td>Age and experience</td>
</tr>
<tr>
<td>17</td>
<td>92.8</td>
<td>92.8</td>
</tr>
<tr>
<td>19</td>
<td>89.3</td>
<td>25.4</td>
</tr>
<tr>
<td>24</td>
<td>81.2</td>
<td>14.1</td>
</tr>
<tr>
<td>29</td>
<td>73.9</td>
<td>11.3</td>
</tr>
<tr>
<td>34</td>
<td>67.2</td>
<td>9.8</td>
</tr>
<tr>
<td>39</td>
<td>61.1</td>
<td>8.6</td>
</tr>
</tbody>
</table>


$M = 8,500$ miles, $X_{17} = 0.3$ years

Table 5 shows, for selected ages (17, 19, 24, 29, 34 and 39), the accident liabilities of drivers (expressed as liabilities per 1,000 drivers, to make the numbers more readable) predicted by Model 3. These predictions are compared in the Table to the ‘STATS19’ accident liabilities of drivers of different ages (columns 4 and 7) estimated simply by dividing the adjusted numbers of STATS19 accidents (Table 1) by the numbers of drivers (Table 2). The mileages used in predicting the accident liabilities for male and female drivers has been taken to be close to the average expected for these drivers from the NTS data (ie 8,500 for men and 4,500 for women). Similarly, since accident liabilities are critically dependent on driving experience in the early years, the baseline for the experience values used in the predictions are the weighted averages for 17-year-old drivers derived from the distributions shown in Table 3 (and its equivalent for female drivers) – specifically 0.3 years for men and 0.26 years for women.
Table 5 illustrates two effects. Columns 2 and 5 illustrate the way the accident liability falls with age for novice drivers. Columns 3 and 6 illustrate the way accident liabilities decline for a driver who starts to drive at 17 and whose liability then declines with both age and driving experience. The final row of the table provides an overall indicator of the magnitudes of the effects by giving the ratios of the accident liabilities at age 17 to those at age 39. These indicators show that for male novice drivers, accident liability falls over this age range by a factor of 1.52; the corresponding effect for female drivers is 1.36. The effect of increasing age and driving experience together results in a reduction of accident liability for male drivers of 10.81, while the corresponding ratio for women drivers is about 6.6.

This modelling confirms the finding of the earlier results derived from the analysis of self-reported accidents, that the effect of driving experience on accident liability is considerably larger than that of age, and is particularly significant in the early years of driving. Figures 6 and 7 illustrate the novice driver age effect, the combined age and experience effect, and the STATS19 liabilities for male and female drivers respectively.
The marked effect of driving experience when combined with age in reducing accident liabilities compared with the effect of age alone are clearly demonstrated. The curves representing the STATS19 liabilities naturally fall between the age-only effect and that of the combined age and experience effect simply because not all drivers in the STATS19 database start driving at 17 – there are some inexperienced drivers at all ages.

There is a very significant difference between the effect of driving experience resulting from the present modelling exercise and that derived from the earlier study (typified by equation (1)). Figure 8 illustrates for male drivers aged 17 to 21 the combined age and experience curve according to the present study (Model 3) and the same relationship modelled using equation (1) matched at age 39. Figure 8 shows that from age 19 or so – i.e., after two years of driving experience – the two models generate virtually indistinguishable results. But the predictions are very different indeed in the first two years. In order to explain the STATS19 data – in particular, the relatively high number of accidents generated by 17-year-olds – a considerably more dramatic reduction in accidents in the earliest months of driving is required than was implied in the earlier work. That this dramatic learning curve was missed in the earlier study is almost certainly due to the fact that the majority of the accident data obtained in the self-report surveys related to three-year periods. It is clear from Figure 8 that in the first three-year period of a driver’s career, accident liability would be changing considerably, and the data collected in the earlier survey would in effect have averaged out these changes.

In fact, Model 3 suggests that, for a driver of any age, accident liability falls by a factor of 2.3 for male drivers and 1.9 for female drivers in the first six months of driving (taken to be from an experience value of 0.05 mid-way though the first tenth-year period to an experience value of 0.55, six months later). In the first year (estimated in the same way) accident liability falls due to increasing experience by a factor of 3.6 for men and 2.7 for women. These are considerably larger effects of experience than those estimated in the earlier survey (30 per cent).

In the case of KSI accidents only the negative exponential model was fitted. The best fit negative exponential age models (Model 3) for KSI accidents for male and female drivers are shown in Table 6.
Apart from a considerably larger age effect for male drivers, these models are very similar to those shown in Table 4 for all injury accidents – apart, of course, from a much lower constant term. Table 7 shows the predictions of these models for selected ages and compares them with the STATS19 accident liabilities. The final row of the table provides an overall measure of the effects by presenting the ratio of liabilities at 17 to those at 39. Because of the larger age effect, for male drivers the ratios are somewhat higher than the corresponding ratios in Table 5; the ratios for female drivers are, however, much the same.

These models for KSI accidents indicate that despite the somewhat higher age effect for male drivers, all the conclusions relating to the relative size of the age and the experience effects, and the very steep learning curve for novice drivers illustrated earlier for all injury accidents, apply equally to the more serious KSI accidents.

### Table 6: Accident Model 3 fitted to KSI accidents

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<td>Overall fit (root mean square %)</td>
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### Table 7: KSI accident predictions comparing the effect of age only, the effect of age and experience combined and the ‘raw’ STATS19 accident liabilities per 1,000 drivers

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<td>Ratio 17:39</td>
<td>1.89</td>
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### Conclusions

1. The simplest model which provided an adequate fit to both male and female STATS19 accidents was one which included a simple negative exponential age effect.

2. This model suggested that in the case of male drivers, ‘all’ injury accident liability falls with age (17–39) for novice drivers by a factor of 1.5; the corresponding factor for female drivers is 1.4. The effect of increasing age and driving experience combined results in a reduction of accident liability for male drivers (17–39) of 10.8 and of about 6.6 for women drivers.

3. The decline in accident liability in the earliest months of driving is particularly marked. The modelling suggests that for a driver of any age, accident liability falls by a factor of 2.3 for male drivers and 1.9 for female drivers in the first six months of driving. In the first year, accident liability falls due to increasing experience by a factor of 3.6 for males and 2.7 for females.
4. The models for KSI accidents, apart from a considerably larger age effect for male drivers, were very similar to those for all severity accidents – except for a much lower constant term. This finding indicates that all the conclusions relating to the relative size of the age and the experience effects, and the very steep learning curve for novice drivers for all injury accidents, applies also to the more serious KSI accidents.

References


## Appendix 1

### Distribution of age when drivers passed the driving test

(Average of 1993 and 1998 smoothed)

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<th>Age range %</th>
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<th>Age range %</th>
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2
Sequential case-study of police road accident files involving young drivers, motorcycles, or work-related accidents

DD Clarke, P Ward, W Truman and C Bartle, School of Psychology, University of Nottingham University Park, Nottingham NG7 2RD

Abstract

We have completed three projects for the Transport Research Laboratory (TRL)/Department of the Environment, Transport and the Regions (DETR)/Department for Transport, Local Government and the Regions (DTLR) on right-turning accidents, overtaking accidents and young drivers’ accidents, and have recently started a fourth study looking at motorcyclists’ accidents and work-related road accidents. This paper outlines our method and reports the findings of the young drivers study. 1,284 detailed accident cases were drawn from Midland police forces, involving drivers aged 17–25, covering four situations: (a) right turns; (b) rear-end shunts; (c) loss of control on bends; and (d) accidents in darkness. Findings include a breakdown of the role of attitude and skill factors, and a profile of changing causal patterns round the clock as road conditions and usage change. The paper also describes progress so far on the study of motorcycling and work-related accidents.

Introduction

The high accident rate for younger drivers has been of concern to such diverse official bodies as insurance companies, driving standards agencies and governments for many years. Road accidents are the most common cause of death among those aged under 25 in the USA, Canada and the European Union. Research conducted in these areas has shown that drivers aged 17–20, particularly males, have an accident rate per km/mile driven that is disproportionately high when compared with other groups. Forsyth (1992) quotes figures from the UK in 1987 that show male drivers between the ages of 17 and 20 having an average of 440 injury accidents per 100 million km driven. The average for all male drivers was 106 injury accidents. Comparable figures for female drivers in this age bracket were 240 versus 125 injury accidents per 100 million km driven.

Accident rates appear to drop rapidly above this age bracket. Figures for male drivers in the age range 20–24 years, for example, show a drop to 180 injury accidents per 100 million km driven. While this is a massive drop, it still represents an injury accident rate that is nearly 70 per cent higher than the baseline for all male drivers.

Recently, the Select Committee on Environment, Transport and Regional Affairs 19th report (1999) contained evidence from the UK showing that, although the 17–24-year-old age group hold only 11 per cent of driving licences, they are involved in 25 per cent of fatal/serious injury accidents each year. Additionally, fatality rates for male drivers aged 17–20 are 10 times those of male drivers aged 35–54.
Some specific problems of younger drivers:

**SPEED**

Speeding was by far the most common offence for young male and female drivers in the UK Cohort study by Forsyth, Maycock and Sexton (1995) and there also appeared to be an increase in the number of speeding violations as a whole over the first three years of driving. Forsyth et al. suggest that this is a result of increasing driver confidence as initial driving experience is gained after passing the test. This is similar to a finding by Quenault and Parker (1973), where newly qualified drivers were assessed at 1, 13, 26, 39 and 52 weeks after passing the driving test. They found that average speeds in 30mph and de-restricted zones tended to become higher with increasing driver experience.

The work of both Parker (1991) and Tuohy and Stradling (1992) showed the importance of driver attitudes in an understanding of the young driver problem. Parker (1991) found that speeding in younger drivers was often mediated by the effects of peer groups and significant others, resulting in the young driver having a perceived lack of control over violations such as speeding. Similarly, Tuohy and Stradling (1992) surveyed the knowledge and beliefs of both young drivers and ‘pre-drivers’ and concluded that both groups had a good knowledge of basic roadcraft: young drivers knew what was the correct behaviour, but attitudes, opinions and beliefs usually stopped them practising it.

**SINGLE VEHICLE ACCIDENTS AND BENDS**

When the type of manoeuvre in aggregate records such as STATS19 (UK) is examined, it can be seen that younger drivers (17–19) are involved in twice the proportion of accidents while negotiating a bend that older drivers are (in this example, those aged 30–39). This is a feature associated with the over-representation of younger drivers in single vehicle accidents. Clarke, Ward and Jones (1998), in their study of overtaking accidents, found that the second most common overtaking injury accident for drivers under the age of 21 occurred as a result of overtaking into a bend with little visibility ahead.

**RIGHT TURNS**

In a previous study at Nottingham, Clarke, Forsyth and Wright (1998) discovered that young drivers (under the age of 25) were more than three times more likely to be involved in right turning accidents (either onto or off a more major road) than typical mileage travelled each year by this age group would lead one to expect. Research by West and French (1993) revealed that young drivers were at greater risk of ‘passive’ right of way violations. They reported that ‘younger drivers [are] more at risk of an accident where another driver pulls out in front of them’. West and French say that this is most likely to occur due to a combination of such factors as speeding, slow perception of potential hazards, and a ‘[determination] to assert their own right of way’.

**REAR–END SHUNTS**

Rear-end shunts have been found to be among the most common types of accidents for all drivers. West and French (1993) estimated that at least 30 per cent of all accidents on UK roads were shunts. While many of these accidents are seemingly trivial, whiplash injuries that can result from them are a significant problem. West and French, in their analysis of different types of shunt, found that ‘active involvement in shunts was a function of being young and male’. (‘Young’, in West and French’s terms, being under 23-years old, with a sample deliberately selected to contain 50 per cent 17- and 18-year-olds.)
DARKNESS

Accidents for all drivers per unit distance travelled are much higher during the hours of darkness than during the daylight. Laapotti and Keskinen (1998) found that fatal loss of control accidents involving young male drivers typically took place during evenings and nights. The high numbers of accidents occurring in the early hours of the morning are also associated with the high numbers of single vehicle accidents for this age range.

Another possibility is that the problem of increased young driver accident involvement during the hours of darkness is caused by the purposes for which young drivers are on the road during these hours. These include driving for social purposes and 'driving for pleasure', both of which younger drivers do more than other groups of drivers (Stradling and Meadows, 2000). Driving is viewed as an expressive activity by many young drivers, and is for many a significant leisure activity.

Motorcycle accidents

Motorcyclists have a poor safety record when compared to other road user groups. Their killed and serious injury (KSI) rate in the UK per million vehicle kilometres is approximately twice that of pedal cyclists, and over 16 times that of car drivers/passengers. Motorcycles and mopeds make up less than 1 per cent of vehicle traffic, but their riders suffer 14 per cent of the total deaths and serious injuries on Britain's roads (DETR report, March 2000). Although changes in motorcycle training contributed to a fall in the number of motorcyclist casualties in the early 1980s and mid-1990s, this trend has reversed in more recent years. Possible reasons for this include the increasing sales of mopeds and scooters, and increasing numbers of older motorcyclists returning to the road on fairly powerful machines after a long break.

Motorcycle accidents also have somewhat different characteristics from other vehicle groups. KSI casualties in the UK peak through the 20–39 rider age bands, and motorcyclists are over-represented in right of way violation accidents, high speed accidents involving running off the road on bends, and accidents that are related specifically to the sort of manoeuvres that motorcycles can perform, eg overtaking other traffic without crossing the centre line, or 'filtering' between lines of traffic. Preusser, Williams and Ulmer (1995) found that a subset of fatal motorcycle accidents with characteristics similar to these accounted for around 85 per cent of the total, in a sample of over 2,000 such accidents.

Mannering and Grodsky (1995) point out several reasons why the characteristics of motorcycle accidents differ from those of other vehicles. Firstly, they claim car drivers ‘tend to be inattentive with regard to motorcyclists and have conditioned themselves to look only for other [cars] as possible collision dangers’. Mannering and Grodsky also state that, because motorcycle riding is well known to be a dangerous activity, it ‘may tend to attract risk-seeking individuals, in all age and socio-economic categories’, which would have a corresponding effect on the total motorcycle accident figures.

Work-related accidents

Research carried out over recent years has suggested that drivers who drive for business purposes are at an above average risk of accident involvement relative to the general driving population. Lynn and Lockwood (1998), for example, found that company car drivers in the UK are 49 per cent more likely to be involved in an accident than an ordinary driver, even after demographic variables and their relatively high mileages are taken into account. Grayson's (1999) work on fleet drivers draws similar conclusions, and it is noted that the reasons
for fleet drivers’ higher accident liability are still poorly understood, although several possibilities have been suggested. These include time pressure exposure, work schedule fatigue, larger average engine size of fleet cars, reduced personal cost of accidents, and psychological characteristics such as aggression or extraversion.

Work that has investigated the effectiveness of various measures to reduce road accidents involving business drivers includes that of Gregersen, Brehmer and Moren (1996). This research on drivers in a large Swedish company showed that interventions such as structured driver training and group discussions with company drivers produced decreased accident involvements over the two years after the interventions. A lesser improvement was shown with monetary bonuses for accident-free driving, while an information campaign showed the least improvement. All interventions, however, produced significantly improved results over the control group. Later work by Gregersen (1999) led him to conclude that improvements in safety shown in the most effective interventions occurred as a result of improving drivers’ risk awareness.

However, the situation in the UK detailed by Grayson (1999), led him to believe that there is little evidence that measures currently employed to improve fleet safety are effective. This is perhaps because measures that might work in a single large organisation are not necessarily applicable to all fleet drivers. Grayson points out that fleet drivers are a highly diverse group, making it unlikely that their accidents are homogeneous and susceptible to any single remedial measure.

Research work already carried out in the School of Psychology at Nottingham (Chapman, Roberts and Underwood, 2000) has indeed found that employees who differ in employee status and business mileage requirements show important differences in self-reported driving behaviours, accident frequency, and the types of accidents reported. Company drivers who drove a car that could be described as a ‘perk’ car (received as part of a remuneration package) and sales staff driving company cars appeared to be at a particularly increased risk of accident. Staff driving their own vehicles on business mileage allowances and staff driving liveried vehicles appeared to have an accident rate much closer to that of the general driving population. Chapman et al. (2000) comment that these findings highlight the importance of understanding that company car drivers are not a single homogeneous group.

Methods of studying road accidents

The causality of real road accidents can be a difficult phenomenon to study. One possible solution to this is the use of methodology that investigates road accidents after they have occurred, rather than the more familiar psychological research that relies for its method on examination of driver behaviour in controlled environments.

Many studies have used in-depth techniques applied to secondary data sources such as police reports, interviews and questionnaires. Fell (1976) was among the first to claim that an ‘accident causal schema’ could be constructed from such sources. Fell was of the opinion that in-depth work using police reports, while still having some limitations, could be used to improve the ‘state of the art’ in understanding accident causation.

More recently, Malaterre (1990) used police reports to break down and analyse accidents. Malaterre constructed four stages in his analysis – driving, accident, emergency and collision. Factors identified in his analysis stage were next used in synthesis; the building of prototype cases. Such an approach, Malaterre claimed, focused effectively on functions not correctly carried out by the driver, which are sometimes difficult to locate. Malaterre’s sample was, however, quite small (115 cases) and was also heterogeneous. He ended by concluding that more precise analysis needed to be carried out by referring to complete police accident reports, with all their varieties of information.
Case-study methods were used by Clarke, Forsyth and Wright (1998) in the analysis of police road accident files in right-turn accidents, a key feature of this work being that it treated accidents as a 'clinical' problem, rather than just an 'epidemiological' one as in many traditional approaches. For the first time sequence analysis was used in conjunction with rule-finding computer software. This approach concentrated on the relatively homogeneous class of right-turn accidents to produce new findings. It was, however, felt that much of the information from the original police reports was being lost. The rich nature of an accident report that made it understandable to a human observer had to be left out when the data were being prepared for computer analysis. Subsequent work investigating overtaking accidents, by Clarke, Ward and Jones (1998), placed more emphasis on the interpretation of causal patterns by the human coders, but retained the powers of a computer database for the later stages of storing, sifting and aggregating explanatory models of individual cases. This later approach was continued in the present study.

Method

Our method largely relies on the human interpretation of road accident case reports. Furthermore, the construction of interpretations, typologies and models has not been driven by theory in the main, but generated primarily from the data itself, although theoretical models are acknowledged. Most attention is given to the full sequential nature of the accident story in each individual case, which is where the technique of qualitative human judgement methodology proves more useful than more traditional statistical methods applied to aggregated data. Full details of our method can be found in previous reports and papers (e.g. Clarke, Ward and Jones, 1998).

The first step was to draw a heterogeneous sample of police road accident files involving young drivers. These were used to gain an initial impression of the quality of data available, to pilot methods of analysis and to assist in choosing the type of accident best suited for the main study. The files were found to contain varying amounts of information depending on the circumstances of the accident and any subsequent legal proceedings.

The minimum contained in each file is a report sheet/card which is a summary of information about the accident, such as date, time, location, weather conditions, junction type and many other items. The sheet also includes a brief accident story as interpreted by the attending police officer. This is constructed by the officer a short time after the accident by reference to his or her pocket book. It contains the actions and, in some cases, the reported intentions and behaviours of drivers and witnesses.

In addition to the report sheet/card, the most detailed files contain a range of further items which help to fill out the often complex circumstances of the accident. These include maps, photographs, statements of vehicle examiners and, perhaps most importantly, interview and witness statements which are rich in information. The interpretation consisted of the reconstruction of an entire accident story from the information available in the police file.
The data were entered into a FileMaker Pro database customised to handle the information and search parameters required for this project. Figure 1 shows the standard data entry set-up.

The following table provides a sample of data entry:

<table>
<thead>
<tr>
<th>Record number</th>
<th>TOM1462</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver 1 Age</td>
<td>21 M F</td>
</tr>
<tr>
<td>Driver 2 Age</td>
<td>59 M F</td>
</tr>
<tr>
<td>Vehicle 1 Owner</td>
<td>Owner driver</td>
</tr>
<tr>
<td>Primary blame</td>
<td>Driver 1</td>
</tr>
<tr>
<td>Severity</td>
<td>Slight</td>
</tr>
<tr>
<td>Date</td>
<td>31/10/95</td>
</tr>
<tr>
<td>Day</td>
<td>Tuesday</td>
</tr>
<tr>
<td>Time 24hrs</td>
<td>06:10</td>
</tr>
<tr>
<td>Road Type</td>
<td>A class</td>
</tr>
<tr>
<td>Speed Limit</td>
<td>40</td>
</tr>
<tr>
<td>Area</td>
<td>Rural</td>
</tr>
<tr>
<td>Types of Vehicles</td>
<td>1-Peugeot 105</td>
</tr>
<tr>
<td>Drivers Familiar?</td>
<td>yes</td>
</tr>
<tr>
<td>Driver 1 Passengers</td>
<td>None</td>
</tr>
<tr>
<td>Passengers age, sex</td>
<td>N/A</td>
</tr>
<tr>
<td>Test Pass Date</td>
<td>N/A</td>
</tr>
<tr>
<td>Changes</td>
<td>1-DWDC</td>
</tr>
<tr>
<td>Grade of info.</td>
<td>A B</td>
</tr>
<tr>
<td>Independent Witnesses</td>
<td></td>
</tr>
<tr>
<td>Veh. 1 cc</td>
<td>1500</td>
</tr>
<tr>
<td>Drive?</td>
<td>FWD yes</td>
</tr>
<tr>
<td>ABS?</td>
<td>yes</td>
</tr>
<tr>
<td>Licence Type</td>
<td>Full</td>
</tr>
<tr>
<td>Prose Account</td>
<td>It was early in the morning on a damp day in late autumn. It was still dark and streetlamps were lit. The road was wet, but it wasn’t raining. The driver (F, 21) of a Peugeot 105 (1) was travelling along an urban A road towards a 40mph limit. The junction was controlled by traffic lights and she wished to make a right-hand turn. She wasn’t really paying much attention, and she said she saw a light change and thought it was her signal. She pulled off and turned right in front of an articulated HGV (2), driven by (M, 59).</td>
</tr>
</tbody>
</table>

Figure 1: A standard data entry sheet on the database (continued overleaf)
Data are entered describing the relatively objective facts of each case: time of day, speed limit, class of road etc. The database includes some fields configured as check boxes or ‘radio buttons’; these provide quick access to selected cases during further analysis. Summary fields are also used to calculate things such as mean age of involved drivers. Any combination of fields in the database can be used to search for cases matching a variety of criteria. A variety of layouts are also used to present and analyse the data, in addition to the data entry layout above.

A ‘prose account’ is also entered for each case giving a step-by-step description of the accident. The causal story is always written from the viewpoint of the young driver, who is labelled as ‘driver 1’, though much consideration is also given to other drivers’ actions and intentions. The prose accounts give a detailed summary of the available facts, including information from witnesses that appears to be sufficiently reliable. Discrepancies can occur between the interviews of drivers and the statements of independent witnesses, but these can usually be resolved by considering all statements together with various other reported facts. These can include the measurement of skid marks by police, vehicle damage reports etc. Figure 1, it should be noted, only shows part of a typical prose account because the text is held in an ‘expandable field’ in the database.

Next, a sketch plan of each accident is made from sources in the file. The orientations of the sketch plan and the icons contained in it are standardised for speed of entry and to allow direct comparisons between example or prototype cases.
A minimum set of possible explanations for each accident is recorded from a standard checklist adapted and developed from a previous study (Clarke, Ward and Jones, 1998). The list has subsections for the road environment, vehicle and driver characteristics, and specific driver actions. The emphasis throughout is on giving the finest grain description possible of each accident, not for use as a formal coding scheme, but rather to provide search and selection aids to identify homogeneous groups of cases for further qualitative analysis. In addition, we entered data for a version of a national ‘contributory factors in accidents’ form developed at TRL which involves the identification of one major precipitating factor (PF) from a possible list of 15, and a further coding of up to four contributory factors (CFs), together with a confidence rating in the CFs identified. Finally, entries are made in additional fields for comments and quotes from involved drivers.

The ultimate aim of entering facts and figures, prose accounts, standardised graphics and explanatory factors in the database was to build a library of analysed cases stored as a series of case studies. In this sense, the database is used to find groups and recurring patterns, rather than being considered as ‘raw’ data awaiting analysis. In this way it was possible to find patterns, sequences and processes within each group of accident. Statistical examinations were not the primary focus of the study, even though simple statistics were used to characterise the sample.

Results

ATTITUDE VERSUS SKILL DEFICITS

In addition to looking at the sequential nature of young driver accidents, reported in earlier papers, eg Clarke, Ward, and Truman (2002), one of the key themes of the work was a division between causal factors that were primarily about driver attitude, and those that were apparently concerned with skill deficits. It has often been assumed that the problem of young drivers is primarily one of skill deficits, whether in high- or low-level skills. However, our results indicate that a fair percentage of young driver accidents result from driver attitudes, rather than any particular failure of skill.

This stage of the analysis therefore attempted to separate attitudinal and skill factors. Figure 2 shows a histogram of the raw proportions of these factors. Figure 3 shows that, for all ‘to blame’ accidents, once deliberate attitudinal factors have been removed, nearly 50 per cent of the accident involvement is accounted for. This occurs no matter which of the four types of accident is examined, but the fall occurs more rapidly for darkness and rural bend accidents, a large proportion of which are dealt with by removing the attitudinal factors of alcohol, recklessness and deliberate speeding. A large percentage of the remainder (after attitude problems are removed) can be accounted for by various skill deficits, for example, failure to take account of a restricted view. The ordering of these factors is from the most obviously reckless to the least; the pattern would look different if the rankings were changed, but the overall conclusions would be similar. The distribution of raw proportions in Figure 2 is positively correlated with the distribution of percentage fall in each of the four accident types shown in Figure 3 (Pearson’s r being between a minimum of 0.32 in the case of shunts, and a maximum of 0.52 in the case of darkness).
DEFINITION OF FACTORS

**Alcohol** – All cases where the driver has been discovered to be over the legal limit for alcohol as measured in blood or breath sample (80mg/100ml of blood, equivalent to 35mg/100ml in the breath).

**Recklessness** – All cases where there appears to be elements of deliberate recklessness, for instance racing another vehicle, speed of more than twice the posted limit, and so on.

**Speed** – All cases where the driver exceeded the posted speed limit.

**Risky o/ts** – Risky overtakes: cases involving overtaking against Highway Code guidelines, for instance at junction, hillcrests, corners etc.

**Close follow** – Deliberate close following of another vehicle.

**Light jump or crossing** – All cases involving crossing a red light, either at traffic light controlled junctions, or pedestrian crossings.

**TWOC** – All cases involving a vehicle taken without the owner’s consent.

**Looked but did not see** – All cases involving a lack in continuity of observation on the part of the driver.

**Ignorant of correct speed** – All cases where the driver appeared to be ignorant of the correct speed for the conditions, inside the speed limit, but still too fast for wet road conditions, bends, and so on.

**Close follow in ignorance** – All cases where the driver appears ignorant of the correct stopping distance when following a vehicle, for instance the increased following distance needed on a wet or icy road.
**Restricted view** – All cases where the driver has failed to take into account a restricted view before making a turning manoeuvre.

**Not looked in relevant direction** – All cases where the driver has not looked in the relevant direction at all.

**Distracted** – All cases where the driver has become distracted by something inside or outside the vehicle.

It is important to note that when splitting any given group of accidents by attitudinal or skill factors, such as removing all speed accidents, it does not necessarily follow that the same proportion of accidents would ‘disappear’ if the manipulation were to happen in the real-world environment. The removal of one factor may simply reveal the influence of another, in the same way that eradicating a disease ‘x’ entirely in a population might result in a greater mortality from disease ‘y’.

### ATTITUDE VERSUS SKILL DEFICITS: YOUNG DRIVERS OF ‘PERFORMANCE’ CARS

A search of the database was performed to identify all young drivers that were accident-involved in ‘performance’ cars. This was done by using the indexing function of the database and searching on all manufacturer suffixes found in the ‘vehicles’ field that appeared to denote cars of above average performance, eg ‘16v’ to denote a 16 valve engine. (Note that, in the years of accidents studied, this would not have been a widespread option on most cars.) In total 221 cases were discovered, which represents 8.6 per cent of all accidents where the young driver has been considered as fully/partly to blame.

A series of 2 x 2 analyses were performed using the Chi-square test, in order to find which attitude or skill factors young drivers of performance vehicles might be over-represented in.

Accident involved young drivers of performance cars are more likely to be male, and are more likely than other young drivers to be driving at excessive speed deliberately, or driving recklessly. They are more likely to have

<table>
<thead>
<tr>
<th>Factor</th>
<th>% of all 'to blame' accidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>10</td>
</tr>
<tr>
<td>Gender</td>
<td>20</td>
</tr>
<tr>
<td>Speed</td>
<td>30</td>
</tr>
<tr>
<td>Attitudes &amp; Skill Deficits</td>
<td>40</td>
</tr>
</tbody>
</table>

**Figure 3: Fall in percentage of all accidents where the young driver is to blame, removing attitudinal and skill factors cumulatively**
taken the car without the owner's consent, but are no more likely than other young drivers to have drunk excessive amounts of alcohol prior to their accident, or run across red traffic lights. There appear to be no significant differences in the number of accidents involving performance cars across the three age bands studied (in a 2 x 3 Chi-square analysis), but perhaps this is not surprising as this age group as a whole (17–25 years) could be assumed to have a higher than average degree of interest in such cars.

Young drivers of performance cars are no more likely than other young drivers to exhibit any skills deficits in their accident involvement and, indeed, indications are that, on two of the skill factors examined (‘looked but did not see’ and ‘close follow in ignorance’), they are less likely to be represented. Therefore, they can perhaps be considered as drivers with, if anything, above average skills, but whose attitude deficits more than make up for that apparent advantage.

**ATTITUDE VERSUS SKILL DEFICITS: YOUNG DRIVER ACCIDENTS BY TIME OF DAY**

Of all the accidents where they are fully or partly to blame, young drivers have 50.4 per cent of their accidents during the hours of darkness in this sample. The table below, Table 1, shows the percentage of total accidents involving specified factors for different driver groups from the set of contributory factors detailed earlier. Figures show the percentage of accidents involving the specified factor where the young driver was judged primarily at fault, for all accidents occurring during the hours of darkness.

<table>
<thead>
<tr>
<th>Factor (% in each group)</th>
<th>Male drivers (n=1037)</th>
<th>Female drivers (n=244)</th>
<th>All 17–19 year olds (n=486)</th>
<th>All 20–22 year olds (n=443)</th>
<th>All 23–25 year olds (n=351)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet road</td>
<td>25.1</td>
<td>25.4</td>
<td>29.0</td>
<td>24.2</td>
<td>21.1</td>
</tr>
<tr>
<td>Excess alcohol</td>
<td>14.0</td>
<td>4.1</td>
<td>9.6</td>
<td>10.8</td>
<td>17.1</td>
</tr>
<tr>
<td>Poor observation (all categories)</td>
<td>24.7</td>
<td>35.2</td>
<td>25.2</td>
<td>27.8</td>
<td>27.4</td>
</tr>
<tr>
<td>Misjudged speed/distance of other vehicle</td>
<td>5.1</td>
<td>8.6</td>
<td>6.1</td>
<td>4.5</td>
<td>6.8</td>
</tr>
<tr>
<td>Overbraking/oversteering</td>
<td>4.5</td>
<td>6.1</td>
<td>6.1</td>
<td>4.5</td>
<td>3.4</td>
</tr>
<tr>
<td>Excess speed (limit+conditions)</td>
<td>47.8</td>
<td>23.0</td>
<td>46.1</td>
<td>43.1</td>
<td>39.0</td>
</tr>
<tr>
<td>Close following</td>
<td>4.0</td>
<td>6.6</td>
<td>4.5</td>
<td>4.7</td>
<td>4.0</td>
</tr>
<tr>
<td>Aggressive recklessness</td>
<td>9.8</td>
<td>1.6</td>
<td>9.0</td>
<td>7.2</td>
<td>8.5</td>
</tr>
<tr>
<td>Column totals</td>
<td>135.0</td>
<td>110.6</td>
<td>135.6</td>
<td>126.8</td>
<td>127.3</td>
</tr>
</tbody>
</table>

Table 1 All accidents occurring during the hours of darkness, where the young driver is considered fully or partly to blame (n=1282). Figures show percentage of accidents involving the specified factor.
The second table below, Table 2, shows the same thing for the hours of daylight.

<table>
<thead>
<tr>
<th>Factor (% in each group)</th>
<th>Male drivers (n=908)</th>
<th>Female drivers (n=354)</th>
<th>All 17–19 year olds (n=405)</th>
<th>All 20–22 year olds (n=427)</th>
<th>All 23–25 year olds (n=431)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet road</td>
<td>23.2</td>
<td>20.3</td>
<td>24.0</td>
<td>21.5</td>
<td>21.8</td>
</tr>
<tr>
<td>Excess alcohol</td>
<td>2.3 (14.0)</td>
<td>0.6 (4.1)</td>
<td>1.5 (9.6)</td>
<td>1.9 (10.8)</td>
<td>2.1 (17.1)</td>
</tr>
<tr>
<td>Poor observation (all categories)</td>
<td>40.2 (24.7)</td>
<td>44.9 (35.2)</td>
<td>41.5 (25.2)</td>
<td>43.3 (27.8)</td>
<td>39.7 (27.4)</td>
</tr>
<tr>
<td>Misjudged speed/distance of other vehicle</td>
<td>5.6</td>
<td>7.6</td>
<td>7.4</td>
<td>5.2</td>
<td>6.0</td>
</tr>
<tr>
<td>Overbraking/oversteering</td>
<td>3.9</td>
<td>3.4</td>
<td>5.9</td>
<td>3.0</td>
<td>2.3</td>
</tr>
<tr>
<td>Excess speed (limit+conditions)</td>
<td>38.3 (47.8)</td>
<td>19.2 (23.0)</td>
<td>37.0 (46.1)</td>
<td>32.6 (43.1)</td>
<td>29.5 (39.0)</td>
</tr>
<tr>
<td>Close following</td>
<td>16.3 (4.0)</td>
<td>17.8 (6.6)</td>
<td>13.6 (4.5)</td>
<td>16.4 (4.7)</td>
<td>20.0 (4.9)</td>
</tr>
<tr>
<td>Aggressive recklessness</td>
<td>4.1 (9.8)</td>
<td>0.0 (1.8)</td>
<td>4.0 (9.0)</td>
<td>3.0 (7.2)</td>
<td>1.9 (8.5)</td>
</tr>
<tr>
<td>Column totals</td>
<td>133.9</td>
<td>113.8</td>
<td>134.9</td>
<td>126.9</td>
<td>123.3</td>
</tr>
</tbody>
</table>

Perhaps surprisingly, observational failures, taken as a global group, are more common in daylight accidents. This suggests that visibility problems caused by darkness itself are not having much effect on these accidents, and that the problem is, again, not so much a matter of skill deficits in young drivers, as with attitudinal factors found in this group. Aggressive recklessness peaks during the hours of darkness, particularly for male drivers, and the younger driver group (17–19 years). Accidents involving driving while over the alcohol limit are also more likely to occur at night; they are more likely to involve male drivers, and the older driver age group (23–25 years). Accidents involving inappropriate or illegal speeding show an increase in the hours of darkness, particularly for male drivers. Accidents caused by close following decline markedly at night, perhaps due to lower traffic volumes. The high incidence of wet roads as a factor in accidents occurring under both lighting conditions is almost certainly due to the set of accidents being studied, ie rear-end shunts and ‘loss of control on bend’ accidents are more likely to occur in slippery conditions.

It is important to note that factors in Table 1 and 2 are not mutually exclusive, and so their percentages can sum to more than 100. This, to a certain extent, represents how ‘multifactorial’ the accidents of different driver groups are. In the case of darkness accidents versus daytime, however, there appears to be little difference between the two conditions, even though there are differences between various driver groups.
If we examine the proportion of accidents involving the ‘attitudinal factors’ identified earlier (Figures 2 and 3) by time of day, Figure 4 is produced.

Most ‘attitudinal factors’ in Figure 4 (above) peak during the hours of darkness. A similar plot (Figure 5, below), showing the proportion of the remaining ‘skill’ factors from Figure 2, reveals that the proportions either peak during the day instead, or remain more or less constant independent of the time.
The evidence seems to point to the fact that the problem of increased young driver accident involvement during the hours of darkness is not caused by darkness per se, but rather the purposes for which young drivers are on the road during these hours. These include driving for social purposes and 'driving for pleasure', both of which younger drivers do more than other groups of drivers (Stradling and Meadows, 2000). Driving is viewed as an expressive activity by many young drivers, and is often a significant leisure activity for many. Attitudes revealed in police interviews seem to bear this out:

Driver 1:
“... there was lots of people and everything and my car was clean and like and my mate used to pose a bit like and so instead of doing what I usually do ... I did a circle round ... ‘cos there was a lot of people around so we just drove back down and ... I’m roughly doing about 30 mile an hour or something round about 33 something like that just you know not taking very much notice of my speedo okay , but I was doing about 30 and I’m in about 2nd or 3rd gear so that, you know, my exhaust is sounding nice and everything, and I’m going down the street all the way and I get to about where the pizza shop is ... I see this Sierra ... and it seemed to be pulling into the causeway, so I just didn’t think no more of it and I just went to proceed round him as you do, and all of a sudden he just popped out on me, no indicators or anything and I just went to swerve to miss him and me, me front end of me car just caught him.”

(DRIVER 1’S FRONT SEAT PASSENGER WAS KILLED IN THIS COLLISION.)

Darkness seems, therefore, not to be especially dangerous in itself; rather it is the young drivers' reasons and attitudes towards driving in the evening that put them at an increased risk of having an accident. Deliberate speeding, recklessness, and excessive alcohol consumption seem to be the main problems for young drivers travelling during the hours of darkness.

Driver fatigue also seems not to be a significant problem in these cases. Though accidents verifiably involving tiredness are four times more likely to happen during the hours of darkness than they are during daylight, they form less than 1 per cent of this sample. The majority of fatigue accidents in darkness occur between 12 midnight and six in the morning, as might be expected. It should be noted, however, that the contribution of fatigue to any given accident is hard to quantify unless there is absolute evidence of the driver having lost consciousness. This may not be apparent, even to the driver involved. Horne and Reyner (2002) have pointed out, for example, that in the first stages of sleep in fatigued drivers, subjects are actually not aware that they have lost consciousness. Clearly fatigue can play a part in young driver accidents, but this is very difficult to investigate in a study of this type.

Skill factors: an analysis of observational failure

It was decided to look at a select group of cases in one particular skill failure category, failure of continuity of observation. It had been noted by researchers that, in a certain proportion of observation failure cases of this type, the vehicle that the young driver had failed to see was so close to the junction that they had been negotiating that there appeared to be no explanation as to why they had not seen it, even when looking in that direction. This is commonly referred to as 'looked but did not see', in the police co–factors used in this study, and in a review of work by Brown (2002), for example. Two 'prototypical' cases with this particular failure of observation are outlined below.
CASE 1
It was early in the evening on a fine autumn day. The driver (F, 18) of a Renault 5 (1) was travelling along a rural A road with a 40mph limit as it went through a small village. She intended making a right turn ahead into a garage. She slowed down and indicated right, stopping opposite the junction to allow a car coming in the opposite direction to proceed. After the car had gone past, she made her turn directly into the path of a motorcycle (2), ridden by (M, 27) that had been following the car at a speed of about 30mph. The rider was knocked from the machine and received serious injuries. Both the bike and the car received heavy damage. The driver was charged with driving without due care and attention and fined. She said that she had not even seen the motorbike until she had hit it.

CASE 2
It was early in the evening on a fine day in spring. The driver (M, 19) of a Metro (1) was travelling along an unclassified rural road with a 60mph limit when he came to a T junction at a rural A road that was controlled by give way lines. He pulled up at the give way lines, intending to turn right. He had to wait to let two or three vehicles go past. He then edged forwards a couple of feet to get a better view to the right. He saw a car approaching from the right, but it looked far enough away for him to pull out. He started to pull out, then suddenly saw a black Ford Sierra (2), driven by (M, 33) that was approaching from the right at about 60mph, and which was closer than the car he had already seen. He accelerated to make his car turn faster in an effort to get out of the Sierra’s way, but at that point the Sierra driver was braking and steering towards the offside of the road in an effort to avoid the turning car. The Sierra went into a full skid and hit the emerging Metro hard on the offside front wing, spinning it round in the road. Both vehicles were written off, but injuries were minor. Driver 1 could not explain how he had seen an approaching car at a distance, but had missed the Sierra travelling in front of it, even though it had headlights on. He was charged with driving without due care and attention.
It seems that the only explanation for accidents such as these is that young drivers in these circumstances ‘overlook’ the foreground while concentrating on the more distant view beyond the junction mouth. Unfortunately, it is quite difficult to quantify the distances involved, or the angle of gaze required, from the information available.

Motorcycle accidents

Preliminary results would indicate that, in a sample of 50 motorcycle accidents, two-thirds are categorised under ‘right of way violations’, or ‘overtaking’. The category of overtaking alone covers slightly over a quarter of all accidents examined so far. This is perhaps unsurprising, given that motorcyclists are able to make use of many more opportunities to overtake than drivers of other vehicles, and even small capacity machines have comparatively high power/weight ratios. Given increasing levels of congestion and motorcycle/scooter use, accidents such as the two detailed below could increase.

CASE 1

It was early in the evening on a damp night in winter. It was dark and streetlamps were lit. It had been raining lightly for between five and ten minutes. The rider (M,26) of a small Yamaha motorcycle (1) was travelling along a busy and wide urban A road with a 30mph limit. The road was wide enough for two lines of traffic in queues, and traffic was moving very slowly. Rider 1 travelled through some traffic lights on green at a crossroads, and was almost immediately confronted by stationary queuing traffic on the left-hand side of the road ahead. He also saw that there was no traffic coming from the other direction, as this had stopped for a set of red lights around 200 yards distant. Rider 1 elected to use the opposite carriageway to overtake the queuing traffic ahead, and pulled out onto the offside to do this, passing at a speed of about 10mph. He started passing the traffic and was about to overtake a Peugeot 405 (2) that was queuing, when its driver (M,26), decided that he would U turn into a layby on the opposite side to pick up some chips from a shop there. His car was very nearly stationary, and although he looked in his rear view mirror, he did not check his offside door mirror or glance over his shoulder to check his blind spot. In addition, he only indicated his intention to turn once he had already started to do so. The motorcycle rider had no chance to avoid a collision, ran into the driver’s side door of the car and was knocked off his machine, sustaining minor injuries.

Driver 2 claimed that he had not looked in his side mirror as he thought that the opposing lane was clear, and had not considered that it might be used for overtaking purposes by any vehicle behind him. He was charged with driving without due care and attention, and failing to report an accident; he had not reported it to the police because he thought the motorcyclist was not badly injured. The results of these charges were not recorded.
CASE 2
It was the middle of the evening on a fine night in summer. It was still light and weather conditions were good. The rider (M, 22) of a Honda motorcycle (1) was travelling along an urban A road with a 30mph limit. He noticed that ahead there was a line of cars queuing back from behind a bus that had stopped at a bus stop. As he approached, he thought that the cars would begin to overtake the stationary bus, there being no oncoming traffic, but the front car, a Nova (2), driven by (M, 22), appeared to make no move to do so. Rider 1 elected to overtake the line of cars and the waiting bus as neither appeared to be moving, and he pulled out and began passing the vehicles on their offside, the road being wide enough at this point to enable him to do this without crossing the centre line. He was only travelling at around 5 mph as he passed the cars, and he had just got to the Nova at the front of the queue when it suddenly turned right without indicating, heading towards a car park entrance on the offside.

The rider hit the front offside wing of the turning car and lost control of his bike. He fell from the bike sustaining minor injuries, but his bike was badly damaged. It transpired that driver 2 was only a provisional licence holder and was driving unaccompanied. He had been mending the car and had taken it for a test drive. He had been unable to select a gear while at the front of the traffic queue, and then he had found first gear and elected to turn the car round in the car park entrance and get it back home. He denied the accident was his fault. Police charged him with driving otherwise than in accordance with a licence, but when the case came to court, it was dismissed through no evidence being offered.

It is also interesting to examine the behaviour of other drivers in relation to motorcycles in such cases. It would seem that, for non–motorcyclists at least, there is sometimes little appreciation of how a motorcyclist might perform an overtaking manoeuvre where another driver would not. The following interview transcript, from Case 1 (above), would seem to bear this out:

Police: “Why didn’t you see the bike?”

Driver 2: “I didn’t expect to see anything – it was the oncoming traffic’s lane.”

Police: “Did you check your wing mirrors?”

Driver 2: “No because when you turn into an oncoming vehicle lane you don’t expect a vehicle to be there.”

Police: “What would you do if you changed lane on a motorway?”

Driver 2: “Check your rear and side mirrors, and maybe glance over your shoulder to make sure there’s nothing in your blind spot.”
Police: “Why didn’t you do that on this occasion?”

Driver 2: “Because there was nothing by rights that should have come that side of my car.”

## Work–related Accidents

Analysis of work-related accidents is at an early stage, but initial signs are that, if a sample of all accident cases from Nottinghamshire is taken, then approximately 16 per cent identifiably involve a driver driving a vehicle in relation to work.

Top vehicle categories in the sample of work–related accidents to date are:

- LGV/HGV (38 per cent)
- company cars (27 per cent)
- vans/pickups (13 per cent)

Within this sample, 62 per cent of drivers driving any kind of vehicle in a work-related capacity were considered to be to blame or at least partly to blame in the accidents they were involved in.

It is likely, however, that there is an under-estimation of the true numbers of work-related accidents as a whole, and company car drivers in particular, due to inconsistencies in the recording of vehicle ownership.

## Conclusion

It seems that the central difference in the accidents of young drivers is between accidents that are caused by attitudinal factors rather than skill deficits. In particular sub-groups of young drivers, for example drivers of performance cars, this difference is especially marked. Such drivers have, if anything, higher than average control skills, but this is more than offset by their attitudinal failures.

Young driver accidents in the dark might be expected to arise from problems of visibility. We find this not to be generally true. The hours of darkness are not only a time of reduced visibility and artificial lighting, they are also a time quite unlike mornings and afternoons, when different groups of road-users are about, travelling for different reasons, and in different ways. To a striking degree, the problems of accidents in the dark are not a matter of visibility, but rather a matter of who uses the roads at night, and why, and how. There appears to be a high number of accidents associated with ‘recreational’ driving, or driving in relation to the social life typically engaged in by people of this age group.

For many young drivers, especially males – to judge from those who end up in accident case files at least – driving is fun, challenging, exciting, a way of testing themselves, and a way of showing off. Of course there are limits. Speed, road conditions, weather, traffic, and vehicle performance all combine to produce a ‘space’ – a part of the multi-dimensional graph describing vehicle, driver, and environment, in which one can move about safely. The safe region has edges. (Test pilots call them ‘the envelope’, and their job is to find and to ‘push back’ that envelope when flying new kinds of plane.) Some young drivers think they are test pilots too. Their interest is to find and explore the envelope, or else to assume they know where it is and to operate on its edges. They talk and behave as if this envelope – the dividing line between accident-free driving and collision – is visible, precise and stable. If that were true, they would get away with what they do, to the extent they were as skilful as they thought. But they are prancing on a crumbling cliff, not a hard edge. If it gives way, it will do so without warning, without apparent cause, and without the chance of recovery. No one can tell exactly where...
the danger zone begins. There is no clear line between safety and catastrophe. And what division there is, is constantly changing. Given that ‘the envelope’ works like that, the only skill is to keep well away from the edge. This is the essential message that we must put across to young drivers. They must always attempt to drive with ample safety margins.

While some improvements can doubtless be made to young driver accident involvement by focussing on issues of skill-based learning and hazard perception, a way to address the attitudinal problems of a significant number of young drivers must also be found, if the greatest improvements are to be made.

Work on motorcycle and work-related accidents is still in its initial stages. However, it would seem that right of way violations and overtaking accidents form a high proportion of motorcycle accidents, and that it is just as important when examining motorcycle accidents to take account of other drivers’ behaviour as of the riders’ behaviour.

If anything, we are probably underestimating the percentage of work-related accidents, but there does seem a sufficient number for us to sample from. Such work should become easier in the future, if a proposal to record work-related accidents on STATS19 forms is implemented.

References


3
EU-project ‘Andrea’: analysis of driver rehabilitation programmes

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Abstract

Driver rehabilitation courses for the reintegration of traffic violators are a growing market in many European Union (EU) states. It was the objective of the ‘Andrea’ project to analyse which elements of these courses are more or less effective. Evaluation studies have been analysed, all course programmes described, expert workshops were held and a feedback analysis, including data from 1,375 participants and 60 course trainers, has been conducted in France, Austria, Belgium, the Netherlands and northern Italy. Results of this study give an insight into the course programmes (methods, contents and client–trainer relationship). The feedback generally is rather positive. The majority of clients believe that the course programme was useful for them to avoid further offences, which is in correspondence with the significant reduction of recidivism rates of participants compared to control groups found in the literature analysis.

Introduction

High-risk drivers are a small group of traffic participants but they are responsible for fatalities and injuries to a great extent. Obviously, punishment and withdrawal of the driving licence alone have to be considered as not sufficient to prevent these drivers from repeated offences.

Driving a motorised vehicle in traffic does not primarily require skills for manoeuvring but rather social responsibility. Traffic violators primarily do not lack skills but positive attitudes towards social responsibility. In particular, drunk drivers and speed offenders are characterised as not reliable in traffic. Consequently, their licence is withdrawn. In order to improve drivers’ reliability, rehabilitation programmes have been developed in certain EU countries. Certain evaluation studies, especially of rehabilitation programmes for drunk drivers, indicated that such programmes can reduce the recidivism rate of participants compared to control groups without participation in these programmes. Consequently, such courses are going to be implemented in a growing number of EU countries. Research in this field is required in order to optimise and harmonise best practise in the EU. The ‘Andrea’ project was launched in 1999 and finalised in 2002.
Definition

*Rehabilitation programmes* are systematic measures for traffic offenders – in particular drunk drivers and speed offenders – aiming at a change of their behaviour in order to prevent further offences and so that they can keep or regain their driving licence.

Rehabilitation programmes are so far applied in:

- Austria
- Belgium
- Finland
- France
- Germany
- Great Britain
- Italy
- The Netherlands
- Portugal
- Switzerland.

Results

It was the objective of the ‘Andrea’ project to analyse effective factors of driver rehabilitation programmes. In this project it is postulated that the following four effective factors can be distinguished:

- frame conditions of the entire system (course setting, selection system, legal system behind it, surveillance, etc.)
- client–trainer relationship
- methods applied in the courses
- contents of the courses.

Following this classification, the effective factors were analysed in this project by a literature analysis, a feedback study on clients and course leaders, and by expert opinions in two workshops in connection with empirical and theoretical findings on human behaviour.

LITERATURE ANALYSIS

Literature evaluations from the 1990s and the early 1980s were found and studied. These evaluations analysed recidivism rates of drink drivers, which can give indirect information on accidents as the blood alcohol concentration is disproportionately connected with the accident risk (Borkenstein et al., 1974; Krüger, 1995). Such hard fact evaluation studies for other than alcohol offenders have not yet been carried out. Studies which had a control group and could control for the self-selection bias have been carried out in Austria by Michalke, Barglik-Chory and Brandstätter (1987) and Schützenhöfer and Kainz (1999) – see Figure 1 below – in Germany by Winkler et al. (1990) and Jacobshagen (1997, 1998), in England and Wales by Davies, Braughton, Harland and Turnbridge (1999) and in the USA by Jones et al. (1997). These studies indicate that the recidivism rate of course participants is about 50 per cent lower compared to individuals of control groups without a treatment. Results of one study are highlighted below (Figure 1).
Following these results, driver rehabilitation courses are effective if there are about 10 participants per trainer, alcohol offenders are not mixed together with other than alcohol offenders, the courses are run over a period of a few weeks (not just a weekend) so that the time between the sessions can also have an influence, and course leaders are psychologically educated, can make use of group-dynamic processes, can motivate resisting clients towards self reflection instead of merely teaching, and can set up a professional client–trainer relationship.

The contents are client centred and do not follow a fixed programme scheme.

These conclusions are confirmed by an evaluation study of courses which did not have these characteristics. In contrast to the positive results of the studies mentioned above, a Swiss evaluation by Mahey, Fahrenkrug and Schmid (1997) of a different course model found no reduction in recidivism rates of course participants compared to a control group. These experimental courses in Switzerland were held in groups with 20 participants, were rather short term, focused on teaching following a fixed programme schedule and were led by experts in their field (eg law, medicine) but not experts in leading problematic groups. Hence, a professional client–trainer relationship could not have been set up.

**FRAME CONDITIONS OF THE ENTIRE SYSTEM**

Driver rehabilitation courses contribute to enhanced road safety by focussing on the small group of serious traffic offenders. But it also is a business market. And this market does not follow the principles of a free market where supply and demand sets the price and the quality, because the customer primarily is the public represented by their authorities (licensing authority or court). Participants only become customers after having infringed the applicable law. Consequently, the demands of the public – effect on road safety – must be satisfied first. In this sense, the state is responsible for quality assurance of driver rehabilitation courses. Private institutes can be authorised to conduct courses and evaluations but the state must take its responsibility of guaranteeing high quality in this compulsory domain.
When studying the various course descriptions of EU countries (detailed descriptions can be seen in the ‘Andrea’ annex, Bartl et al., 2002) and extracting best practise, the following conclusions can be made concerning system requirements for courses.

**Programmes must fit the national traffic system**
The key issue of driver rehabilitation courses is that they fit to the traffic system in the respective country. As mentioned earlier, traffic problems, safety attitudes and national mentalities vary between EU countries. And the course programmes must fit to the clients’ deficits. The following factors must be considered when implementing a programme.

**Programme**
A clear description of the target group, of the goal and the methods applied must be set up, including an explanation of how it fits the target group’s deficits. The programme must be laid down in a written manual.

**Staff**
The basic and specific education as well as the continuous further education of the staff must be clearly defined in order to make sure that the course leaders have the competence to reach those goals with those methods which are outlined in the programme manual for the specific target group. The staff must be especially trained in how to motivate clients who do not participate voluntarily and who are not concerned about their problems. The higher the level of education the better (which is not to say that a university diploma is absolutely necessary). So far there is no scientific knowledge about which education is the best. For example, concerning psychotherapy there is no psychotherapeutic school which can be recommended as the best.

**Client selection**
A standardised and transparent client selection system is necessary. Random selection must be avoided as it counteracts with the client’s acceptance of the course. It would be experienced by the client as unfair, which results in a decreased readiness to transfer external attribution (‘it was just bad luck’) into internal attribution (‘it was my mistake and only I can do anything about it for my future’). Participants with different deficits should not be mixed together in one course. In particular, alcohol violators are different from others. And also the group of alcohol offenders cannot be seen as being homogeneous: addicts are different from merely drink drivers, who primarily lack in the readiness to accept the social norms and legal rules or are not sufficiently concerned about the potential danger of their behaviour. (Simply looking at the blood alcohol concentration at the offence is no valid indicator of whether the client is an addict and whether the course will be successful – see more details in ‘Andrea’ chapter ‘Literature Analysis’, Bartl et al., 2002) A standardised diagnostic procedure prior to the course seems necessary.

**Police surveillance**
If police surveillance is very low the chance of being detected and ordered to participate in a driver rehabilitation course is a random case and is therefore negative for the acceptance of the course. Further, the client is not so motivated to change his or her behaviour because there is almost no risk of being detected after the course. Consequently, the level of police surveillance is a key factor for a positive effect of driver rehabilitation courses.

**Public opinion**
A positive public opinion supports the successful execution of the courses wherever necessary (police, licensing authority). The more the social environment of a violator favours courses and vice versa disfavours traffic violations, the more a course participant will be ready to change behaviour.

The public should be informed about the existence of driver rehabilitation programmes and their positive effects. In this manner, rehabilitation courses can also have a general preventive effect.
Quality assurance
It is self evident that compulsory courses must have a quality assurance system. It must be guaranteed that the
goals are reached and that the staff are well educated. This shall be done by scientific evaluation and by regular
audits of the courses. Course programmes must be authorised by representatives of the states.

Client–trainer relationship

The importance of a positive client–trainer relationship can be transferred from studies on psychotherapy
(Grawe, 1994; Tschuschke and Czongalik, 1990). It was found that it is not the psychotherapeutic method
applied in the therapy which is correlated with the success of the therapy, but the person's characteristics
conducting the therapy. For the non-voluntarily participating clients of driver rehabilitation courses, Christ
(2000) found indications that a positive client–trainer relationship seems to be significantly correlated with a
lower recidivism rate and Posch (2000) found a correlation with a more positive change in attitude.
Consequently, an education for course leaders which guarantees a high social competence to run such courses
with problematic clients successfully is seen as an essential precondition.

In short, one important aspect of a positive client–trainer relationship can be defined as follows: the trainer
and the client should have the same beliefs (‘personal theories’) on what makes the course effective, based on
the findings of Eckert and Biermann-Ratjen (1990) for psychotherapy and underlined by indications found by
Christ (2000) for driver rehabilitation courses.

And these indications fit well with the findings in the ‘Andrea’ feedback study: clients as well as course leaders
were asked how to lead a course, if they were the course leader, and what they would prefer if they want to be a
good leader. One-quarter of the clients had been asked before the course and this can be compared with those
clients who gave their opinion after they had experienced the course. The results, which are partly statistically
different before and after the course, are shown in Figure 2 below (key overleaf).

<table>
<thead>
<tr>
<th>I would ...</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>I would ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>... urge the participants to join discussions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>... give a speech</td>
</tr>
<tr>
<td>... talk about personal matters of my clients</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>... talk about matter of facts</td>
</tr>
<tr>
<td>... let the clients work out problem/solutions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>... present problem/solutions myself</td>
</tr>
<tr>
<td>... also talk about matters that can be unpleasant for the clients</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>... avoid unpleasant matters</td>
</tr>
</tbody>
</table>

Figure 2:
Clients who had been asked before the course tended to avoid talking about personal matters in the course and preferred instead to talk about facts. But clients after the course favoured talking about personal matters. This difference is statistically significant (U-test, $p=0.000$).

Before the course clients favoured avoiding talking about unpleasant matters. In contrast, clients, after they had experienced the course, favoured talking about matters which could be unpleasant for the clients. This difference is also statistically significant (U-test, $p=0.006$). Further differences were only tendencies.

After the course the clients had roughly the same beliefs as their trainers on how to run a course. This indicates that at least in those courses which have about 10 participants per group and which are running over a period of a few weeks, it can be achieved that the clients acquire the same ideas as the trainers on what makes the course effective. Of these clients, 89 per cent also stated that the course, generally, was useful for them to avoid further offences in the future.

For the trainers, therefore, the major challenge seems to be getting clients positively interested in the idea of the treatment so that they are convinced of its potential benefits. This of course presupposes that the trainer is convinced of the effectiveness of what he or she is doing.

### Course methods

Driver rehabilitation courses primarily make use of the method of discussion instead of presentation. Referring to the ‘Andrea’ feedback study, about 60 per cent of the course modules were classified by the course trainers as discussion and 40 per cent as presentation. In this study ‘discussion’ was defined as self reflection or learning something about oneself (one’s personal truth) and ‘presentation’ was defined as learning about something which is generally the truth. It was also classified as ‘presentation’ if the group was motivated to elaborate the learning goal in the form of a group discussion (active learning method), but there was only one general learning goal which could be elaborated, not individual learning goals.

All modules were evaluated by the clients as rather ‘useful’ to avoid further offences in the future and as rather ‘interesting’. The mean values on a ranking between 1 ‘best’ and 5 ‘worst’ was lower than 2. In the French study with participants who were not anonymous the mean value was about 1.7, in other EU countries (A, B, NL, I) with anonymous clients the mean value was about 1.95. In France, clients’ feedback did not differ between presentation and discussion modules. In contrast, in other EU countries (A, B, NL, I) clients as well as trainers evaluated presentation modules as significantly more interesting than discussion modules but equally useful.

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**Key to Figure 2:**

<table>
<thead>
<tr>
<th>Statement</th>
<th>Clients before mean/ std dev.</th>
<th>Clients after mean/ std dev.</th>
<th>Course leaders’ mean/ std dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discussion versus speech</td>
<td>1.65/1.10</td>
<td>1.54/0.93</td>
<td>1.42/0.62</td>
</tr>
<tr>
<td>Personal matters versus facts</td>
<td>*</td>
<td>2.62/1.34</td>
<td>*</td>
</tr>
<tr>
<td>Solutions by clients versus by trainers</td>
<td>1.85/1.19</td>
<td>1.72/1.08</td>
<td>1.29/0.55</td>
</tr>
<tr>
<td>Unpleasant versus avoid unpleasant</td>
<td>2.08/1.29</td>
<td>1.66/1.03</td>
<td>*</td>
</tr>
</tbody>
</table>

*Significant: U-test, $p<0.01$
This can be interpreted to show that self-reflection (discussion modules) is less convenient for both the clients and the trainers, but it is not experienced as less useful.

These findings seem to be in contradiction with the result of another form of questionnaire in this study with regard to methods (see section above: client–trainer relationship). It was found that clients as well as trainers favoured the method of discussion rather than the giving of a speech by the trainer. The mean value was about 1.5 on a profile ranking between 1 to 4. But here discussion stands for active learning, which can be self-reflection but can also be elaboration of a learning goal in the form of discussion.

Further distinctions between methods applied in the courses have not been analysed because of earlier evaluations of the effectiveness of various psychotherapeutic schools. These studies have come to the conclusion that primarily it is not the therapeutic school which makes the difference in the effect of the treatment but the personality of the therapist (also see the section on client–trainer relationship). Therefore, the influence of the various therapeutic trends on feedback were not analysed in this study because these results are likely to be transferable to rehabilitation courses, it would have been too complex in this feedback survey, and the psychotherapeutic influence is only a background and is not so relevant for the differences between the courses.

Course contents

The contents of the courses were described on the module level (discussion unit). Brief minutes of courses with descriptions of the contents of each module are included in the ‘Andrea’ annex.

To evaluate the contents of the courses each module was classified by the trainers according to which concrete sub-goal was intended to be reached. The general goal of driver rehabilitation courses is to change attitude and behaviour. In this study the trainers classified each module following a catalogue of sub-goals (this catalogue was seen as comprehensive by the trainers).

The following distinctions were significant (Chi2, \( p=0.000 \)). Clients generally evaluated modules with contents that increased knowledge about psycho-physiology (alcohol in the body, human perception, drivers’ reaction capacity etc.) as significantly more useful for avoiding further offences in the future and as more interesting. In France also, modules with contents that increase knowledge in driving physics were evaluated as significantly positive (not so in the other EU countries).

In contrast, modules that increased self-reflection in order to change attitudes concerning the acceptance of social norms and legal rules were evaluated as significantly less positive. In any case, the mean value was rather positive (about 2). These results were found in both data files (France and other EU countries) and obviously reflect the conflict of clients with their major problematic: they have to participate because they have not accepted social norms and legal rules. It can be interpreted that the key issue of the courses becomes apparent: to reintegrate drivers into the traffic system, which is based on the social responsibility of each individual. Here, it must be made clear that positive feedback is not necessarily correlated with a positive change in attitude and behaviour, and vice versa. And it is one important issue of the courses to confront offenders with their problems and this usually is less convenient/interesting than learning about psycho-physiology and driving dynamics. But it is closer to the main problem of the clients. Summarised, it can be concluded that enhancing the acceptance of social norms and legal rules is important but also problematic in the driver rehabilitation course.

In contrast, those modules which were aiming at a change of attitude concerning sensitivity towards the danger of alcohol and/or speed were evaluated as significantly more positive in the courses of A, B, NL, I (not France). This can be interpreted as corresponding with the results of Posch (2000) and Davies et al. (1999),
who found that participants were more concerned about the danger of drink driving and stated that they should drink less if they want to drive safely.

Also, the trainers gave their feedback on the module categories (not in France): apart from two exceptions the trainers evaluated all module categories as equally useful and interesting for their clients. Only modules which were aiming at self-reflection to increase impulse self-control were evaluated as significantly more useful for the clients. And, as with the clients, the trainers also evaluated modules on knowledge about psycho-physiology as significantly more interesting (but not more useful).

By summarising the feedback results it can be concluded that a ‘good’ course should have the following contents: information about psycho-physiology and driving dynamics should be briefly presented and discussed, perhaps at the beginning of the course, not only to provide this kind of information but also to positively activate and motivate clients so that they are interested in the course. Information about traffic law should be presented even more briefly.

Also at the beginning of the course, self-reflection concerning the awareness of the personal problems in the client’s life should take place. The confrontation with the client’s attitudes concerning social norms and legal traffic rules seems to be highly important, even when this aspect is not so favoured by the clients. (But clients agree that it is important also to talk about unpleasant matters instead of avoiding them – see above.) Finally, the chance should be taken to change the client’s attitudes concerning sensitivity towards the danger of alcohol or speed in traffic.

Modules with primary source-oriented contents (primarily focusing on the entire life of the client regardless of traffic) were only rarely applied in the courses analysed and the few results neither indicated a positive nor a negative interpretation. Consequently, a recommendation is not possible.

Generally the clients evaluated the courses as helpful for avoiding further offences in the future. In France 68.8 per cent and in other EU countries 89.2 per cent answered this question with ‘yes’. Only 2.8 per cent in France and 8.5 per cent in other EU countries (anonymous) wrote individual statements after the course that, in their opinion, the course was only helpful because it was so cost intensive and aversive. In the sub-group which had been asked before the course 18 per cent wrote statements in this vein. Obviously, this prejudice could be positively biased during the course. The majority of statements were positive about the course contents and became even more positive after the course compared to the statements of the before sub-group. Further, clients who answered this question with ‘no’ can be characterised as ‘stable course resisters’. They stated to a significantly lower amount that they had learned something about themselves as drivers, agreed significantly less to the two statements that social norms and legal rules are necessary and that a drink driver should change something in his or her life, because simply saying ‘I will never do it again’ is not enough (U-test, p<0.05). Participants who are negative about the course are an important minority which can be identified and described. In future, further analysis of this group and the development of methods about how to better reach them should be emphasised.

In summary, it can be concluded that the clients’ feedback on rehabilitation courses is generally rather positive, although they do not participate voluntarily. These results are underlined by evaluation studies which indicate a significant reduction of recidivism rates after the courses compared to control groups. Hence, driver rehabilitation courses can be seen as an appropriate method to support the reintegration of violators into the traffic system.
Recommendations

Specific types of driver rehabilitation courses have been proven to change attitudes and behaviour of traffic violators positively. The following preconditions must be fulfilled.

1. The programme must fit to the specific deficits of the target group. At the least, the major distinctions between alcohol and other than alcohol offenders and between novice and experienced drivers are recommended.

2. The staff must be educated sufficiently to set up a professional working relationship with problematic and resisting clients who are not concerned about their problems.

3. The methods applied should be personal self-reflection instead of teaching. Tailored interventions are better than a fixed programme scheme.

4. The course sessions should run over weeks in order to also make use of the time between the sessions, because a change in attitude and behaviour needs time.

5. The group size should be about 10 participants.

6. A transparent and objective client selection system is as important as the level of police surveillance to make the order to participate more acceptable for the clients and to avoid attributing it to just bad luck.

7. Quality assurance is the responsibility of the state primarily, as the main customer is the public. Programmes should be approved by an official institute which approves the contents of the programme and checks that the following preconditions are fulfilled:

   - the programme must be laid down in a written manual
   - basic, specific and further education of staff must be defined
   - programme evaluations must be carried out.

References


4

Multiphase driver education in Austria

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Abstract

Based on findings of the European Union (EU), project ‘DAN’, Austrian experts elaborated a proposal for an improved driver education system. Following this multiphase concept, novice drivers have to participate in two further feedback drives in real traffic, in a six-hour safe driving course and in a two-hour traffic psychological seminar. Now the Government is convinced of the advantages and the law proposal will pass through parliament with the new law expected to take effect in January 2003. By referring to a successful multiphase system in Finland, a significant accident reduction can be expected in Austria (about 20 per cent). National economic savings of about €270 million per year are estimated as a result of this accident reduction.

Introduction

Novice drivers are disproportionately involved in road accidents. About 80 per cent of novice drivers are between the ages of 18 to 24 years. In an EU ranking, Austria is penultimate, only ahead of Germany, in the number of killed drivers in this age group (source: IRTAD). Young people primarily die in road accidents, not from diseases, suicide, leisure time accidents etc. In Austria every second fatal road traffic accident in this age group is the result of a single vehicle accident. The recent driving education system focuses primarily on the teaching of knowledge. There is a lack of raising risk awareness. Consequently, the multiphase driver education system was developed by Austrian traffic experts of the Kuratorium für Verkehrssicherheit (Road Safety Board), driving school associations, automobile clubs and experts in the Ministry of Transport. The first concept was developed in 2000 based on findings of the EU Project ‘DAN’ (Description and Analysis of post licensing measures for Novice drivers). Today, both the Minister of Transport and the Minister of Internal Affairs are in favour of this new model. On 10 April 2002 it will be included in the parliamentary traffic panel and will then pass through parliament so that the new law can take effect on 1 January 2003.

In Finland, after the introduction of a similar multiphase model, a significant accident reduction was observed. Taking into account a 2 per cent lower mileage, two years after the introduction the accident reduction shown in Table 1 was found.

<table>
<thead>
<tr>
<th>Target group</th>
<th>Accident reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male novice drivers at the age of 18–21</td>
<td>-25%</td>
</tr>
<tr>
<td>Male novice drivers older than 21 years</td>
<td>-50%</td>
</tr>
<tr>
<td>Female novice drivers at the age of 18–21</td>
<td>-16%</td>
</tr>
<tr>
<td>Female novice drivers older than 21 years</td>
<td>0%</td>
</tr>
</tbody>
</table>
In Austria the probationary driving licence for novice drivers, with a zero alcohol limit, and driver improvement courses for offenders, introduced in the year 1992, has already led to a significant accident reduction.

Five years after the introduction of the probationary driving licence, an analysis was carried out concerning the number of passenger car drivers involved in accidents with personal injuries and fatalities. In this analysis holders of probationary driving licences were compared with all the other drivers. The results indicate a continuous decrease of accident involvement of 32.5 per cent within the group of novice drivers, whereas the decrease within the group of all the other drivers is merely 8.9 per cent in the same period of time.

In the year of the introduction of this law (1992), 19.2% fewer new licences were issued compared to the year before. Even when taking into account this declining number of novice drivers, the analysis still indicates an accident reduction of 18.7 per cent (the number of novice drivers involved in accidents with personal injuries and fatalities related to the declining number of holders of probationary driving licences). These results are described in Table 2.

| Table 2: Number of car drivers involved in injuries and fatalities in Austria |
|------------------------------------------|---------------------------------|------------------|
| Novice car drivers (absolute)            | 1991 (absolute) | 1996 (absolute) | Per cent change |
|                                         | 9,035            | 6,099           | -32.5           |
| Novice car drivers (related to new licences issued) | 4.11%            | 3.34%           | -18.7           |
| all other car drivers (absolute)         | 44,372           | 40,434          | -8.9            |

The multiphase concept

During the first year after the acquisition of the driver licence, the novice driver has to participate in the following new further education modules (Figure 1, overleaf). This extended supported learning period should be helpful for a safe beginning of a driver’s career.
so far established modules of driver education:

<table>
<thead>
<tr>
<th>Module</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandatory driving school education. (Now: 20 hours practice, 40 hours theory. New: 18 hours practice, 32 hours theory)</td>
</tr>
<tr>
<td>Driving test</td>
</tr>
<tr>
<td>Licence with a two-year probation period and a zero alcohol limit</td>
</tr>
</tbody>
</table>

new modules:

<table>
<thead>
<tr>
<th>Module</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Feedback drive in real traffic including discussion (two hours) 2–4 months after the acquisition of the licence</td>
</tr>
<tr>
<td>Safe driving course (six hours) and traffic psychological group seminar (two hours) 3–9 months after the acquisition of the licence</td>
</tr>
<tr>
<td>2. Feedback drive in real traffic including discussion (two hours) 6–12 months after the acquisition of the licence</td>
</tr>
<tr>
<td>Still one year of probation period left. In cases of serious offences one more year of probation and participation in a compulsory psychological driver improvement course</td>
</tr>
</tbody>
</table>
THE FEEDBACK DRIVES

The feedback drives are not just some more driving lessons, but will have the character of further education. In particular, hazard perception, an accident-avoiding defensive driving style (e.g. the optimal and realistic safety distance), social behaviour in traffic and an analysis of the influence of other traffic participants who do not keep to the rules will be analysed. A feedback drive consists of a 50 minute drive and a 50 minute discussion about the drive which shall be held in small groups of three drivers. The first feedback drive should take place as early as possible (2–4 months) because the accident risk is the highest during the first months. The second part will take place after the safe driving course and will primarily be aimed at avoiding wrong driving habits. The driving teachers have to be specifically trained.

THE SAFE DRIVING COURSE

It cannot take place too early (3–9 months). Candidates must be able to automatically manoeuvre the vehicle. A demonstration of the danger of driving dynamics is intended, not the training of skills. Particularly, emergency braking and the difference in speed for the stopping distance must be emphasised. Individual weaknesses will be detected and mastered. Overconfidence as a result of such a course must be avoided. Therefore, the psychological seminar has to take place on the same day. The education of the staff and the minimum requirements for the track are strictly defined in the law.

THE TRAFFIC PSYCHOLOGICAL SEMINAR

In groups of six to twelve candidates, a two hour group discussion takes place on the same day as the safe driving course. The focus lies not on teaching but on self reflection. First, typical accident risks of novices will be elaborated on (primarily the single vehicle accident) in the group and then participants will discover their individual accident risks. They must be guided by the psychologist to find out what would be their typical accident, what typical strengths they have as drivers and what specific part of higher responsibility are they ready to take over in traffic. The psychologists must be specifically educated.

Consequences for participants

Participants cannot fail. There are no further tests. If they do not participate in time they get a reminding letter by the licensing authority and if they have not completed the multiphase modules after a further four months, their licence is withdrawn until they have done so.

Economic aspects

First, it is the aim of the multiphase education to save human lives. Second, national economic savings are expected too. If the approximately 80,000 novice drivers per year cause 20 per cent less accidents (only injuries and fatalities) during a two-year observation period, the savings can be estimated to be €27 million per year.

For the novice drivers the entire driver education will not become significantly more expensive, as the number of mandatory hours for the basic education will be lowered at the same time from 40 hours theory to 38 hours and from 20 hours practice to 18 hours. This is the result of a political compromise and it may be considered that in some EU countries fewer lessons for the basic driver education are required.
Additional costs for the public do not arise. Almost all administrative concerns are privatised. Investments are not necessary. Sufficient test tracks all over Austria already exist or are going to be built next year. The highly educated staff is also available. The co-operation between the different professionals and organisations already proved successful in a two-year voluntary ‘Road Expert’ campaign for novice drivers. Participants were in favour of further education on a test track including a psychological seminar. The public opinion in Austria is positive too. 70 per cent of all Austrians (63 per cent of young people) are in favour of the multiphase driver education proposal.

References

A laboratory comparison of two steering techniques

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Introduction

Manuals for the instruction of drivers at every skill level assert that the only safe way of controlling the vehicle is to hold the steering wheel with the hands in a '10-to-2' position and not to allow either hand to pass beyond the 12-o-clock position; see for example, Royal Automobile Club (1984), Institute of Advanced Motorists (1982) and Home Office (1985). During earlier research on the training of both professional drivers and private motorists it became clear that instructors were imposing these criteria very strictly in their teaching of steering techniques. Any tendency for the learners' hands to pass the 12-o-clock position or cross one another was prohibited. However, it was also observed that trainees with no previous driving experience almost invariably tried to use a crossed-hand technique for turns which required a steering-wheel rotation of more than about 180 degrees. Thus a substantial amount of training time was spent in eliminating what appeared to be a 'natural' control action.

There is some anecdotal evidence that the apparent 'naturalness' of the crossed-hand method of vehicle steering is difficult to train out. A typical letter to the media (see Ripley, 2000), protesting at insistence by an advanced driving instructor on the ‘10-to-2, push-pull’ method, claims: “I haven’t used this type of steering technique for more than 20 years, since I passed my driving test. It was both uncomfortable and foreign to me and, on certain occasions it felt dangerous. I was concentrating so much on steering that I found it impossible to think about more important issues”. In response, Ripley himself, whose column claims he is ‘Britain’s premier driving expert’, states: “I have yet to meet a driver who has perfected the art of pull-and-push steering – I have been using the technique for more than 25 years and still haven’t got it 100 per cent right”.

When asked why they insist on teaching the '10-to-2, push-pull' steering technique, instructors have invariably claimed that it is the only one accepted by driving examiners. However, comments solicited from both the Driving Standards Agency (DSA) and the Institute of Advanced Motorists (IAM) emphasised that while they “do not consider crossing the hands to be in the interests of safe driving . . . examiners would not fail a candidate for adopting a particular steering technique unless it was clear that that technique actually impaired their control of the vehicle”. They also agree that push-pull is too slow a method of steering control under certain conditions, for example skid correction. Thus there appears to be a difference of opinion between driving instructors and examiners on the requirements for safe driving in relation to vehicle steering. More importantly, there appears to be no objective evidence in the scientific literature to support any view on these requirements.

A number of arguments could, however, be advanced to support the view that the ‘10-to-2, push-pull’ steering technique is not necessarily the safest method of vehicle control. It is certainly obvious that holding the wheel in a '20-to-4' rather than a '10-to-2' position would allow smoother continuous movements to be made by either hand over a larger angle of rotation, especially if either hand were allowed to pass the 12-o-clock
position and retain control through a maximum movement of about 180 degrees. It may also be speculated that the ‘20-to-4’ position would produce less muscular fatigue in the arms and shoulders during prolonged spells of driving and therefore be less likely to exacerbate delayed response to an emergency than the recommended ‘10-to-2’ position. More importantly, there is objective evidence that if the ‘10-to-2, push-pull’ technique is not a ‘natural’ method of steering control, then it may actually be dangerous to insist on its use. Fundamental ergonomics research (see Garvey and Taylor, 1959) showed that when individuals are stressed they exhibit a regression of skill towards earlier and more natural control actions, ignoring instruction and experience with inferior control-display relationships. Thus, if learner drivers are forced to use the push-pull steering technique and it really is unnatural, their potential regression to an apparently more natural, but unpractised, crossed-hand technique under demanding road and traffic conditions could result in confusion, delayed responding, or complete loss of vehicle control.

Objective

The objective of this pilot study was therefore to compare steering performance using the following.

1. The 10-to-2 push-pull technique, in which the controlling hand moves from rest to the 12-o-clock position, where it relinquishes control to the other hand which has moved up to meet it. Both hands then move down until control is resumed by the original hand, which again moves up to the 12-o-clock position. Turns are thus made by pushing with one hand and pulling with the other, each hand staying on its own side of the wheel and moving between 12-o-clock and either 4- or 8-o-clock.

2. The crossed-hand technique, in which no constraints are imposed on where the hands are to be placed on the wheel during straight-ahead steering, nor on passing either controlling hand through the 12-o-clock position.

Method

SUBJECTS

Three groups of eight male volunteers between the ages of 18 and 25 were tested:
(a) those having a full driving licence
(b) learner drivers
(c) non-drivers.

THE STEERING TASK

The subject was seated facing a simulator screen which displayed a small circle at its centre. At the beginning of each trial the screen also displayed a small spot of light in the centre of the circle. This spot could move horizontally to the right or left of centre at irregular time intervals and with varying velocities. The task was to maintain the spot in the centre of the circle by controlling its velocity with a 16-inch steering wheel mounted at an angle of 50 degrees with the horizontal, which Dupois (1957) showed to permit near-optimal rates of rotation to be achieved and which is acceptable to men within the height range of the subjects participating in the study (see McFarland and Domey, 1958). Maximal displacement of the spot could be corrected by turning the wheel at a rate of about 100rpm. A constant torque of approximately 1lb.ft was used to simulate the self-centring effect obtained when steering a road vehicle. This compensatory tracking task was thus similar to driving at a fixed speed along a narrow winding road with occasional sharp bends. Steering performance was measured as time-on-target (with the spot inside the circle) per trial.
PROCEDURE

Half the subjects in each group were tested with the push-pull technique and half with the crossed-hand technique. Each subject was thus tested in only one condition in order to avoid any contamination of skill which might have resulted from transfer of training and experience between conditions.

After brief verbal instructions on the task and on the particular steering technique he had been allocated, each subject had 5 one-minute trials on the task, separated by rest pauses of one minute. Each trial started with the spot in the centre of the circle and with the steering wheel centred. Each trial also began at a different point in the sequence of velocities displacing the spot, so that the order of correcting movements could not easily be anticipated. The experimenter watched each trial for any departure from the required steering technique and, where necessary, corrected the subject by verbal instructions or by demonstration during the following rest period. The procedure was repeated on each of the following four days so that each subject had 25 one-minute trials on the task in all.

Results

Table 1 shows the mean percentage of time-on-target achieved on each of the five days of testing under the two main experimental conditions. Although the push-pull and crossed-hand techniques produced almost identical levels of steering performance initially, there was a tendency for the latter to be superior after the first day of testing. This difference was not statistically significant, even when scores were pooled over the latter four days of testing (p>0.05).

Tables 2–4 show similar comparisons of the two techniques for the three different groups of drivers, learner drivers and non-drivers, respectively. It is clear from these tables that the tendency shown in Table 1 for the crossed-hand technique to produce superior steering performance resulted largely from the data obtained among the two groups of subjects who had had real driving experience. However, even when the scores of these two groups were pooled there was no statistically valid difference between the two techniques, either on a comparison of daily scores, or on pooled scores from all five days (p>0.05). But when mean scores from the first and last days of testing were compared, it was found that drivers who used the crossed-hand technique had significantly improved their time-on-target as compared with drivers who used the push-pull technique (p>0.029), although learners and non-drivers showed a comparable improvement over time (p>0.05).
Table 1: Mean percentage of time-on-target: all subjects

<table>
<thead>
<tr>
<th>Trial No.</th>
<th>Crossed-hand ((N_{ch} = 12))</th>
<th>Push-pull ((N_{pp} = 12))</th>
<th>Advantage for crossed-hand</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>44.5</td>
<td>43.9</td>
<td>+0.6</td>
</tr>
<tr>
<td>2</td>
<td>55.9</td>
<td>51.6</td>
<td>+4.3</td>
</tr>
<tr>
<td>3</td>
<td>65.5</td>
<td>60.8</td>
<td>+4.7</td>
</tr>
<tr>
<td>4</td>
<td>58.8</td>
<td>57.2</td>
<td>+1.6</td>
</tr>
<tr>
<td>5</td>
<td>62.6</td>
<td>59.2</td>
<td>+3.4</td>
</tr>
<tr>
<td>Mean</td>
<td>57.5</td>
<td>54.5</td>
<td>+3.0</td>
</tr>
</tbody>
</table>

Table 2: Mean percentage of time-on-target: drivers

<table>
<thead>
<tr>
<th>Trial No.</th>
<th>Crossed-hand ((N_{ch} = 4))</th>
<th>Push-pull ((N_{pp} = 4))</th>
<th>Advantage for crossed-hand</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>44.2</td>
<td>44.6</td>
<td>-0.4</td>
</tr>
<tr>
<td>2</td>
<td>57.9</td>
<td>52.9</td>
<td>+5.0</td>
</tr>
<tr>
<td>3</td>
<td>68.0</td>
<td>64.4</td>
<td>+3.6</td>
</tr>
<tr>
<td>4</td>
<td>58.3</td>
<td>56.1</td>
<td>+2.2</td>
</tr>
<tr>
<td>5</td>
<td>53.4</td>
<td>50.7</td>
<td>+2.7</td>
</tr>
<tr>
<td>Mean</td>
<td>56.3</td>
<td>53.7</td>
<td>+2.6</td>
</tr>
</tbody>
</table>

Table 3: Mean percentage of time-on-target: learners

<table>
<thead>
<tr>
<th>Trial No.</th>
<th>Crossed-hand ((N_{ch} = 4))</th>
<th>Push-pull ((N_{pp} = 4))</th>
<th>Advantage for crossed-hand</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>47.3</td>
<td>43.7</td>
<td>+3.6</td>
</tr>
<tr>
<td>2</td>
<td>58.1</td>
<td>46.2</td>
<td>+11.9</td>
</tr>
<tr>
<td>3</td>
<td>64.2</td>
<td>58.3</td>
<td>+5.9</td>
</tr>
<tr>
<td>4</td>
<td>58.6</td>
<td>55.4</td>
<td>+3.2</td>
</tr>
<tr>
<td>5</td>
<td>62.6</td>
<td>63.2</td>
<td>-0.6</td>
</tr>
<tr>
<td>Mean</td>
<td>58.2</td>
<td>53.4</td>
<td>+4.8</td>
</tr>
</tbody>
</table>

Table 4: Mean percentage of time-on-target: non-drivers

<table>
<thead>
<tr>
<th>Trial No.</th>
<th>Crossed-hand ((N_{ch} = 4))</th>
<th>Push-pull ((N_{pp} = 4))</th>
<th>Advantage for crossed-hand</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>42.3</td>
<td>43.8</td>
<td>-1.5</td>
</tr>
<tr>
<td>2</td>
<td>51.1</td>
<td>56.0</td>
<td>-4.9</td>
</tr>
<tr>
<td>3</td>
<td>65.8</td>
<td>59.5</td>
<td>+6.3</td>
</tr>
<tr>
<td>4</td>
<td>59.5</td>
<td>59.7</td>
<td>-0.2</td>
</tr>
<tr>
<td>5</td>
<td>64.1</td>
<td>65.1</td>
<td>-1.0</td>
</tr>
<tr>
<td>Mean</td>
<td>56.6</td>
<td>56.8</td>
<td>-0.2</td>
</tr>
</tbody>
</table>
Conclusion

Given the small number of subjects tested, no firm conclusion can be drawn from the finding that overall steering performance did not differ significantly between the two techniques. Vehicle control may, in fact, be equally efficient with either technique. However, there may be an important difference which would be revealed only by more elaborate experimentation, using a more realistic simulation of the driving task or on-road testing in a real vehicle. There are two points of interest which emphasise such a need for further research:

1. Among both drivers and learners superior steering performance tended to result from the use of crossed-hands, which is generally regarded as “not in the interests of safe driving”. In addition, the crossed-hands technique enabled drivers to improve their steering performance significantly over the test period, compared with the use of push-pull.

2. Among non-drivers, there was no tendency for either technique to produce superior steering performance or to permit greater improvement in control over the test period as compared with the other technique.

It could be concluded from these results that the crossed-hands technique has no inherent advantage over the push-pull technique under normal undemanding road and traffic conditions for individuals in the early stages of learning to drive, but that it may provide more rapid and accurate steering when some experience of vehicle control has been gained. This pilot experiment has certainly provided no evidence that the crossed-hand technique is inferior to push-pull or inimical to safe driving.

The general conclusion is that the inefficiency and potential danger of some crossed-hand steering techniques, such as turning the wheel while gripping it firmly with both hands, may have produced a bias among driving instructors and examiners against all crossed-hand techniques. If further research shows that crossing the hands is in fact a more natural and superior steering control action, to which drivers revert in an emergency regardless of their instructed technique, it could be dangerous to prevent their practising and using it appropriately.

Implications for future research

A controlled study is indicated in a more realistic driving simulator of the steering techniques used spontaneously by individuals with no driving experience, in the absence of specific instructions. The aims would be: (a) to reveal the extent to which a ‘natural’ steering technique exists and, if it is ubiquitous, (b) whether its precise nature persists unchanged over a longer period of time than that tested in the present experiment. A complementary field study is indicated of the steering techniques used by qualified drivers when they are not aware of being observed. The aim here would be to explore the extent to which the approved push-pull technique continues to be used after learners pass their test.

A simulator study is indicated of the accuracy of qualified drivers’ steering performance and of the rates at which they meet sudden demands for large steering corrections, when using either the push-pull or crossed-hand technique. The aims here would be: (a) to quantify any performance differences there may be between the techniques when drivers operate under low-stress driving conditions; and (b) to investigate the prediction that emergency demands for control action may result in confusion, delayed responding and loss of vehicle control among drivers using push-pull, if this is in fact shown to be an ‘unnatural’ steering technique.
References


Police drivers’ visual search in hazardous situations

Chapman, Crundall, Phelps and Underwood, Accident Research Unit, School of Psychology, University of Nottingham, Nottingham NG7 2RD

Introduction

Previous research in our laboratory has described changes in drivers’ visual search patterns during the transition from novice to experienced driver. Such changes were particularly notable when the driver was viewing and responding to hazardous situations. In such situations drivers reduced their spread of visual search and increased the time spent fixating on individual objects; moreover, this focusing effect was greater for novice than experienced drivers. It thus seems likely that experience with hazardous driving situations allows the driver to reduce this potentially dangerous focusing of attention. Police pursuit and response drivers regularly experience extremely hazardous driving situations. In the study reported in this paper, trained police drivers, matched experienced drivers, and a group of novice drivers all viewed a selection of films of driving situations, some of which came from actual police response drives, some from police pursuit situations, and some of which were control drives on the same roads. Physiological responses, subjective ratings, and eye movements were recorded from all driver types. The results extend our previous findings on visual search in hazardous situations as a function of traffic experience and have implications for the effectiveness of advanced driver training courses.

DRIVERS’ EYE MOVEMENTS AS A FUNCTION OF ROAD TYPE AND HAZARD

The typical pattern of eye movements recorded from drivers involves a large number of fixations near to the focus of expansion with occasional excursions to items of road furniture and road edge markers (Mourant and Rockwell 1970, 1972). This reliance on the focus of expansion in the scene has been assumed to be because it provides precise directional information to the driver and is the location near to which future traffic hazards are likely to be first visible. When the road situation becomes more complex (for example in the transition from rural to urban driving), the number of eye movements made increases and the mean fixation durations on individual objects decrease (Chapman and Underwood, 1998a, 1998b; Luoma 1986; Miura 1990; Robinson, Erickson, Thurston and Clark, 1972). This seems to be a natural response to having more objects available in the visual field to look at. However, it is not clear whether decreases in fixation durations mean that objects are processed incompletely or that redundant fixation time is simply reduced. Cohen (1981) found that subjects viewing slides in the laboratory adopt longer fixation durations than those actually driving a vehicle in the same situations. He concludes that this is because of the lack of time pressure in his laboratory task and argues that on the road subjects adopt more task-relevant strategies and pick up more information per unit time. Whether or not this is the case, it suggests that fixation durations while driving may be determined both by the visual stimulus and by the task as perceived by the subject.
Evidence that the nature of visual search depends not only on the nature of the visual scene, but on the task perceived by the driver, is provided by Chapman and Underwood (1998a, 1998b). While showing that fixation durations decrease and the spread of search increases in the transition from rural to suburban and then urban situations, they found that in each case the opposite pattern occurs when situations become more dangerous. For each road type the presence of a hazard in the scene causes a focusing of attention such that fixation durations increase, saccade lengths decrease and the spread of search reduces. Such a pattern of results accords with Easterbrook’s (1959) general hypothesis that with increases in arousal the range of cues utilised by an organism is reduced and may explain a range of research in attention and memory which suggests a narrowing information processing in stressful situations (eg Christianson, 1992; Hammond, 2000). Such changes have also been extended by Crundall, Underwood and Chapman (1999) to show that the reduced spread of search in hazardous situations additionally involves an impaired ability to detect target objects which are not being fixated. Although this focus of attention upon objects which have been already identified as potential hazards may often prove advantageous, it may also cause problems when the driver is unable to disengage attention from a single hazard in time to detect additional hazards within a situation.

VISUAL SEARCH AS A FUNCTION OF TRAFFIC EXPERIENCE

Research at Nottingham University has consistently found changes in visual search as a function of traffic experience (eg Underwood, Crundall and Chapman,1997). In on-road driving we observe that novice drivers have particular limitations in visual search compared to experienced drivers when driving on high demand dual-carriageways (Crundall and Underwood, 1998). It is possible that such differences are partly attributable to problems that novice drivers have with simple control skills on high speed roads (cf. Underwood, Chapman, Bowden and Crundall, 2002). Until a driver has learned to control steering with information from peripheral vision, frequent fixations are necessary on the edge of the road to determine road position. Although such effects are of concern, it seems likely that drivers will rapidly develop the control skills necessary to get around such problems in visual search. Novice drivers seem to be well aware of such limitations and may attempt to adjust their exposure appropriately in order to avoid such situations until their competence has developed. What is of greater concern is the possibility that visual search may be inadequate in hazardous situations which are harder to avoid. The study by Chapman and Underwood (1998a) mentioned above is particularly interesting here. They found that there were overall differences between novice and experienced drivers in fixation durations (with experienced drivers generally having shorter fixation durations), but also that such effects interacted with the danger present in the situation. Although experienced drivers also suffered from attention focusing in the sense described above, this was less dramatic than that observed in novice drivers. The authors suggest that becoming more experienced with hazardous situations may allow the driver to process hazards faster and hence disengage attention sooner. Evidence supporting this effect is also provided in a study by Miltenburg and Kuiken (1990). They had drivers watch video recordings of six common traffic situations while recording their eye movements. They tested 47 subjects split into four groups on the basis of their driving experience, ranging from novice drivers with less than one year of driving experience, to very experienced drivers with more than five years of experience and more than 100,000 km driven in the previous year. They found that for one of their scenes, crossing an intersection, experienced and very experienced drivers fixated more briefly than inexperienced drivers who in turn fixated more briefly than novice drivers. An inability to rapidly recognise and process driving hazards in novice drivers is clearly of considerable practical importance and we have explored possibilities for training interventions to counter such effects (Chapman, Underwood and Roberts, 1998, 2002).

Having identified hazardous situations as being of particular interest in terms of changing visual search strategies as a function of traffic experience, a question of immediate interest is whether additional training and experience, particularly with hazardous scenarios, can further alter visual search strategies. One group of drivers who have to routinely cope with highly dangerous situations are police drivers. According to the Police Complaints Authority, in the year 1998–99 police pursuits accounted for 17 deaths in the UK, reflecting an increase of 88 per cent over the previous year. Though the absolute numbers are a mere fraction of the total
number of road fatalities that occur every year, the high-profile nature of these cases can potentially undermine public confidence in the police force. Despite the need to understand the cognitive prerequisites of such hazardous tasks, very little empirical research has been conducted on the nature of rapid response and pursuit driving. Those studies that have looked at these aspects of police driving have been primarily concerned with collating statistics on pursuit outcomes (eg Alpert and Fridell, 1992; Falcone, Wells and Charles, 1992), attitudes to pursuit (Alpert, 1998; Dunham, Alpert, Kenny and Cromwell, 1998; Homant and Kennedy, 1994; MacDonald and Alpert, 1998), or else with correlations of personality factors with the likelihood of choosing to pursue (eg Homant, Kennedy and Howton, 1994; Homant and Kennedy, 1993). Data relating to actual skill requirements in police driving are scarce. The study reported in this paper contains preliminary results from a series of studies that we are conducting looking at visual search, attention, memory and decision making in police drivers. The full studies include a group of matched control drivers with similar driving experience to trained police drivers, however, in this initial study we compare the performance of police drivers with a group of young novice drivers.

Method

PARTICIPANTS

The participants were 24 drivers split into two groups. The first group consisted of 12 young novice drivers, with a mean age of 20.4 years, a mean annual mileage of 1,500, and a mean of 2.9 years’ driving experience (all drivers having less than five years’ driving experience). The second group was a group of police drivers, with a mean age of 41.3 years, a mean annual mileage of 19,687, and a mean of 23.8 years’ driving experience. All police drivers who volunteered for the study were male, and we decided to recruit only male novice drivers to maintain compatibility between the groups.

STIMULI

The stimuli were a set of 48 videos of driving situations recorded from the point of view of the driver. Each video lasted approximately 60 seconds. Sixteen of the videos were recorded from police vehicles engaged in pursuits of other vehicles in and around Nottingham, such pursuits typically involved following another vehicle at high speeds and contravening traffic laws. A further 16 were recorded from police vehicles engaged in rapid response driving in and around Nottingham, in these situations there was no particular vehicle being followed, but the driver’s vehicle proceeded at high speeds, often passing through red lights, and frequently passing other vehicles which had stopped for it to pass. The final 16 were standard control drives from similar environments in and around Nottingham, but with the driver remaining within the prevailing speed limit and abiding by the Highway Code. For each group of 16 videos, half were recorded in daytime and the remaining half recorded at night-time.

PROCEDURE

Individual participants performed a short practice task familiarising them with the types of video to be viewed. They then watched a series of 48 videos projected on a projection screen just over one metre from them such that videos subtended approximately 60 degrees of visual angle horizontally and 38 degrees vertically. While watching each video their heart rate, skin conductance, and eye movements were recorded, and they made a continuous record of ongoing hazard level using a sliding response scale. Participants were told that the lowest position of the slider represented ‘low or no hazard: eg clear visibility and no other road users present’ and the highest point represented ‘high hazard: extreme likelihood of an accident occurring to yourself or another road user – a situation that may require immediate evasive action’. They started each clip with the slider placed at the mid-point of the scale and were asked to adjust its position constantly in response to changing road conditions. Skin conductance,
heart rate and hazard level were recorded on line using a Biopac MP30 biopotential amplifier connected to a Macintosh computer. Eye movements and pupil size were recorded using a head mounted SMI (SensoMotoric Instruments) eyetrack eye movement recorder. After watching the first 24 videos, participants had a short break during which they were able to remove the eye movement recorder. The order of presentation of videos was counterbalanced across participants.

Results

The main variables that will be presented here are overall results concerning on-line assessment of hazards in the different clips and a series of eye movement measures – mean fixation durations, mean gaze position and spread of search (horizontally and vertically separately). Each variable was subjected to an analysis of variance with the between subjects factor of driver experience (novice versus police), and two within subjects factors, time of day (day versus night), and type of driving (control, pursuit, or response). For each analysis of each variable all significant main effects and interactions are reported. The interpretation of these results is based on post hoc tests that were conducted using Tukey tests and analysis of simple main effects.

Figure 1: Mean hazard ratings for three types of driving in both day and night

Figure 2: Mean hazard ratings for three types of driving by both novice and police drivers
For the purpose of analysis a continuous trace of hazard level throughout each clip was used to calculate an overall mean hazard level for the clip, and the standard deviation of this value was used to give a measure of overall variability in hazard assessment. There was a main effect of driving type, $F(2,44)=63.78, p<0.01$, and significant interactions between this factor and both time of day, $F(2,44)=12.62, p<0.01$, and driver experience, $F(2,44)=3.65, p<0.05$. The interaction with time of day is plotted in Figure 1, demonstrating that pursuit and response drives were rated as more hazardous than control drives for both daytime and night-time conditions, but that night-time films were only rated as more dangerous than daytime films in the control condition. Figure 2 plots the interaction with driver experience. Analysis of variability of hazard level in the clips revealed a main effect of time of day, $F(1,22)=27.67$, and interaction between this and driving conditions, $F(2,44)=4.32, p<0.05$, demonstrating that daytime conditions produced greater variability in hazard ratings than night-time conditions for both control and response drives, but not for pursuit ones.

Mean fixation durations were calculated for each clip separately, excluding any fixations below 100ms. There were main effects of driver experience $F(1,22)=9.81, p<0.01$, time of day, $F(1,22)=14.25, p<0.01$, and type of driving, $F(2,44)=17.66, p<0.01$. There were also interactions between type of driving and both time of day, $F(2,44)=19.72, p<0.01$, and driver experience, $F(2,44)=4.39, p<0.05$. The interaction with time of day is plotted in Figure 3, which shows that fixations were longer in the night-time versions of control and pursuit films, but longer in daytime versions of the response films. For daytime films, fixation durations were longer in both pursuit and response drives than in the control ones. For night-time films, fixation durations were again longer in pursuits than control films, but there was no difference in fixation durations between control and response situations. The interaction with driver experience is plotted in Figure 4. Police drivers had shorter fixation durations than novices for all three types of driving. For police drivers, fixations were significantly longer in pursuit films than control films. For novice drivers, fixations were significantly longer in pursuit films than either control or response films.

**Figure 3: Mean fixation durations for three types of driving in both day and night**

![Graph showing mean fixation durations for three types of driving in both day and night](image)
Analyses of fixation locations were conducted separately in the horizontal and vertical planes. In the horizontal plane there were main effects of time of day, \( F(1,22)=91.95, p<0.01 \), and type of driving, \( F(2,44)=723.65, p<0.01 \). There was a significant interaction between these two factors, \( F(2,44)=370.10, p<0.01 \). This complex interaction involved drivers fixating further to the right in response drives, particularly daytime ones, than in the other two types of drives. There was also an interaction between time of day and driver experience, \( F(1,22)=4.62, p<0.05 \), with fixations tending to be further to the right on daytime films, and a slight tendency for novice drivers to fixate further to the left than police drivers on night-time films. In the vertical plane there were main effects of both time of day, \( F(1,22)=43.97, p<0.01 \), and type of driving, \( F(2,44)=131.52, p<0.01 \), and an interaction between these two factors, \( F(2,44)=170.95, p<0.01 \). This complex interaction involved a general tendency for fixations to be higher vertically in the control films than in pursuit and response films, and a general tendency for fixations to be higher in night-time than daytime films which was reversed in films of response drives.

Spread of search was assessed as the standard deviation of fixation locations vertically and horizontally. Analysis of horizontal spread of search demonstrated a main effect of driver experience, \( F(1,22)=19.86, p<0.01 \), with police drivers having a wider spread of search than novices, see Figure 5. There was also a main effect of type of driving, \( F(2,44)=6.00, p<0.01 \), and an interaction between type of driving and time of day, \( F(2,44)=268.35 \). This interaction demonstrated greater spread of horizontal search in daytime pursuit drives than night-time ones, but a reversed effect for response drives where there was greater spread of search in night-time than daytime ones.

For vertical spread of search there was a main effect of time of day, \( F(1,22)=7.56, p<0.05 \), and of type of driving, \( F(2,44)=11.88, p<0.01 \), and an interaction between these two factors, \( F(2,44)=17.17, p<0.01 \), such that daytime pursuit drives have greater spread of vertical search than all other conditions, and response drives show less spread of search in daytime than night-time. Preliminary analyses of skin conductance and heart rate have revealed no significant differences between driver types or film types, however, analyses of these data are still ongoing.
Discussion

The broad pattern of results obtained so far accords well with the predictions made from earlier work (eg Chapman and Underwood, 1998a, 1998b; Chapman et al., 2002; Underwood et al., 1997) looking at changes in visual search as a function of experience, however, there are also a wealth of new details provided by the type of stimuli used in this study. Ratings of hazard level confirm our expectations that pursuit and response drives will be perceived as notably more hazardous than control drives on similar stretches of road, although there is no clear differentiation between pursuit and response drives in overall hazard level. Although night-time drives appear more dangerous than daytime ones in the control conditions, this difference is not clear in the more hazardous pursuit and response scenarios. Of greater interest is the difference in danger levels reported by trained police drivers in comparison to the novices. Although the two groups do not differ in their assessments of control drives, it is clear from Figure 2 that novice drivers regard the response and particularly the pursuit drives as notably more hazardous than the police drivers do. This makes good sense in that the police drivers will have had first-hand experience with these situations in a way that the novice drivers will hopefully not have had.

We had initially thought that the standard deviation of hazard level might provide a useful measure of the driver’s sensitivity to individual hazards in a film, such that films with many individual hazards would elicit more variable traces than those with fewer hazards. We also suspected that police drivers might detect more hazards than novice drivers and hence have higher variability in their trace. In fact the analysis of standard deviation of hazard level proves much less sensitive to changes in film or driver than we had expected. The only clear differences are between night-time and daytime clips, where more variability is observed in daytime, except in pursuit films. This makes sense if we assume that daytime films allow more individual hazards to be detected, except in the case of pursuits where a focus on the vehicle ahead may render such peripheral details irrelevant. Nonetheless it would be surprising if larger differences between the different film types could not be detected. Although it is possible that the lack of effect reflects task demands inherent in the task of monitoring a continuous hazard level, it seems likely that a more sensitive analysis of these data (for example, focusing on turning points in the trace) will make differences between films and drivers easier to spot (cf. Quimby and Watts, 1981).

Fixation durations in driving scenarios can be hard to interpret. In some cases long fixations are associated with situations of low demand – for example the rural routes in Chapman and Underwood (1998b) and Crundall and Underwood (1998). In other cases long fixations are elicited by specific events – for example the
hazards in Chapman and Underwood (1998a, 1998b). This latter interpretation is closer to the standard interpretation of fixation durations in other areas of psychology, with increases in demand being closely linked to increase fixation durations. The pattern of fixation durations in the daytime conditions follows the demand interpretation that we would have predicted. The more hazardous pursuit and response conditions produce longer mean fixation durations than the control clips. For control clips we could explain the increase in fixation durations at night as being consistent with the higher danger ratings given to the night-time films, however, a different explanation is required for the day-night differences in pursuit and response drives. It is possible that the long fixation durations in the pursuit drives at night are similar to those previously observed for rural roads. When little other information is available, long fixations on the vehicle being followed are inevitable. This may also explain why the effect is not observed in the response drives, as no such vehicle is present in these conditions. The effects of driving experience on fixation durations are much clearer. The more experienced police drivers have shorter fixations in all cases. This is consistent with the idea that their greater knowledge of the road environment allows them to process relevant information faster than novice drivers. It is worth noting that this effect is present equally in all three types of road situation. Although this was not found in Chapman and Underwood (1998a), it is consistent with research on training (Chapman et al., 2002) where training in visual search affected safe situations as much as dangerous situations. It will be extremely interesting to see what pattern of results is observed with experienced but untrained drivers.

Analyses of exact fixation locations are easy to overinterpret. Although we have used a good range of different types of stimulus, no attempt has been made to exactly match the types of road and traffic between the pursuit and response conditions or between daytime and night-time drives. Some differences in fixation position are thus likely to arise from the precise nature of the clips we have used. The only difference between subjects’ effect that was observed was a slight tendency for police drivers to fixate further to the right on night-time films than novice drivers. It is perhaps worth noting that we do not observe any general tendency for novice drivers to fixate closer to the front of their vehicle than police drivers (cf. Mourant and Rockwell, 1972, though see also Underwood et al., 2002).

The differences in horizontal spread of search that are observed mirror closely the differences between driver group that were observed in fixation durations. Police drivers have shorter fixation durations, and their fixations are spread more widely in the horizontal plane than those of novice drivers. As was also found with the fixation durations, this effect occurs equally in control clips as in pursuit and response drives. It would appear that the police drivers have adopted a routine scanning strategy which is broader and faster than that used by novice drivers in all situations. Vertical spread of search is a less sensitive measure than horizontal, and particularly given that drivers do not have to control the vehicle in our task it is perhaps not surprising that the large differences that were observed in horizontal search are not obtained in the vertical plane.

A series of analyses remain to be conducted on these data, and some of the age-matched control participants still have to be tested. The performance of more experienced control participants may have been illuminating in helping to disentangle the potential roles of training and experience in changing visual search strategies. However, to fully understand the relationship between these data and those obtained by Chapman and Underwood (1998a) and Chapman et al. (2002) we will also need to distinguish more carefully between chronic hazards (such as driving fast, or pursuing another vehicle) and specific hazards (a car about to pull out, or a pedestrian approaching a crossing). Our previous work has focused very much on these specific hazards and it is possible that the continuous level of hazard in the pursuit and response situations has a very different effect. One approach which we are currently investigating is dividing all clips into five second sections based on the rated hazard level and analysing the visual search data separately for each section. Sections could then be categorised as safe or dangerous either relative to the other events in the clip, or relative to all the events viewed during the study.

Two further lines of research that we are currently pursuing involve the implications of changes in visual search strategy. The first question is one of whether focusing on a central hazard (as in a pursuit situation) impairs your ability to detect peripheral hazards (eg Crundall et al., 1999). Clearly this could have severe
implications for police pursuit driving; however, it is possible that police drivers have already developed strategies that overcome such problems. We will be investigating the ability of both chronic and specific hazards to impair detection of peripheral targets in police, age-matched controls and novice drivers. The second line of research relates to the possibility that reductions in search and in peripheral processing will have direct effects on drivers' memory for situations and their ability to make appropriate decisions.

Conclusions

The preliminary findings reported in this paper support our prediction that trained police drivers would have markedly different visual search strategies from those used by novice drivers. In general, police drivers regarded the hazards present in pursuit and response driving as less significant than novice drivers did, and they adopted a style of search characterised by many brief fixations which were well spread out in a horizontal plane. This change in pattern of search is similar to (but much larger than) the changes we have previously observed between newly qualified drivers and those with five to ten years of experience. Such changes were previously found to be larger for hazardous situations than safer ones, however, this does not appear to be the case in our police drivers, who adopt this widened search strategy in all situations. This may be the result of conscious training of visual search, or it may be an inevitable consequence of high levels of experience with hazardous situations. Our current research is engaged in exploring this question and making practical recommendations about the safety of police driving and possible training that may be appropriate for both police and other drivers.

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References


Antilock braking systems: do they reduce accidents?

CJ Baughan, J Broughton and L Smith, Safety Group, TRL Limited, Crowthorne

Introduction

Antilock braking systems (ABS) are fitted increasingly to new cars. Their main effect is to improve lane-keeping while braking on bends, and the ability to steer and avoid obstacles under heavy braking. They can also reduce stopping distances, though not in all circumstances.

Clearly, such systems have a potential safety benefit – see, for example, a number of articles cited by Smith, Grayson and Baughan (1999). However, they present the driver with new task demands and new expectations. Whether the safety benefit is realised in practice may depend on how drivers deal with these changes. This, in turn, is likely to depend on drivers’ knowledge, training and experience.

TASK DEMANDS

To minimise stopping distance with ABS, the brake pedal must be pressed down hard. It is often advised that the clutch pedal should be depressed early to disconnect the driven wheels from the engine and allow the ABS full control over their rotation. Drivers of non-ABS cars may have become used to braking more lightly to avoid skidding, and to keeping the clutch engaged until later in the manoeuvre, which is the technique usually taught in the UK.

A non-ABS car with wheels locked will not react to steering inputs. Drivers transferring to an ABS-equipped car will find, if they try, that they can steer under emergency braking. The question is: will they try and, if they do, will they inadvertently swerve too violently? A driver who does keep steering control of an ABS car under emergency braking will be faced with a new task of path selection and collision avoidance.

These new task demands have to be met during a ‘panic’ manoeuvre in which the car may be behaving in an unexpected way. The ABS itself may be producing pedal vibration and other noises and vibrations that may prompt the driver to release pressure on the brake.

EXPECTATIONS

Drivers of ABS cars are likely to have expectations of what ABS does. It seems at least possible that they may modify their driving behaviour on the basis of such expectations. This would become particularly undesirable if the expectations were over-optimistic, since drivers might then adopt risky behaviours on the erroneous belief that ABS will protect them.
EARLIER STUDIES

A number of studies, mainly in the USA, have used accident data to assess the effects of ABS on safety, with varying results. Several of the studies controlled for exposure to risk by making questionable assumptions that certain types of accident were not affected by ABS – e.g. accidents on dry roads, or accidents in which the vehicle of interest was run into from the side. Farmer, Lund, Trempel and Braver (1997) took a different approach, using fatal crash rates per vehicle-year of exposure to compare vehicles with and without ABS. At the time of the survey described in this paper, the overall indication from previous research was that ABS leads to a decrease in fatalities amongst cyclists, pedestrians, and others not in the vehicle of up to a fifth, but an increase in vehicle occupant fatalities of perhaps a quarter – largely as a result of more single-vehicle and rollover crashes. The net effect of ABS on fatalities appeared to be zero or, for older vehicles, an increase. The evidence was inconclusive for non-fatal accidents – the most optimistic indication being that there was a 10 per cent reduction overall, with larger reductions on wet roads than on dry. Again it appeared that some types of single-vehicle non-fatal accidents may increase when ABS is fitted.

The applicability of these results to conditions in Britain is unclear – comparison between countries is difficult for many reasons, including the fact that the types of ABS used, and the braking behaviour of non-ABS vehicles, may differ between countries. However, it was clear that the potential safety benefits of ABS had not been demonstrated in practice, and that there were worrying indications of increased risk to car occupants.

The Vehicle Standards and Engineering Division of the Department for Transport, Local Government and the Regions (DTLR) asked the Transport Research Laboratory (TRL) to conduct a study to assess the effectiveness of ABS at reducing accidents in the UK. This paper describes some of the results and discusses them in the context of more recent research findings. A full description of the survey is published elsewhere (Broughton and Baughan, 2000).

The survey

Questionnaires were sent, in March 1999, to 80,000 registered keepers of cars with a ‘P’ registration prefix (these are cars first registered between August 1996 and July 1997). The questionnaires asked about accidents within the preceding 12 months. It also requested information on the vehicle, mileage driven, knowledge about the performance of ABS, experience of its operation, and driver training and education. A total of 20,973 replies were received – a response rate of 26 per cent. 1,684 accidents were reported, 198 of them injury accidents. Questionnaires that did not provide complete data for all the necessary variables had to be excluded from the statistical modelling. Consequently the final models were able to use only about two-thirds of the returned questionnaires.

Results

Table 1 shows the accidents reported for ABS and non-ABS vehicles, expressed as relative rates where:

Relative rate = \( \frac{\text{rate of accidents per year of exposure for the group}}{\text{overall rate of accidents per year of exposure}} \)
Table 1: Relative accident rates for ABS and non-ABS vehicles (raw)

<table>
<thead>
<tr>
<th>Is car equipped with ABS?</th>
<th>Relative accident rate (injury accidents)</th>
<th>Relative accident rate (all accidents)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>0.96</td>
<td>0.95</td>
</tr>
<tr>
<td>No</td>
<td>0.99</td>
<td>1.05</td>
</tr>
<tr>
<td>Not known</td>
<td>1.13</td>
<td>1.00</td>
</tr>
<tr>
<td>Number of accidents</td>
<td>194</td>
<td>1,646</td>
</tr>
</tbody>
</table>

Note that a number of questionnaires were excluded from the analysis summarised in Table 1 because the information on the period for which the car had been owned was missing.

Table 1 shows that ABS-equipped vehicles had about 10 per cent fewer accidents than those without ABS. These unadjusted figures will be misleading if the proportion of vehicles fitted with ABS depends on variables that are themselves associated with safety. For example, if the only effect of this type was that vehicles doing a high annual mileage are more likely than others to be fitted with ABS, Table 1 would tend to underestimate the benefit of ABS. In fact, the rate of ABS fitment was found to be associated with a number of variables including sex and age of driver, annual mileage, engine size, years of driving experience, car model, and car colour – all of which are associated with accidents. Figure 1 shows how the percentage of cars fitted with ABS varied with engine capacity.

The importance of car model and colour is illustrated in Table 2. Three car-model risk groups were used, and the table shows the estimated percentage increase in accidents for the medium- and high-risk groups as compared to the low-risk group. Similarly, three colour-groups were used; the table shows the estimated percentage increase or decrease in accidents for groups 2 and 3 as compared to group 1. The estimates in the table were derived from the statistical models to be described in the next section – that is, they take account of differences between the groups in terms of the listed variables.
To adjust simultaneously for such effects, generalised linear models were fitted to the data, using accidents in the last 12 months as the dependent variable, and the following explanatory variables:

- sex of driver
- age of driver
- annual mileage
- percentage of total mileage on motorways
- percentage of total mileage on rural roads
- car model ‘risk group’: low, medium, high (based on raw relative accident rates)
- car colour group: three groups, optimised by statistical modelling.

This approach allowed the effects of ABS on accidents to be estimated while correcting for differences between the ABS and non-ABS samples in the above variables.

**MODELLING RESULTS**

Table 3 shows the estimated effect of ABS on all accidents for several groups of drivers. Men aged 17 to 55 have been grouped together because sub-groups within this age range showed similar effects of ABS. Men over 55 showed a different effect. There was no evidence of any interaction between age and effect of ABS for female drivers, so all women are grouped together in the table.

<table>
<thead>
<tr>
<th>Table 2: Effects of car model and colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>All accidents</td>
</tr>
<tr>
<td>---------------------------------------</td>
</tr>
<tr>
<td>‘Medium-risk’ cars</td>
</tr>
<tr>
<td>‘High-risk’ cars</td>
</tr>
<tr>
<td>Car colour group 2</td>
</tr>
<tr>
<td>Car colour group 3</td>
</tr>
</tbody>
</table>

Note: 90 per cent confidence intervals shown in brackets

Table 3 shows that, for men aged 17–55 years, ABS was estimated to reduce accidents by 16 per cent (90 per cent confidence interval: 28 per cent to 1 per cent). This was the only result statistically significant (p<0.1). However, the result for all women (ABS increases accidents by 18 per cent) was on the edge of statistical significance, as is shown by the fact that the confidence interval only just includes zero. Older men were estimated to have their accidents increased by 10 per cent by ABS but this result was not statistically significant. The overall estimated effectiveness of ABS was a non-significant 3 per cent reduction in accidents – the confidence interval ranges from a 12 per cent reduction in accidents to a 7 per cent increase.
To benefit from ABS, drivers need to use it correctly and to cope with the task difficulties outlined in the
Introduction. They are presumably more likely to do this if they have been trained in the use of ABS or if they
at least know how it should be used and what its effects are likely to be. Similarly, it would be undesirable for
them to have over-optimistic beliefs about the degree of protection afforded by ABS.

Very few drivers reported any actual training with ABS, but the questionnaire did assess knowledge of the
effect of ABS on stopping distances, and on steering-while-braking. Both these types of knowledge tended to
be beneficial to drivers of ABS cars in the sense that higher knowledge scores were associated with greater
beneficial effects of ABS on accident risk. However, it does not necessarily follow that the knowledge itself
produces this benefit by helping ABS drivers to use the system properly. Drivers who are well informed about
ABS may also tend to have other characteristics that reduce their accident risk. If so, drivers of non-ABS cars
who have such knowledge should also show a reduced risk. This proved to be the case for knowledge about
the effect of ABS on stopping distances, which appeared to reduce the risk for non-ABS drivers as much as it did
for ABS drivers. However, for knowledge about the steering-while-braking capability of ABS there was a
tendency for ABS drivers to benefit more than non-ABS drivers.

Figure 2 shows how the estimated risk of ABS drivers (relative to that of non-ABS drivers) reduced as the
knowledge score increased from zero to four. For example, men aged 17–55 with a knowledge score of zero
obtained no safety benefit from ABS, whereas those with a knowledge score of four had their accident risk
reduced by 32 per cent by ABS. The suggestion is that increased knowledge of the steering-while-braking
capability of ABS is beneficial to all groups of drivers but that good knowledge may not be sufficient for women
or older men to obtain a safety benefit from ABS.

Discussion

The survey estimated that, once differences in the number of driver, exposure and vehicle-related variables
have been adjusted for statistically, ABS produces a safety benefit for male drivers aged 17–55 years. For older
men there was a suggestion of increased risk from ABS. There was a strong indication that women tend to
experience an increased accident risk from ABS. Knowledge of the steering-while-braking capability of ABS
appeared to increase the benefit (or reduce the disbenefit) of ABS to all groups – but even good knowledge (as
measured by the question) did not appear to be sufficient to allow women or older men to gain a safety benefit
from ABS.
Taking these results at face value, there would seem to be two implications for ABS and road safety. The first is that the safety benefits of ABS might be increased, perhaps substantially, if drivers had better knowledge, or better skills, to enable them to use ABS more effectively and/or avoid undue reliance on the protection they think it offers. More work is needed to identify the important knowledge and to develop training methods. The driving test is currently the main instrument for influencing learner driver training in Britain (Baughan, 2000) and there would appear to be a case for considering how ABS should be dealt with in both the theory and practical tests. Given that drivers transfer between ABS and non-ABS cars, any braking or other emergency procedures they are taught need to be suitable for both types of vehicle. The hard braking and early de-clutching required for optimum stopping in an ABS-equipped car is not the procedure traditionally taught to learner drivers in Britain. Before it could be introduced as a standard procedure to be taught for all cars, a safety case about its suitability for non-ABS cars may need to be made. This could involve both track testing and investigation of the braking techniques taught in other countries. The dangers of producing over-confidence, now well recognised by driver training researchers and discussed in the context of this project by Smith et al. (1999), would also need to be borne in mind – especially if training were to include demonstrations or practice with the steering-while-braking characteristics of ABS and non-ABS cars.

The second implication is that improved training and education may not be sufficient to allow all groups of drivers to benefit from ABS. The reasons why women and older men do not appear to benefit merit further investigation. One possibility is that they tend not to have the types of accident that ABS is designed to protect against – e.g. accidents that involve heavy braking on bends or while swerving to avoid obstacles. Another is that they may tend not to react early enough to give ABS the opportunity to help. A third is that their generally slower and less risky driving styles may mean that they become used to gentle applications of the brakes, and do not then brake hard enough to activate the antilock system even in an emergency. Some may have difficulty in exerting the necessary force on the pedal. A fourth is that they may tend not to try to steer while braking in an emergency. Such effects might explain a lack of benefit from ABS; to account for an increase in accident risk further mechanisms would be needed. It may be that these groups of drivers tend to find it particularly difficult to maintain steering control and/or to choose a path past obstacles when suddenly faced with a vehicle that does react to steering inputs under panic braking. Another possibility is that they are particularly susceptible to the noise and vibration of ABS, and tend to release the brake pedal or become distracted from the steering task when the ABS starts to operate. Which, if any, of these explanations are correct is not at present known. Given the size of the improvement in safety that might be expected if all drivers maximised their benefit from ABS, it would be well worth finding out.

Further insight into what might be happening is available from recent studies. Farmer (2001) added fatal accident data for the three years 1996 to 1998 to the dataset used by Farmer et al. (1997), and found that the excess risk to occupants of ABS vehicles had disappeared in the later period. This resulted from a combination of an increase in risk between the two periods for non-ABS vehicles and a decrease in risk for ABS vehicles. Farmer suggests that the increase for non-ABS vehicles may result from the vehicles being re-sold to younger/riskier drivers. As regards the decrease in ABS risk over time, he speculates that the publicity created by the earlier ABS studies may have reduced drivers’ over-confidence in the system or, following Hertz, Hilton and Johnson (1998), that drivers may have become more skilful in using ABS.

A re-analysis of the same data by Harless and Hoffer (2002) paints a somewhat different picture. These researchers found that the excess risk to occupants of ABS vehicles is not something that occurred in the period 1993 to 1995 (Farmer et al. [1997] first analysis period) but has now disappeared. Rather, the excess occurs during the early life of an ABS vehicle, and disappears after a few years. Moreover, the excess appears, in the US data, to apply almost exclusively to drinking drivers. Harless and Hoffer (2002) argue that there are probably two mechanisms at work here. First, drink drivers inexperienced with ABS may find it particularly difficult to use ABS effectively in emergencies, but may improve as they gain experience with the system. Secondly, those drivers who are most likely to drink and drive and have difficulties with ABS will tend,
because of their crashes, to remove themselves and their vehicles from the sample. Harless and Hoffer do not favour an alternative explanation – that the drinking behaviour itself is a form of risk compensatory behavioural adaptation to the perceived protection offered by ABS. They argue that if ABS were inducing some drivers to drink and drive, we should expect it to induce other forms of risk compensation among the more risky of the sober drivers. In fact the data show that among sober drivers, ABS appears to be of more benefit to the ‘riskier’ drivers than to those who are ‘safer’ – as judged by age, seatbelt use and previous driving record. The authors do not discuss an alternative possibility – namely that, when drunk, drivers may be more likely to adapt their driving behaviour to the perceived protection offered by ABS.

The finding that ABS is particularly beneficial to (sober) risky drivers is consistent with our finding that ‘younger’ men benefit more from ABS than do women and older men. It may be that younger men, who also tend to be the riskier drivers, are more likely to drive in a way that can benefit from ABS. The extent to which Harless and Hoffer’s results apply in Britain is unknown. However, in the sense that they imply that excess risk of ABS to vehicle occupants decreases as driver experience with ABS increases, they reinforce the indications of our own study that improved knowledge of the capability of ABS improves its effectiveness. They also imply that alcohol-impaired drivers (and possibly drivers with other impairments) are particularly vulnerable to the difficulties of using ABS effectively in emergencies.

Conclusions

1. Antilock braking systems offer several potentially useful safety benefits. Whether these are realised in practice may depend on how well drivers deal with the new task demands imposed by ABS, and whether drivers have unrealistic expectations of the protection provided.
2. Studies in other countries, principally in the USA, indicate that ABS reduces fatal accident risk to people outside the car, but increases risk to those inside – such that the net effect is around zero. However, the extent to which these findings can be generalised to the UK is unclear – especially as the road conditions, the types of ABS used, and the braking performance of non-ABS vehicles may differ between countries.
3. A survey of the accident involvement of P-registered cars strongly indicated that, during a 12-month period starting when the cars were 18 to 30 months old, ABS produces a safety benefit for male drivers aged 17–55 years. For older men there was a suggestion of increased risk from ABS. There was a reasonably strong indication that women tend to experience an increased accident risk from ABS.
4. Knowledge of the steering-while-braking capability of ABS appeared to increase the benefit or reduce the disbenefit of ABS to all groups – but even good knowledge (as measured in the survey) did not appear to be sufficient to allow women to gain a safety benefit from ABS.
5. These results suggest that the safety benefits of ABS would be increased, perhaps substantially, if drivers had better knowledge, or better skills, to enable them to use ABS more effectively and/or avoid undue reliance on the protection they think it offers. There would therefore appear to be a case for considering how ABS should be dealt with in both the theory test and practical driving test, and for identifying a braking procedure suitable for both ABS and non-ABS cars.
6. A second implication of the results is that improved training and education may not be sufficient to allow all groups of drivers to benefit from ABS. Given the size of the improvement in safety that might be expected if all drivers maximised their benefit from ABS, it would be worth exploring why women and older men tend not to benefit.
7. Results from the USA indicate that the safety benefits of ABS increase as drivers gain experience with ABS-equipped cars, and that drunk drivers who are inexperienced with ABS are at particularly high risk.
Antilock braking systems: do they reduce accidents?

Acknowledgments
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References


The effect of new technologies on speed distributions

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Introduction

A multitude of literature confirms the negative effect of speed on road safety. To complement this there are numerous studies that have investigated the effects that various ‘traditional’ safety improvements have had on vehicle speeds and consequently accidents. New technologies, in particular Intelligent Speed Adaptation (ISA), now offer the possibility of traffic calming through the vehicle. Studies on the safety impact of ISA have typically either considered the effect of speed control on particular accident types or have estimated accident reductions based upon an overall reduction in mean speed. Considering only accidents that are clearly speed related ignores the fact that reduced speed allows the driver more reaction and evasion time. This reduces the likelihood of an accident situation arising, increases the chances of an avoidance action being successful and reduces the severity of impact should the evasive action be unsuccessful. Reducing speeds will therefore impact upon a wider range of accident types than just those accidents which are clearly related to excessive speed. On the other hand, considering only the relationship between accidents and speed does not account for the ability of ISA to impact more severely on accidents that occur at higher speeds. Neither method can be considered satisfactory since both include some implicit assumptions about the shape of the speed distribution overall. The advanced technologies currently being considered have the ability to change the speed distributions so dramatically that these methodologies and the associated assumptions are invalidated. In particular they create a ‘spike’ of persons travelling at or just below the speed limit set by the system (Tate, 1997).

In order to assess the potential benefits of such new technologies it is important to clearly establish:

- the link between the accident liability of individuals and their location within the speed distribution, and
- the likely pattern of relocation when drivers who would typically travel at higher speeds are limited in their speed.

Method

Using a within subjects design, the experiment required participants to undertake three drives in the Leeds Advanced Driving Simulator:

1. Control Drive – a drive with no additional technology
2. Advisory System – a drive with an in-vehicle display showing the current speed limit for information only
3. Mandatory System – a drive with a system that displayed the current speed limit and controlled the vehicle such that the speed limit could not be exceeded.
The drivers were nominally allocated to one of four groups based on their volume of travel and accidents during the last five years. Although this restricted time limit was not ideal, initial investigations suggested that some drivers had difficulty estimating their average mileage and accident involvement over longer periods. These four groups formed the basis of a counterbalanced design for order effects.

The route was the same for each experimental drive and covered an urban CBD (central business district) environment under light traffic conditions, and urban arterial, rural road and motorway driving. Within each environment drivers encountered a range of situations as set out in Table 1.

Table 1: Road environment and situations

<table>
<thead>
<tr>
<th>Situation</th>
<th>Urban</th>
<th>Arterial</th>
<th>Rural</th>
<th>Motorway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed limit (mph)</td>
<td>30</td>
<td>40</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>Length (km)</td>
<td>4</td>
<td>2</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Free speed</td>
<td>Unconstrained</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Following</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Gap acceptance</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Red light running</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overtaking</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

The major analysis carried out was as follows.

1. Examining the correlations between the various negative behaviours observed in the Control (no ISA) condition
2. Cluster analysis to determine if relatively homogeneous subject groups could be determined on the basis of the observed unsafe behaviours
3. Modelling by regression of how the observed behaviours together with subject characteristics (age, gender, driving experience) were able to predict self-reported accident involvement rates
4. Analysis of the effect of ISA, both Advisory and Mandatory, on the negative behaviours
5. Modelling of the predicted impact of ISA on accident rates, by applying the models developed in (3).

Of necessity, only a brief summary of this extensive analysis can be presented here.

Negative behaviours in normal driving

Figure 1 shows that, as in real life, speeding was most common on the urban roads and motorways. From Figure 2 it can be seen that mean time headways while car following tended to be shorter on the rural roads and motorways than on the urban roads. The largest amount of very close following, at less than one second, tended to be on the rural roads. This is perhaps related to the smaller amount of speeding observed there: drivers may have become impatient at their inability to speed and so 'pushed' against the vehicle in front.
For the rural roads, speed choice on the straights was compared to speed choice on the curves. As can be observed from Figure 3, speed on the first straight was highly correlated ($p < 0.01$) with speed on subsequent curves, indicating that drivers who chose high speeds on straights also drive fast in curves. The same conclusion can be drawn from Figure 4, which shows the same type of relationship for the second straight, and from Figure 5, which looks at overall speed choice on the rural roads compared to speed in the curves. Here all the correlations are greater than 0.9 ($p < 0.01$), but they are less strong on the sharper curves, where geometry has more of a role. All these relationships on consistency of speed behaviour are approximately linear.
The effect of new technologies on speed distributions

Note: ** denotes the correlation is significant at the 0.01 level.

Figure 3: Speed on Straight 1 compared to speed on subsequent curves

Straight 1 vs Curve Radius 230: \( r = 0.925^{**} \)
Straight 1 vs Curve Radius 55: \( r = 0.768^{**} \)

Note: ** denotes the correlation is significant at the 0.01 level.

Figure 4: Speed on Straight 2 compared to speed on subsequent curves

Straight 2 vs Curve Radius 509: \( r = 0.797^{**} \)
Straight 2 vs Curve Radius 230: \( r = 0.735^{**} \)
Free speeds and headways were significantly negatively correlated with each other at the 0.01 level. The percentage of travel time exceeding the speed limit and of travel time when the headway is less than two seconds were positively correlated with each other at the 0.01 level. These findings indicate that drivers who drive fast will tend to follow the lead car closely.

The strength of the correlations between speed and headway varies across road environments as can be seen from Table 2; the strength reduces from left to right in the table. This trend implies that drivers are more influenced by other factors in the traffic situation and so less 'free operators' on urban roads than on rural roads. On motorways they were more able to avoid close following by changing lane and overtaking. Figure 5 shows that speed in the rural curves was negatively correlated with mean headway, but less so on the sharp curves where geometry acted more as a constraining factor.

**Table 2: Correlations between speed and headway**

<table>
<thead>
<tr>
<th>Pair of safety measures</th>
<th>Rural</th>
<th>Urban</th>
<th>Arterial</th>
<th>Motorway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean free speed &amp; mean headway</td>
<td>-0.746**</td>
<td>-0.534**</td>
<td>-0.504**</td>
<td>-0.327**</td>
</tr>
<tr>
<td>Max free speed &amp; min headway</td>
<td>-0.651**</td>
<td>-0.542**</td>
<td>-0.470**</td>
<td>-0.351**</td>
</tr>
<tr>
<td>% of travel time exceeding the speed limit &amp; % of travel time when headway &lt; 2 sec</td>
<td>0.671**</td>
<td>0.587**</td>
<td>0.476**</td>
<td>0.310**</td>
</tr>
</tbody>
</table>

Note: ** denotes the correlation is significant at the 0.01 level.

Gap acceptance in left turns was significantly negatively correlated with mean free speed ($r = -0.393$, $p < 0.01$) and with percentage of travel time exceeding the speed limit ($r = -0.299$, $p < 0.01$), but the correlation between speed and gap acceptance in right turns was not significant. Neither in left nor right turns was gap acceptance correlated with mean headway.
Cluster analysis to derive homogeneous groups of drivers

A number of different indicators of self-reported accident rate were tested. The measure with the strongest correlation with other safety indicators took into account both on-road accidents and various kinds of parking incidents (parking accidents and parking ‘bumps’). The denominator for calculating rate was reported annual mileage. This rate correlated with 12 other safety indicators at the \( p < 0.05 \) level; it was used in this and all subsequent analysis.

The original groupings on which the subject selection was based did not reveal any robust differences. So, using cluster analysis, a number of alternative groupings were evaluated. In the end, the most powerful grouping was one in which subjects were classified into two groups by the accident rate. Group 1 was ‘safe’ drivers, with high annual mileage and low accident involvement; Group 2 was ‘dangerous’ drivers, with low annual mileage and high accident involvement, as shown in Table 3.

Subjects from Group 1 consistently behaved more safely than those from Group 2 across all safety measures, although not every pair of comparison of the safety measures between these two groups was able to show significant difference. The trend of changes in the safety indicators between the groups is summarised in Table 4. The riskier group drove faster and adopted shorter headways.

<table>
<thead>
<tr>
<th>Table 3: Comparison of accident risk groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criterion</td>
</tr>
<tr>
<td>Accident rate (No. of accidents per 1,000 miles)</td>
</tr>
<tr>
<td>Annual mileage (1,000 miles)</td>
</tr>
<tr>
<td>Accident involvement (No. of accidents per year)</td>
</tr>
</tbody>
</table>

Note: Figures shown in cells are group means.
** denotes the correlation is significant at the 0.01 level.

<table>
<thead>
<tr>
<th>Table 4: Differences in safety indicators between the accident risk groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety measure</td>
</tr>
<tr>
<td>Mean speed</td>
</tr>
<tr>
<td>% of travel time exceeding speed limit</td>
</tr>
<tr>
<td>Mean headway</td>
</tr>
<tr>
<td>% of travel time at short headways</td>
</tr>
</tbody>
</table>

Regression modelling on accident rates

The independent variables used as candidate predictors of accident rates in the regression modelling were sex, age, driving experience, mean free speed and a number of measures of headway. The dependent variable was the overall self-reported accident rate, not a rate for the particular class of road. The procedure adopted was a backwards stepwise approach in which at least one indicator of speed and one indicator of headway were forced into the models, as were a minimum set of the demographic variables. The stepwise process was stopped when explained variance \( (R^2) \) dropped by a substantial quantity.
According to these criteria, the best fitting models were as follows:

Urban roads: accident rate = -0.1811 + 0.0926 sex - 0.0046 driving experience + 0.0055 mean free speed + 0.0011% headway < 1 sec \( (R^2 = 0.1934) \)

Arterial roads: accident rate = -0.6783 + 0.0451 sex - 0.0050 age + 0.0022 mean free speed + 0.1980 mean headway + 0.0032% headway < 1 sec + 0.0061% headway < 3 sec \( (R^2 = 0.1892) \)

Rural roads: accident rate = -0.4475 - 0.0042 sex - 0.0197 driving experience + 0.0185 age + 0.0053 mean free speed - 0.0013% headway < 1 sec + 0.0011% headway < 2 sec \( (R^2 = 0.2387) \)

Motorways: accident rate = 0.6165 + 0.0534 sex - 0.0058 driving experience - 0.1007 mean headway \( (R^2 = 0.1817) \)

The most powerful of the models is that for rural roads, indicating perhaps that in that environment drivers were more able to exhibit their risky behaviours. The models are able to explain a substantial portion of individual differences in accident risk.

**Effect of ISA on negative behaviours**

The effects of ISA were examined in terms of both speed and headway. Table 5 compares speed and headway between the Control and Advisory ISA conditions; Table 6 compares the Control and Mandatory ISA conditions. With Advisory ISA, speed is slightly reduced and mean headway increases, although not significantly. With Mandatory ISA, speed is substantially reduced except on the rural roads where there was relatively little speeding in the Control condition. Where there is significant change in headway, it is the safer direction (on rural roads headway reduces, but not significantly).

Another negative behaviour, red light violations, also reduced with Mandatory ISA as shown in Table 7. But this reduction was only for the safer drivers (those in Group 1). The more risky drivers in Group 2 had an increased number of red violations both with Advisory ISA and, although to a lesser extent, with Mandatory ISA. This confirms other findings: ISA has been shown in previous experiments to reduce red light violation, but it has also been shown to result in frustration and negative behavioural adaptation. Here the negative adaptations seem to be limited to the more risky drivers.

### Table 5: Comparison of safety indicators between Control and Advisory conditions

<table>
<thead>
<tr>
<th>Road type</th>
<th>Mean free speed (mph)</th>
<th>Mean headway (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Advisory</td>
</tr>
<tr>
<td>Urban</td>
<td>87</td>
<td>33.52</td>
</tr>
<tr>
<td>Arterial</td>
<td>87</td>
<td>44.01</td>
</tr>
<tr>
<td>Rural</td>
<td>48</td>
<td>50.74</td>
</tr>
<tr>
<td>Motorway</td>
<td>81</td>
<td>74.00</td>
</tr>
</tbody>
</table>

Note: * denotes that the difference between the two systems is significant at the 0.05 level. † denotes that the difference between the two systems is significant at the 0.1 level.
The effect of new technologies on speed distributions

Modelling of the predicted impact of ISA on accident rates

The regression models developed from the non-ISA (Control) condition were applied to the data gathered with the Advisory and Mandatory systems. The models used for this purpose were those with all the candidate variables because with these the $R^2$ was highest. Table 8 shows the predicted change with Advisory ISA, for all drivers and for the drivers in Group 1 (safe) and Group 2 (unsafe). There is little overall change, and for Group 1 even a small increase in predicted accident rates on some road categories. But for Group 2, there is reduced accident risk on every road category, with significant effects on the urban and rural roads. These results are perhaps a little surprising, in that it might be expected that Group 2 would be rather resistant to the effects of an advisory ISA. What the results appear to show is that even quite small changes in behaviour, induced by an Advisory ISA, will have large effects on safety for very risky drivers.

The results of the same modelling process for the Mandatory condition are shown in Table 9. They indicate a predicted reduction in accident rates on urban roads with the effect being on the risky drivers. However, the effects are much smaller than those predicted by looking at overall changes in speed distributions in the External Vehicle Speed Control project (Carsten and Tate, 2000). The difficulty here is that the model has been developed with a non-ISA speed distribution and that the parameters for the various headway variables assume a mean value of speed which is far too high for the ISA condition. Close following becomes less risky if speed is reduced, and models are needed that take into account that interaction.

### Table 6: Comparison of safety indicators between Control and Mandatory conditions

<table>
<thead>
<tr>
<th>Road type</th>
<th>Mean free speed (mph)</th>
<th>Mean headway (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Mandatory</td>
</tr>
<tr>
<td>Urban</td>
<td>87</td>
<td>33.52</td>
</tr>
<tr>
<td>Arterial</td>
<td>86</td>
<td>43.95</td>
</tr>
<tr>
<td>Rural</td>
<td>47</td>
<td>50.73</td>
</tr>
<tr>
<td>Motorway</td>
<td>77</td>
<td>74.40</td>
</tr>
</tbody>
</table>

Note: * denotes that the difference between the two systems is significant at the 0.05 level.
Note: † denotes that the difference between the two systems is significant at the 0.1 level.
** denotes that the difference between the two systems is significant at the 0.01 level.

### Table 7: Red light violations

<table>
<thead>
<tr>
<th>Condition</th>
<th>Group 1</th>
<th>Group 2</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>7</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>Advisory</td>
<td>4</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Mandatory</td>
<td>2</td>
<td>6</td>
<td>8</td>
</tr>
</tbody>
</table>

The results of the same modelling process for the Mandatory condition are shown in Table 9. They indicate a predicted reduction in accident rates on urban roads with the effect being on the risky drivers. However, the effects are much smaller than those predicted by looking at overall changes in speed distributions in the External Vehicle Speed Control project (Carsten and Tate, 2000). The difficulty here is that the model has been developed with a non-ISA speed distribution and that the parameters for the various headway variables assume a mean value of speed which is far too high for the ISA condition. Close following becomes less risky if speed is reduced, and models are needed that take into account that interaction.
Conclusions

The results confirm the original hypothesis that new technologies such as ISA may have differential effects, depending on driving style and hence risk. Individual differences between drivers can thus significantly modify the impacts of new in-vehicle systems. There is a group of drivers who have more risky behaviours across a wide range of parameters and who have elevated risk. These drivers exhibit very different responses to the new systems from those of less risky drivers.
The modelling results show the strong relationships between observed safety-related behaviours and accident risk, and confirm that ISA will bring safety benefits. However, further analysis needs to be undertaken to look at the interaction of speed and headway.

The results have confirmed that there is a strong correlation between various negative driving behaviours and that, using these behaviours, it is possible to identify a group of very risky drivers. The regression modelling indicated important relationships between observed behaviours and self-reported accident rates.

In terms of the effects of new technologies in the form of ISA, the project has indicated that there is scope for an Advisory system to reduce the accident rates of the riskiest drivers, even if other research has predicted, and the results here have confirmed, that Advisory ISA will not have a large effect overall.

References


The impact of speeding tickets on speeding behaviour

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Introduction

Exceeding the speed limit is not yet seen as an anti-social act, but the seemingly harmless offence of driving above the speed limit has real costs to society. Finch, Kompfrner, Lockwood and Maycock (1994) reported that every 1mph increase in mean traffic speed elevated accidents by about 5 per cent on UK roads. In their study of the costs of crime, Brand and Price (2000) include the non-notifiable offence of driving above the speed limit. They explain that while this offence usually causes no direct harm to people or property it can sometimes have extremely serious consequences when this action leads to vehicle crashes or increased severity of injuries. From Department of the Environment, Transport and the Regions (DETR) figures, Brand and Price (2000) deduce that illegal speed causes 300 deaths and 25,000 injuries each year. For 1998 the costs of these fatalities and injuries, including lost output, medical and ambulance and human costs, were estimated to total £885 million.

Bourne and Cooke (1993) sum up the challenge: ‘Convincing people of the dangers of speeding is not an easy task. Unlike drink driving, there has been no social stigma attached to being a speedster. The flashy executive or sporty youth with a racy car can be a fashionable role model. Moreover, no one believes that he or she is a bad driver.’ (page 180).

WHO SPEEDS?

Research has repeatedly concluded that male drivers are more likely to speed than female drivers. When responding to speeding issues, Brook (1987) reported men aged between 25 and 54 generally regarded speeding as less serious than did women. French, West, Elander and Wilding (1993) found young male drivers more associated with higher driving speeds. Waterton (1993) found men under the age of 45 years who drive over 10,000 miles per year reported high levels of traffic violations. Arnett (1996) found driving over 20mph over the speed limit was one self-reported factor that correlated positively with sensation-seeking men. Buchanan (1996) found male drivers twice as likely to commit a minor speeding offence and four times more likely to commit a serious speeding offence than female drivers. Exceeding speed limits and other traffic regulations was proposed, by Norris, Matthews and Riad (2000), as a constituent of higher male accident risk. Shinar, Schechtman and Compton (2001) found male drivers reported themselves less likely to drive within speed limits.

Analysis of the speeding behaviours and attitudes of female and male drivers lead Meadows and Stradling (2000) to conclude that greater proportions of female drivers thought that the possible adverse consequences of speeding are more likely to occur. Also, greater proportions of male drivers indicated preference for high speed, reported speeding behaviour and pro-speeding attitudes.
However, not all studies reached the conclusion that speeding is predominantly a male pursuit. Wasielewski (1984) found no link between gender and vehicle speed. Boyce and Geller (2002) believe that over three different age groups both men and women drive with the similar degrees of risk. They suggest that women are less likely to admit to risk taking while driving. Parker and Stradling (2001) found female drivers under the age of 20 reported similar speeding behaviour as male drivers in the same age group. Parker, Reason, Manstead and Stradling (1995) found that male drivers are more likely than female drivers to be involved in crashes linked to traffic violations including speeding. Interestingly, Lajunen, Parker and Stradling (1998) found women drivers reported similar amounts of anger at similar intensities to that reported by men, leading them to assume that women drivers are managing to contain their feelings of aggression to a greater extent than men.

Two population segments whose driving behaviour put themselves and other road users at risk were identified by drivers (Stradling, Meadows and Beatty, 2000). This study examined the demographic and driving characteristics of speeding, violating and thrill-seeking drivers in England. The first group was young, mostly but not exclusively male drivers. The second group was drivers from high income households, living out of town, driving larger engine cars for high annual mileage as part of their work.

Fildes, Rumbold and Leening (1994) analysed Australian research conducted prior to the Victoria Speed Camera Programme. Those drivers more likely to exceed the speed limit include drivers under the age of 34, those driving without passengers in the vehicle, and business travellers. Further categories of those likely to exceed the speed limit include: drivers who reported that they were late for their destination; those driving vehicles that were four years old or newer; drivers with a high weekly mileage in urban areas; and those who had been involved in at least one crash in the previous five years. The survey found neither the distance travelled before the interview nor that still to be travelled were significantly related to travel speed. Sex of the driver, ownership of the vehicle and tiredness did not significantly relate to travel speed. The survey distinguished between urban and rural roads. For urban roads, exceeding the speed limit was more likely for drivers who were under 34 years old, those reporting high safe driving speeds, drivers of cars less than five years old, and drivers on business with a high weekly mileage.

WHO CRASHES?

Stradling et al. (2000) showed that English drivers who speed, who violate other rules of the road, and who seek thrills when driving pose greater risks to themselves and to other road users. They argued that speeders should be constrained because 35 per cent of the car drivers in their study, who had been penalised for speeding in the previous three years, reported also having been accident-involved in that period. This compared to 22 per cent of those who had not been penalised, indicating that the kind of drivers recently caught for speeding are 59 per cent more likely to have also been recently crash-involved. However, there were no data in that study to demonstrate that such drivers had their crashes while speeding, only that speeders were more likely to have crashes.

SPEED (SAFETY) CAMERAS

When measuring drivers’ attitudes, Waterton (1993) found 29 per cent of drivers thought accidents were caused by driving too fast. Respondents’ reasons for speeding included lack of perceived danger and that speeding was not ‘dangerous driving’. Eighty per cent of respondents indicated they were in favour of the introduction of speed cameras. A follow up survey by Market Research Scotland Ltd (1994) found increasing approval of speed cameras, with more drivers perceiving speeding as a serious offence.

In a report commissioned by the DETR, Corbett and Simon (1999) examined drivers’ perceptions, beliefs and attitudes to cameras. The aim was to discover what changes occur in drivers’ perceptions, beliefs and attitudes as a result of interventions and over time. They found six factors that are likely to influence drivers’ speed.
These are estimates of the threshold speed; knowledge of the cameras’ location; proportion of working cameras; risk of being caught; likelihood of police action if photographed; likely penalty if caught by camera. While this report found promising results in the positive opinions of speed cameras held by the majority of their respondents, it warns of ‘preaching to the converted’, with those most in favour also being those drivers least likely to speed excessively. This is confirmed by Parker and Stradling (2001), who report that speeding drivers thought themselves less likely to be caught and less likely to experience disapproval from others than drivers who did not speed.

METHODOLOGY

To gain an understanding of the impact on drivers of receiving a speeding ticket through the Cost Recovery for Safety Cameras Project, a questionnaire was sent to drivers who were detected by speed cameras. Questionnaires were sent to recipients of a Conditional Offer letter produced from speed cameras in Glasgow over a two-month period, February and March 2001. A Conditional Offer letter was sent to each driver detected of exceeding the speed limit by speed cameras, requiring the recipient to either pay the fixed penalty or contest the accusation in court.

To ensure compliance with the Data Protection Act (1984) the questionnaires were sent by the Camera Enforcement Unit of Strathclyde Police on behalf of the Transport Research Institute. This method ensured anonymity as well as confidentiality. The questionnaires were sent with a time delay of two months that ensured the sample group had the requisite time period to respond to the Conditional Offer letter before receiving the questionnaire.

The questionnaire consisted of four pages of questions on drivers’ attitudes to speeding and speed cameras, and a further three pages inviting respondents to express their thoughts on speed cameras and road safety issues. The first four digits of the respondents’ postcode were provided to assist analysis of the data.

Results

Just over 500, 18 per cent, of the questionnaires were returned. The age distribution of those returning questionnaires was compared to that of those receiving questionnaires: those at the lower end of the age range were slightly under-represented.

Overall, three-quarters (73 per cent) of those receiving speeding tickets were aged between 25 and 55. Thirty-seven per cent were female, and 63 per cent male. UK national figures (DTLR, 2001) show 42 per cent of those holding a driving licence are female and 58 per cent male, with the average female driver doing a lower average annual mileage. Only 2 per cent of the males in receipt of speeding tickets were in the ‘boy racer’ age group between 18 and 24 years of age.

Of the survey respondents, three-quarters were currently in employment, less than 5 per cent were unemployed. They were from wealthy rather than poor households, 20 per cent from households with an annual household income above £50,000. Ninety-two per cent were driving cars rather than other vehicles. The majority of respondents were driving large cars, one-third of the females and half of the males were driving cars of 1.8 litres or above.

Over half of the survey respondents were not familiar with – not frequent or regular users of – the site where they were caught speeding. Analysis of the first four digits of the postcodes showed that only a quarter of those caught speeding on Glasgow City roads had Glasgow City home postcodes. Drivers from the outskirts of the
city and the rest of the Strathclyde region constituted 57 per cent of those caught. Nine per cent of drivers receiving tickets were from the remaining Scottish regions and 7 per cent had English home postcodes.

**TICKET IMPACT**

Respondents were asked about their emotional reaction on receiving the letter informing them of their speeding offence. The responses indicated that receiving a speed ticket can be a highly emotional experience.

Eighty-one per cent of respondents reported strong feelings, while only 12 per cent discussed their experience with no reference to emotions. The most frequent emotion mentioned was anger, with 45 per cent of all respondents reporting feelings of anger. While this anger was mostly at the system and the situation, there were a significant number of these angry respondents (29 per cent) who were annoyed with themselves.

Some expressed their anger and frustration:

“I am really mad – no speed limit signs up – how are people to know what the limits are?”

“I was frustrated and annoyed as I am not a speed merchant.”

“Shock, fear, concern about my driving licence, followed by annoyance and anger at myself for committing the offence.”

“I was totally angry at myself for paying money for a stupid mistake.”

Some reported an initial shock:

“My first reaction was one of dismay.”

“I received the ticket and my first reaction was dread.”

“I personally felt gutted.”

while a small but finite number reported effects over and above those changes to driving behaviour which the issue of a speeding ticket seeks to achieve:

“I felt physically sick, extremely upset and more than extremely worried. I had visions of being in jail.”

“Since the offence I am not the driver I was. I only drive now when I have to.”

for some drivers the desired effect was reported:

“The punishment was deserved and it has made me make sure I keep to the speed limit wherever I go.”

“I consider myself a competent, confident and safe driver but being caught and having to pay a fine has made me rethink – I have noticeably slowed down.”

while others were affronted by the perceived inequity of the punishment and the attack on their self-image as a driver:

“The punishment was very unfair considering how careful a driver I am.”

“It made me feel that I was not a good driver, which I am.”

Those who have reformed their driving speeds said that they had learned a lesson. Many of the speeding offenders considered themselves safe drivers. Within this group of drivers many had taken the prosecution as a wake-up call.

Some indicated they were now sensitised to their speed at camera locations:

“I certainly drive more slowly along the street with the camera that caught me last time and I am more careful to look out for speed cameras.”

“I didn’t know the road and I didn’t know to look out for the speed camera at this point.”

while others announced themselves unremediated by the experience:

“I drive my car the exact same way as I do not believe that the speed I was driving at was reckless or dangerous.”
Across both types of drivers, some were persuaded to reform their driving from the threat of accumulating points on their driving licence. “Punishment was deserved. I will drive more carefully ‘cause I don’t want to lose my licence”. However, more reported the monetary fine as a reason for slowing their speeds. “It has definitely changed the way I drive as I can’t afford more than half a week’s wages on a speeding fine”.

Punishment hurts, but some of the reactions were more extreme than the intended reduction of normal driving speed. Walter and Grusec’s (1977) statement ‘The fundamental issue of whether punishment can serve to eliminate a response or whether it produces only temporary suppressive effects has still not been resolved’ (page 24) is applicable here. While many drivers caught by a speed camera are making efforts to readjust their driving behaviour, this study finds that a large proportion remain defiant. McKeachie, Doyle and Moffatt (1976) say that punishment may be the fastest and most efficient method of teaching someone not to do something when it is not important what that person does instead. In the situation of speed cameras, it does matter what the driver does instead.

SPEED SENSITIVE AND CAMERA SENSITIVE

In addition, respondents rated their agreement with a number of attitude items. These responses were factor analysed. Among the factors was one that grouped together items telling of speed sensitivity, another labelled as camera sensitive. Table 1 displays the variables for the two factors and shows the level of agreement (Strongly Agree plus Agree) with each item.

<table>
<thead>
<tr>
<th>Table 1: Since I got the ticket</th>
<th>% agree</th>
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<tbody>
<tr>
<td><strong>Speed sensitive</strong></td>
<td></td>
</tr>
<tr>
<td>I keep more of a look out for speed limit signs</td>
<td>80</td>
</tr>
<tr>
<td>I pay more attention to my speed while driving</td>
<td>74</td>
</tr>
<tr>
<td>I look at my speedometer more often</td>
<td>73</td>
</tr>
<tr>
<td>I drive more carefully</td>
<td>58</td>
</tr>
<tr>
<td>* I drive more slowly</td>
<td>56</td>
</tr>
<tr>
<td>I allow more time for journeys</td>
<td>36</td>
</tr>
<tr>
<td><strong>Camera sensitive</strong></td>
<td></td>
</tr>
<tr>
<td>I keep more of a look out for speed cameras</td>
<td>79</td>
</tr>
<tr>
<td>* I slow down when passing any speed cameras</td>
<td>74</td>
</tr>
<tr>
<td>I take extra care when driving past the camera at which I was caught</td>
<td>66</td>
</tr>
</tbody>
</table>

These appear initially to be encouraging levels of agreement. However, cross-tabulation of two core attitude items (shown as * in Table 1) and then of scale scores derived from the two factors, shows three separable groups:

- those who now drive more slowly necessarily including driving slowly past cameras (41–56 per cent);
- those who only slow down at cameras and are not driving more slowly otherwise (30–32 per cent); and
- those doing neither (14–15 per cent).

These results are summarised in Tables 2 and 3.
Those scoring high on the speed sensitive items are drivers who have taken the prosecution as a remediating exercise and have lowered their speeds and now attempt to take more care when driving. Camera sensitive drivers report that since being prosecuted they have made changes to their driving to ensure cameras will not detect them in the future.

Of interest to road safety concerns were those respondents who reported an unwanted change in their driving behaviour. These changes included re-focusing of the driver’s attention and distraction from driving. For some drivers, the experience was so extreme that they reported a dramatic change in their driving:

“Since the offence (speeding) I am not the driver I was, I only drive now when I have to.”

It may be that in some cases it is genuinely true that a warning would have been sufficient to encourage these drivers to keep within speed limits. The prosecution process in these cases had a more powerful effect than was intended.

Other drivers worryingly confessed to redirecting their attention from careful driving to over-vigilant scanning for speed cameras:

“I am now paranoid about cameras and spend more time looking for them than concentrating on other road hazards.”

While there may be some over-emphasis of this behaviour by disgruntled speeders, it is hoped that camera installation does everything possible to reduce the amount of distraction and sudden slowing of the vehicle they could cause.
Conclusion

The study begins to create a picture of how the driving public reacts to speed cameras. Analysis of the questionnaire reveals the wide range of reactions and emotions unleashed by going through the speed camera prosecution process.

Initial analysis has shown that receiving a speeding ticket produces aversive emotional reaction, but does it bring about a change in driving behaviour? Issuing speeding tickets has mixed specific deterrent effects even in the short term, with half of drivers sensitive to their speed and driving more slowly, one-third only slowing down for speed cameras, and one-sixth reporting themselves unremediated and not slowing down at all two months after receiving their ticket.

The most effective way to change people’s behaviour and bring about sustainable change integrated into their behavioural repertoire is to make it as easy as possible for them to change. This means conformity rather than mere compliance. Hogg and Vaughan (1995) define conformity as ‘deep seated, private and enduring change in behaviour and attitudes due to group pressure’ (page 601) whereas compliance is a ‘superficial, public and transitory change in behaviour and expressed attitudes in response to requests, coercion or group pressure’ (page 600). To conform to the local speed limit requires that the driver knows the answer to two core questions: ‘How fast am I going?’ and ‘What’s the speed limit round here?’. Obtaining the answers to these questions, without substantial distraction from the driving task, is more difficult than it need be.

Ten per cent of the respondents referred to ‘frustration’ to explain their feelings. One source of frustration was the opinion that the speeding offence was not a serious crime or sometimes not a crime at all. As Corbett (2001) discusses, this view appears to be held by many speeders and is of concern if speeding is to be tackled effectively. One quote, which expresses the view many respondents had, was “The punishment was very unfair considering how careful a driver I am and the standard of driving on the roads at this time”. The feeling that the driver was a ‘good driver’ was very common. Being caught by the speed camera did not fit with this self-image, “It made me feel that I was not a good driver, which I am”. If the aim is to change driver behaviour, then encouraging drivers to reflect on and redefine the notion of ‘the good driver’ may be necessary.

References


Waterton, J (1993). *Scottish Drivers’ Attitudes to Speeding*. Central Research Unit, Scottish Office.
10
International review of Driver Improvement Schemes

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Introduction

In 2001 the Road Safety Division of the Department for Transport, Local Government and the Regions (DTLR) commissioned Ross Silcock (a member of the Babtie Group) to undertake an international review of Driver Improvement Schemes consisting of two main strands:

(a) undertake an extensive review of Driver Improvement Schemes overseas and
(b) produce a literature review of studies evaluating the effectiveness of these schemes.

This paper draws upon the above ongoing research project and provides some background to the current UK National Driver Improvement Scheme (NDIS) and the policy context with regard to the potential expanded use of NDIS within the UK. The project methodology and some descriptions of the use of driver improvement schemes for 'problem drivers' in Australia, New Zealand and Europe emerging from the research are also presented.

Background to the UK National Driver Improvement Scheme

BACKGROUND

A brief history of the development of NDIS is provided within the Association of National Driver Improvement Scheme Providers (ANDISP) document National Driver Improvement Scheme Guidelines for Instructors (1998). It is explained that a recommendation of the Road Traffic Law Review in 1988 (known as the North Report) was that:

'A pilot study of one day retraining in basic driving skills as a disposal should be undertaken to determine whether such retraining produces a lasting improvement in the driving skills of the offender undertaking it.'

The Devon County Council Road Safety Unit, in consultation with the Devon and Cornwall Constabulary and the Crown Prosecution Service, consequently developed an experimental Driver Improvement Scheme, which was first operated at Devon Drivers’ Centre in September 1991. After an initial evaluation in 1992, the scheme was made available throughout Devon for offenders involved in a crash and facing prosecution for 'driving without due care or consideration'. In 1993, Cornwall was also included in the scheme.
In 1995 Her Majesty’s Inspector of Constabulary noted the Devon scheme as good practice, and the scheme was awarded the Prince Michael of Kent Road Safety Award in 1997.

Burgess and Webley (1999) advised that:

‘The content, structure and administrative system of the course became known as the “Devon Model”, which has been accepted by the National Service Providers Group as a National Model for all NDIS courses offered elsewhere in the UK.’

NDIS has consequently been taken up by over 30 police forces, who refer candidates to a number of service providers throughout the UK. Devon and Cornwall Constabulary found that 85 per cent of candidates who were offered the choice of attending the scheme accepted.

**POLICY CONTEXT**

An important aspect of NDIS in the UK is that drivers who choose to complete the course do not have to face prosecution for the original offence of careless driving. The drivers have to pay the cost of the retraining they receive. The schemes in effect offer retraining for payment, rather than prosecution (and a maximum fine of £2,500, possible disqualification and penalty points if found guilty) for individuals who have committed careless driving errors.

NDIS has not been incorporated into national legislation and the discretion to offer the option to attend a scheme rests with the police, who decide whether to institute proceedings for offences. At the moment only a retest or extended retest (not a driver improvement course) can be included as a sentencing option in UK courts. *The Highway Code* (Driving Standards Agency, 1999) states:

‘Where a court disqualifies a person on conviction for *Causing death by dangerous driving* or *Dangerous driving* it must order an extended retest. The courts also have discretion to order a retest for any other offence which carries penalty points: an extended retest where disqualification is obligatory, and an ordinary retest where disqualification is not obligatory.’

It is useful to note, however, that the courts do not always apply these sentencing options correctly. Previous research (Pearce, 1996) has shown that many drivers convicted for dangerous driving did not have a retest imposed as part of their sentence (38 per cent did not in 1995). Also in many cases the retest imposed is standard rather than extended (in 1995 only 31 per cent were extended retests).

The Government’s road safety strategy *Tomorrow’s roads: safer for everyone* (DETR, 2000) states:

‘10.35 We are considering how the courts might be able to send convicted offenders on retraining courses (such as Driver Improvement Schemes) as part of their sentence. This would require primary legislation.

‘10.36 We will also examine ways of extending retraining to other penalties involving re-testing, now that a fairly standard training package is available. To include training would emphasise that re-testing is a safety measure, not simply another punishment.’
The Government paper *Road Traffic Penalties. A Consultation paper* (Home Office, December 2000) proposes a new penalty point system with a quota of up to 20 points and states:

‘9.2 … Driver retraining and improvement programmes should form a constructive part of the “penalty” in a wide range of cases.’

Comments are invited upon the following proposal within the document:

‘Proposal 2 Retraining
It is our intention that those receiving an endorsement or penalty points which take their points total up to or beyond 10 points – halfway to totting up – should ideally be offered automatically the opportunity to attend, at their own expense, a driver retraining and improvement programme. This practice would inevitably entail gradual implementation. Successful completion of the course would earn remission of 5 points.

‘Those disqualified for a period of over 56 days up to and including 12 months should be automatically offered the opportunity to attend, at their own expense, a driver retraining and improvement programme. Successful completion of the programme would earn remission of 20% of the period of disqualification. The opportunity of a driver retraining and improvement programme should however be available no more frequently than once in 2 years. Those whose further offences suggested that they had not benefited by a recent course should not be eligible to reduce the sentence by attending another one.’

Methodology

**INTRODUCTION**

The primary source of information on the evaluations of Driver Improvement Schemes was through literature searches. The primary method of obtaining information on the operation of such schemes was through the use of a questionnaire. The questionnaire was designed so that it could be sent to individuals from operating authorities, scheme providers or road safety and driver improvement ‘experts’ in countries where Driver Improvement Schemes may operate. In the eventuality of no suitable person being found who was willing to complete the questionnaire, then it provided a pro-forma for gathering information through other means.

In some cases it was not possible within the resources and time available to identify an individual willing to complete a questionnaire or provide information on Driver Improvement Schemes for some areas or jurisdictions. However, summary information was often obtained from other sources. These included previously published documents providing a basic summary description of all schemes within one country, for example. Evaluation reports of a particular scheme (obtained from literature searches) also usually contained a summary description of the scheme being evaluated. A further source of information was from the numerous web sites that exist for government and local authority departments, many of which include information on driver licensing, and how to enrol for their Driver Improvement Scheme, for example.

It is considered that in most cases, at the very least, a summary level of information was obtained, and this was sufficient to be able to identify the schemes of particular interest and which merited more resources for investigation. Further detailed investigation was not considered worthwhile for other schemes of less apparent use to the project.
QUESTIONNAIRE DESIGN

It was important to define what was meant by a 'Driver Improvement Scheme' within our questionnaire. At the beginning of the questionnaire we provided a background description of the project, which included a brief description of the UK situation and the type of scheme that we were interested in obtaining information about. These were schemes (some of which are compulsory, others may be voluntary) that offer retraining to 'problem drivers', who are judged to be those with a higher than average risk of further violations or involvement in crashes.

Because of the different nature of drink or drug driver rehabilitation schemes, it was deemed that, as a general rule, these schemes would be excluded from the study.

It was expected that countries, states or provinces who were most likely to have Driver Improvement Schemes would be those based in Europe, Australasia and North America. Accordingly, efforts to obtain information were focused on (but not limited to) examples of schemes in these locations.

The questionnaire was designed to seek information regarding a number of issues. The research specification provided by the DTLR lists a number of issues that the review is required to cover. After further consideration of the important operating features of the UK NDIS, and through discussion with the client, this list was expanded. Comments on the questionnaire were also received from the UK ANDISP. The issues that the questionnaire is intended to cover can be summarised thus:

- Is attendance voluntary/compulsory?
- For what offences are the courses used?
- Is attendance instead of or in addition to other penalties?
- Who pays?
- Which offenders are eligible?
- What is the syllabus content?
- Is the syllabus defined by central government/courses approved by authority?
- What is the objective of the course (recidivism/accident prevention etc)?
- Does the course consist of classroom/practical sessions?
- Are courses tailored to offence type?
- Who are the course operators: driving schools/authorities?
- How many operators are available to attendees?
- By whom and how are courses assessed and monitored?
- Are there any evaluations of course success?
- What is the take up by eligible persons?
- What are the failure rates?
- History of course introduction. (What did it replace? Why introduced? Any changes made since being introduced?)
- Are there any perceived problems with courses: authorities/users?
- Are there any plans for changes to the system in the future?

Emerging results

The project has not yet been completed, and information on the operation of schemes is still being collected, compiled and analysed. However, some key features of schemes operating in Australasia and Europe are summarised and tabulated within Tables 1 and 2. It should be noted that at this stage some of this information is still to be verified, and will be analysed and presented in detail in the final reporting for the project. The final reporting will also include schemes from North America and the rest of the world.
### Table 1: Summary description of schemes in Australasia

<table>
<thead>
<tr>
<th>State/country</th>
<th>Type of offender</th>
<th>Attendance</th>
<th>Scheme instead of penalties?</th>
<th>Tuition method</th>
<th>Trainer qualifications</th>
<th>Assessment of attendee</th>
<th>Is course tailored to offence?</th>
<th>Course provision monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>New South Wales</td>
<td>Serious or repeat offenders (eg dangerous driving, excessive speed, unlicensed driving)</td>
<td>Attendance is optional</td>
<td>Penalty may be moderated or waived by magistrate upon completion of course</td>
<td>Classroom lectures and video presentations</td>
<td>None required – volunteers are used</td>
<td>To be obtained</td>
<td>No indication that course content differs between type of offender</td>
<td>To be obtained</td>
</tr>
<tr>
<td>South Australia</td>
<td>Drivers under 25 years of age who are disqualified</td>
<td>Compulsory</td>
<td>Driver also subject to the normal penalty for the offence</td>
<td>Group classroom session lasting 1.5 hours</td>
<td>No educational qualifications, but require training and experience</td>
<td>No assessment</td>
<td>No indication that course content differs between type of offender</td>
<td>Regular monitoring ensuring adequate course content</td>
</tr>
<tr>
<td>Western Australia</td>
<td>Only minor offenders</td>
<td>Minor offenders are offered the option</td>
<td>The course is instead of the ordinary penalty</td>
<td>Home study for 1 hour</td>
<td>No teachers, as it is home based</td>
<td>Written test requiring a 90% pass mark</td>
<td>No indication that course content differs between type of offender</td>
<td>Home based, so no monitoring</td>
</tr>
<tr>
<td>New Zealand</td>
<td>Any offender may be ordered to attend course, but mostly disqualified drivers</td>
<td>Compulsory</td>
<td>Attendance is in addition to normal penalties</td>
<td>Classroom (8 hours) and practical driving assignments</td>
<td>Must meet a minimum education criteria and be registered with Authority</td>
<td>Is a pass/fail, nearly all who persevere will pass</td>
<td>No – just a general course for all</td>
<td>Courses are monitored by government compliance officers</td>
</tr>
</tbody>
</table>

**Australian Capital Territory** – no current courses for other than drink drivers, and no plans to introduce them.

**Northern Territory** – no current courses for other than drink drivers, and no plans to introduce them.

**Queensland** – no current courses for other than drink drivers, and no plans to introduce them.

**Tasmania** – no current schemes, and no plans to introduce them due to lack of evidence as to their effectiveness.

**Victoria** – there is a current scheme operating through one magistrates’ court. This runs independently of input from State road safety agencies. Little detail is available regarding this scheme. Earlier schemes operated in Victoria from 1982, but were discontinued, as evaluation showed there was no benefit in accident reduction.
<table>
<thead>
<tr>
<th>Country</th>
<th>Type of offender</th>
<th>Attendance</th>
<th>Scheme instead of penalties?</th>
<th>Tuition method</th>
<th>Trainer qualifications</th>
<th>Assessment of attendee</th>
<th>Is course tailored to offence?</th>
<th>Course provision monitoring</th>
</tr>
</thead>
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<tr>
<td>Austria</td>
<td>Usually novice drivers who commit serious violations (eg excess speed, accidents involving injury, hit and run). Experienced drivers may also be asked to attend</td>
<td>Compulsory for those ordered on the course</td>
<td>No additional penalty for novice drivers (diversionary), but experienced drivers also receive usual sanction</td>
<td>Group discussions and in-car training, plus some study</td>
<td>Psychologists with 3 years’ experience as well as introduction course</td>
<td>Not graded, but receive a certificate of attendance. Must participate</td>
<td>Different courses for alcohol versus other offences</td>
<td>Operators are approved by the Ministry of Transport, but there is no regular monitoring. There is a Quality Assurance requirement</td>
</tr>
<tr>
<td>Belgium</td>
<td>Mostly young offenders, and includes those involved in accidents, and speeding drivers</td>
<td>Attendance is voluntary</td>
<td>The course is diversionary</td>
<td>Group discussions</td>
<td>Trainers are psychologists and social workers</td>
<td>There is no assessment</td>
<td>No indication that course content differs between type of offender</td>
<td>Evaluation is conducted for courses</td>
</tr>
<tr>
<td>France</td>
<td>Anyone convicted of careless driving (eg speed, seatbelt, or traffic light violations)</td>
<td>Attendance is voluntary, and is used to partially regain points on a licence to prevent disqualification</td>
<td>No additional penalty</td>
<td>Classroom teaching</td>
<td>Trainers are traffic psychologists and driving teachers</td>
<td>Information to be translated</td>
<td>Information to be translated</td>
<td>Information to be translated</td>
</tr>
<tr>
<td>Country</td>
<td>Type of offender</td>
<td>Attendance</td>
<td>Scheme instead of penalties?</td>
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<tr>
<td>Germany</td>
<td>Various, depending on course type: excess demerit points, novice drivers with a serious violation or two minor, repeat offenders, or drivers wanting to reduce demerits</td>
<td>Various: some are compulsory for all, others are compulsory dependent on the magistrate, others are voluntary (to reduce demerits)</td>
<td>For some types of offenders (those losing all demerit points, or for young serious offenders), courses are in addition to other penalties, others are diversionary</td>
<td>This depends on the type of course. Some involve classroom, car training and homework, others just classroom</td>
<td>This depends on the type of course. For some, driving instructors are used, while for others, psychologists. Police are also used for some</td>
<td>No examination, but appearance at course, activity during lessons, and homework are required to receive certificate</td>
<td>In some areas, and for some courses, the content is tailored to the type of offence</td>
<td>Some course types are monitored, others may be (depending on Federal authority), others have no monitoring</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Those committing speed or road rage violations</td>
<td>Once selected, attendance is compulsory</td>
<td>Course attendance may be in addition to other penalties, or ordered alone</td>
<td>One day of teaching, and 6 hours of in-car training</td>
<td>Road traffic experts – generally driving instructors with special training</td>
<td>There is a theory and practical test</td>
<td>General courses differ to alcohol courses</td>
<td>There is no regular monitoring</td>
</tr>
</tbody>
</table>

**Denmark** – There are currently no schemes in Denmark.

**Finland** – There are alcohol-related courses, but not for other types of offences.

**Greece** – There are currently no schemes in Greece.

**Ireland** – There are currently no schemes in Ireland.

**Italy** – There are currently no schemes in Italy.

**Luxembourg** – There are currently no schemes in Luxembourg, but there are plans to introduce them in future in association with a penalty point system.

**Netherlands** – There are no schemes in the Netherlands.

**Norway** – There are currently no schemes in Norway.

**Portugal** – Anecdotally, there are thought to be some schemes in Portugal, but no details of these have yet been obtained.

**Spain** – There are currently no schemes in Spain.

**Sweden** – There are no schemes at present in Sweden, although they have been suggested in the past. The syllabi for previously proposed schemes have not been well defined, and have been rejected. It is thought difficult to define a course that would be valid for a wide variety of offenders.
Conclusion

The combination of the description and analysis of schemes operating around the world and the review of evaluations of schemes are intended to provide useful information for the potential development of Driving Improvement Schemes in sentencing, and in combination with retesting for motoring offences in the UK.

References


11
Reaching a consensus: using the Delphi method to assess expert opinion on countermeasures against unlicensed driving

D J Knox and B M Turner, Babtie Ross Silcock, 125 Pall Mall, London SW1Y 5EA

Introduction

The research reported here describes a Delphi survey and workshop of ‘experts and administrators’ completed as a final strand of a project to complete research into unlicensed driving, commissioned by the Department for Transport, Local Government and the Regions (DTLR). The overall objectives of the research as required by the terms of reference are as follows:

(a) estimate the extent of unlicensed driving, ie the proportion of drivers who drive unlicensed, the frequency and circumstance of unlicensed driving and the miles driven
(b) consider the road safety implications of unlicensed driving with reference to crash reports and self-reported accident involvement
(c) determine the characteristics of unlicensed drivers
(d) identify the motivations for unlicensed driving and the beliefs and attitudes associated with the behaviour, including consideration of possible consequences and the effectiveness of existing and possible deterrents, and
(e) make recommendations for countermeasures.

The objectives (a) to (d) have been researched as part of other strands of the project, and are reported elsewhere. The final objective (e) is that which the Delphi survey and subsequent workshop were designed to address. In addition, focus groups of potential perpetrators of unlicensed driving (also reported elsewhere) have been completed to investigate the potential of various countermeasures in the view of those who may currently drive or have previously driven unlicensed. Some results from these focus groups were used as input to the Delphi workshop.

The comments regarding countermeasures are based on personal opinion, and do not represent any organisational or Government policy on this issue.
The Delphi method

INTRODUCTION

The Delphi method originated in the 1950s and 1960s at the RAND corporation, where it was designed to improve methods of forecasting. Adler and Ziglio (1996), in their examination of the Delphi method and its application to social policy, state that:

‘Informed judgement is central to the theoretical assumptions of the Delphi process’ (page 6)

and that this judgement is the area lying between knowledge and speculation. They also state that:

‘… the Delphi process aims at structuring and distilling the vast amount of information for which there is some evidence (but not yet knowledge) in order to achieve and improve informed judgement and decision-making’ (page 6).

As well as its early use for forecasting (for instance the effects of new technologies on economic and social change), it has also been used in planning, evaluation and the assessment of policy issues. The process has recently been applied by the research team to the area of the speeding driver (Silcock, Smith, Knox and Beuret, 1999).

The Delphi methodology involves the questioning of a group of panellists to pool their judgements in order to determine a satisfactory course of action. This is achieved by a series of questionnaires, interspersed with controlled feedback. The questionnaires are designed to elicit and develop individual responses to the issues presented and to allow the participants to refine their views in the light of group feedback.

Adler and Ziglio (1996) give three considerations that are important for Delphi applications (‘to issues related to social policy and public health’):

- the problem does not lend itself to precise analytical techniques but can benefit from subjective judgements on a collective basis;
- the problem at hand has no monitored history nor adequate information on its present and future development, or
- addressing the problem requires the exploration and assessment of numerous issues connected with various policy options.

Based on the above criteria, the Delphi questionnaire process, culminating in a workshop, was considered particularly suitable for the consideration of countermeasures to unlicensed driving.

One of the main advantages of the Delphi method is that it allows a group of geographically dispersed specialists to communicate through a series of questionnaires. Other features of the Delphi method are that it:

- focuses attention on the issue being investigated
- provides a framework so that individuals from different backgrounds can work together
- minimises the tendency to follow the leader
- provides an equal opportunity for everyone involved to participate
- allows participants to refine their views in the light of group feedback, and
- produces documented records.
In theory, the Delphi method could involve several rounds of questionnaires. However, previous experience has shown that two rounds of questionnaires are effective in allowing an exchange of comments and reaching a broad consensus of opinion. The panellists may suffer fatigue from having to complete more rounds of postal questionnaire, leading to low response rates. In addition to two rounds of postal questionnaire, it was decided to hold a workshop session which selected panellists were invited to attend. This was undertaken in order to discuss the main issues arising from the questionnaire process. This also provided an opportunity to provide panellists with results from focus groups of potential perpetrators of unlicensed driving that were being undertaken in parallel with the Delphi process, investigating some of the same issues and measures as those covered in the questionnaire. Figure 1 below illustrates the stages of the Delphi process that have been used for this study.

A list of panellists was compiled by the research team and was designed to include individuals from various Government departments, administrative agencies, academic researchers and other stakeholders with an interest in reducing, or responsibility for enforcing measures to reduce, unlicensed driving. This included all the individuals who were members of the cross-departmental Unlicensed Driving Advisory Group which had been set up to provide advice during the life of the project. Individuals from the following categories of organisations were invited, and took part in the process:

- Road Safety Division of the DTLR (the client)
- Association of Chief Police Officers
- Police officers
- Driver Vehicle Licensing Agency
- Driving Standards Agency
- Driving Schools and Driving Instructors Associations
- Home Office
- Justice Clerks’ Society
- Crown Prosecution Service
- Magistrates
- Motor Insurers’ Bureau
- Motor industry groups
- Special interest groups
- Road safety researchers
• Local authority road safety staff
• Probation Service
• Young offenders institutions
• Community motor projects.

Although the panel was chosen to include knowledge and expertise from a range of organisations, it was emphasised to the panellists throughout the process that it was their individual views that we sought, not those of the organisation that they represented or that employed them. It was also stated that the process was not a formal consultation exercise and their responses would be treated confidentially.

**QUESTIONNAIRE DESIGN**

The first postal questionnaire was designed using a proven format adopted in previous research completed by the project team. A total of 37 possible measures to reduce unlicensed driving were generated by the project team from discussions and suggestions encountered during the course of the project, and from examples used in other countries identified from the project literature review. The measures were presented within the questionnaire under the following headings:

• Education and Publicity
• The Driving Test
• Driver Licensing
• Law Enforcement
• Judicial Penalties
• Other Measures
• Measures not considered above (under this heading panellists were invited to add their own ideas if they wished).

Some measures, it could be argued, could be placed under more than one of the headings, but the division of the questionnaire into sections was considered useful to assist the panellists in their deliberations. The panellists were also issued with a background paper to describe the purpose of the project and an indication of the findings from the other strands of the research so far.

The questionnaire was divided into two main sections. Within Part One of the questionnaire the panellists were asked to:

1. **Review** all the measures on the questionnaire.

2. **Make comments** on any measure and suggest clarifications, argue in favour of or against measures, ask questions, include amendments to the measures, or make suggestions for other policies or interventions not included.

3. **Rate** the level of effectiveness and acceptability of each measure (on a scale of 1 to 5). Effectiveness was defined as whether the measure would work, and acceptability as whether the general public would accept it.

An example question from this part of the questionnaire can be seen in Figure 2.
Within Part Two of the questionnaire the panellists were asked to select the combination of seven measures that they considered would make the most impact on reducing unlicensed driving.

Initially, 97 individuals were contacted to see if they would like to take part in the study. Questionnaire 1 was then issued to 77 individuals who had agreed to take part. Fifty-one questionnaires from the first round were returned before the deadline (a response rate of 66 per cent).

The results and comments received as part of Questionnaire 1 were then compiled and presented within Questionnaire 2, alongside the listed measures. An additional ten measures were added to Questionnaire 2 in response to comments and suggestions received in Questionnaire 1. The panellists were then asked to complete the same tasks in Questionnaire 2, in light of the responses to the first questionnaire. An example question from Questionnaire 2 can be seen in Figure 2.

The second round questionnaire was issued to 78 individuals (including an additional person whom it had not been possible to contact previously) and a total of 50 were returned before the deadline (a response rate of 64 per cent).

Figure 2: Example question from Delphi Questionnaire 1

<table>
<thead>
<tr>
<th>Measure 35</th>
<th>Comments</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Require employers to check employees’ driving licences if driving is part of the job requirement: a) when taking on staff; and b) periodically afterwards</td>
<td>Please insert here any comments you would like to make</td>
<td>E 1 2 3 4 5  A 1 2 3 4 5</td>
</tr>
</tbody>
</table>

This measure was considered to be effective and of average acceptability. This measure was widely welcomed by respondents and it was considered by many that it should already be undertaken.

Previous Rating:
E: Mean = 2.00
A: Mean = 2.13

New Rating:
E 1 2 3 4 5
A 1 2 3 4 5

Figure 3: Example question from Delphi Questionnaire 2

<table>
<thead>
<tr>
<th>Measure 35</th>
<th>Comments</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Require employers to check employees’ driving licences if driving is part of the job requirement: a) when taking on staff; and b) periodically afterwards</td>
<td>Please insert here any comments you would like to make</td>
<td>E 1 2 3 4 5  A 1 2 3 4 5</td>
</tr>
</tbody>
</table>

This measure was considered to be effective and of average acceptability. This measure was widely welcomed by respondents and it was considered by many that it should already be undertaken.

Previous Rating:
E: Mean = 2.00
A: Mean = 2.13

New Rating:
E 1 2 3 4 5
A 1 2 3 4 5
RESULTS AND ANALYSIS OF DELPHI QUESTIONNAIRE SURVEY

Effectiveness and acceptability
It was important to identify those measures considered the most suitable (‘effective’ and ‘acceptable’) from the questionnaire process. Responding to Questionnaire 1, each respondent gave a rating for the effectiveness and acceptability of each potential countermeasure on a 1 to 5 scale. The overall mean ratings for effectiveness and acceptability for each of the measures listed in Questionnaire 1 were then calculated and presented within Questionnaire 2.

The results of the second round questionnaire were then calculated and the mean ratings for effectiveness and acceptability for each measure were plotted against each other as shown in Figure 4. (The numbers in the plot correspond to the numbering of the measures within the Delphi questionnaires, and in the list below the figure.)

In Figure 4 it can be seen that the further toward the top right a measure is plotted, the more effective and acceptable it was considered to be by the Delphi panel. It was thought that it would be possible to discuss around 16 measures during the time available for the workshop. Therefore a diagonal line was added to the plot to divide the 16 measures that could be considered both effective and acceptable (denoted by a solid circle) from those considered less so (denoted by a transparent circle).

A simple ranking of the measures that are considered both effective and acceptable can be obtained by simply adding up the mean effectiveness and acceptability ratings (E+A). Accordingly the measures are listed in rank order in Tables 1 and 2.

---

Figure 4: Mean effectiveness versus mean acceptability for each countermeasure
<table>
<thead>
<tr>
<th>No.</th>
<th>Measure</th>
<th>E+A</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>Tighten administrative loopholes</td>
<td>3.31</td>
<td>1</td>
</tr>
<tr>
<td>25</td>
<td>Online checking of licence details in police vehicles</td>
<td>3.35</td>
<td>2</td>
</tr>
<tr>
<td>26</td>
<td>Online checking of licence details in police stations</td>
<td>3.76</td>
<td>3</td>
</tr>
<tr>
<td>35</td>
<td>Employers to check driving licences if driving is a job requirement</td>
<td>3.83</td>
<td>4</td>
</tr>
<tr>
<td>15</td>
<td>Explain to provisional licence holders the penalties for unlicensed driving</td>
<td>3.87</td>
<td>5</td>
</tr>
<tr>
<td>18</td>
<td>Convert all licenses to photo-card licenses as soon as possible</td>
<td>4.21</td>
<td>6</td>
</tr>
<tr>
<td>28A</td>
<td>Introduce harsher penalties for repeat offenders</td>
<td>4.31</td>
<td>7</td>
</tr>
<tr>
<td>14</td>
<td>Explain to drivers at their disqualification the penalties for breaking their ban</td>
<td>4.32</td>
<td>8</td>
</tr>
<tr>
<td>29</td>
<td>Introduce a wider range of penalties for various types of unlicensed driving</td>
<td>4.33</td>
<td>9</td>
</tr>
<tr>
<td>27</td>
<td>Police (or Probation Service where appropriate) follow up/monitoring</td>
<td>4.42</td>
<td>10</td>
</tr>
<tr>
<td>33</td>
<td>Increase the use of non-disqualification penalties for motoring offences</td>
<td>4.42</td>
<td>10</td>
</tr>
<tr>
<td>24</td>
<td>Increase police resources for detection</td>
<td>4.43</td>
<td>12</td>
</tr>
<tr>
<td>28</td>
<td>Harsher penalties for unlicensed driving</td>
<td>4.46</td>
<td>13</td>
</tr>
<tr>
<td>4</td>
<td>Increase teaching of safe driving in schools, highlighting unlicensed driving</td>
<td>4.54</td>
<td>14</td>
</tr>
<tr>
<td>4A</td>
<td>Educate young motoring offenders in the long-term effects of committing crime</td>
<td>4.61</td>
<td>15</td>
</tr>
<tr>
<td>13</td>
<td>Explain to drivers at disqualification the start and finish dates of their ban</td>
<td>4.64</td>
<td>16</td>
</tr>
</tbody>
</table>

Table 1: Measures considered both effective and acceptable (shown by a solid circle in Figure 4)

<table>
<thead>
<tr>
<th>No.</th>
<th>Measure</th>
<th>E+A</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Reduce the expected waiting time between applying for and taking driving tests</td>
<td>4.89</td>
<td>17</td>
</tr>
<tr>
<td>8</td>
<td>Enhance public knowledge of the restrictions of the provisional licence</td>
<td>4.98</td>
<td>18</td>
</tr>
<tr>
<td>17</td>
<td>Introduce the mandatory carrying of driving licences</td>
<td>5.00</td>
<td>19</td>
</tr>
<tr>
<td>24A</td>
<td>Add traffic policing to the core functions of the police</td>
<td>5.00</td>
<td>19</td>
</tr>
<tr>
<td>19</td>
<td>Introduce mandatory smart card driving licences</td>
<td>5.17</td>
<td>21</td>
</tr>
<tr>
<td>28B</td>
<td>Use existing penalties better or reduce the discretion of magistrates</td>
<td>5.18</td>
<td>22</td>
</tr>
<tr>
<td>7</td>
<td>Increase local and national publicity on the penalties for unlicensed driving</td>
<td>5.21</td>
<td>23</td>
</tr>
<tr>
<td>1A</td>
<td>Encourage the public to report suspects to a telephone hotline</td>
<td>5.29</td>
<td>24</td>
</tr>
<tr>
<td>19A</td>
<td>Develop smart ignition systems to ban unauthorised drivers</td>
<td>5.31</td>
<td>25</td>
</tr>
<tr>
<td>2</td>
<td>Highlight the insurance cost implications of unlicensed driving to the public</td>
<td>5.34</td>
<td>26</td>
</tr>
<tr>
<td>1</td>
<td>Increase publicity on the road safety problem of unlicensed driving</td>
<td>5.43</td>
<td>27</td>
</tr>
<tr>
<td>5</td>
<td>Encourage community schemes/motor projects for the young</td>
<td>5.48</td>
<td>28</td>
</tr>
<tr>
<td>17A</td>
<td>Allow increased roadside checking of driving documents</td>
<td>5.48</td>
<td>28</td>
</tr>
<tr>
<td>20</td>
<td>Compulsory display of insurance/MOT documents in the vehicle</td>
<td>5.77</td>
<td>30</td>
</tr>
<tr>
<td>6</td>
<td>Develop guidelines for projects for young motoring offenders</td>
<td>5.78</td>
<td>31</td>
</tr>
<tr>
<td>23</td>
<td>Draw attention to the link between unlicensed driving and other crime</td>
<td>5.81</td>
<td>32</td>
</tr>
<tr>
<td>34</td>
<td>Alternatives to car to increase mobility of those without driving licence</td>
<td>5.82</td>
<td>33</td>
</tr>
<tr>
<td>35A</td>
<td>Make it a keeper’s offence ‘to allow an unlicensed driver to use a car’</td>
<td>5.84</td>
<td>34</td>
</tr>
<tr>
<td>37</td>
<td>Develop code of practice for instructors to warn pupils of unlicensed driving</td>
<td>5.87</td>
<td>35</td>
</tr>
<tr>
<td>11</td>
<td>More accessible theory test for those with low levels of literacy</td>
<td>5.93</td>
<td>36</td>
</tr>
<tr>
<td>36</td>
<td>Insurers to obtain copies of drivers’ licences</td>
<td>5.94</td>
<td>37</td>
</tr>
<tr>
<td>3</td>
<td>Publicise link between unlicensed driving and criminal activity</td>
<td>6.09</td>
<td>38</td>
</tr>
<tr>
<td>31A</td>
<td>Electronically tag the cars of unlicensed drivers to allow tracking</td>
<td>6.15</td>
<td>39</td>
</tr>
<tr>
<td>30</td>
<td>Impound the vehicles of disqualified drivers during their ban</td>
<td>6.36</td>
<td>40</td>
</tr>
<tr>
<td>16</td>
<td>Publish ‘shame lists’ of disqualified drivers in local press</td>
<td>6.53</td>
<td>41</td>
</tr>
</tbody>
</table>

Table 2: Measures considered less effective and acceptable (shown by transparent circle in Figure 4)
IMPORTANCE AND EFFECTIVENESS AND ACCEPTABILITY

The Delphi questionnaire respondents were also asked to select, in order, the seven most important measures. An importance score could then be calculated for each measure using the method of attributing seven points to the measure selected as most important down to one point for the measure selected as least important. The importance score for each measure was then plotted against the combined mean effectiveness and acceptability rating (E+A) for each measure, and this is shown within Figure 5. Solid circles have again been used to denote the measures considered both effective and acceptable, identified previously.

It can be seen from Figure 5 that nearly all the measures identified as being both effective and acceptable also obtained an above average ‘importance’ score, apart from measure 13: Explain to drivers at disqualification the start and finish dates of their ban.

Table 2: Measures considered less effective and acceptable shown by transparent circle in Figure 4 (continued)

<table>
<thead>
<tr>
<th>No.</th>
<th>Measure</th>
<th>E+A</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Improve perceived fairness of practical driving exams</td>
<td>6.57</td>
<td>42</td>
</tr>
<tr>
<td>31</td>
<td>Immobilise the vehicles of disqualified drivers during their ban</td>
<td>6.60</td>
<td>43</td>
</tr>
<tr>
<td>10A</td>
<td>Move from theoretical to simulated driving tests</td>
<td>6.76</td>
<td>44</td>
</tr>
<tr>
<td>32</td>
<td>Confiscate the cars of unlicensed drivers</td>
<td>6.78</td>
<td>45</td>
</tr>
<tr>
<td>22</td>
<td>Increase the frequency with which licenses have to be renewed</td>
<td>6.82</td>
<td>46</td>
</tr>
<tr>
<td>12</td>
<td>Means tested fee reduction for driving tests and subsidies for driving lessons</td>
<td>7.46</td>
<td>47</td>
</tr>
</tbody>
</table>

Figure 5: Mean effectiveness and acceptability of measures combined, plotted against importance score
It can also be seen from Figure 5 that a small number of further measures may also be worthy of further discussion if their importance score is taken into account, namely the measures:

17: Introduce the mandatory carrying of driving licences
24A: Add traffic policing to the core functions of the police
19A: Develop smart ignition systems to ban unauthorised drivers
5: Encourage community schemes/motor projects for the young
20: Compulsory display of insurance/MOT documents in the vehicle

THE DELPHI WORKSHOP

Following the second round questionnaire, 30 panellists were invited to take part in the workshop. Panellists were chosen so as to include individuals from a range of backgrounds, who had indicated that they would be willing to attend. A total of 20 panellists were eventually able to attend the workshop, with six members of the project team and four staff from the client organisation also present.

The main aim of the Delphi workshop was to develop further some of the issues highlighted through the Delphi questionnaire process and also to input some results from focus groups of perpetrators of unlicensed driving. The analysis described above identified the measures that were considered the most effective, acceptable and important by the Delphi panellists and which therefore warranted further discussion at the Delphi workshop. Focus groups also highlighted additional issues that were considered important by the perpetrators. It was decided to combine measures dealing with similar themes into a single ‘issue area for discussion’.

At the workshop a short presentation was given at the beginning of each ‘issue area for discussion’ where the results from the questionnaire survey for each of the related measures were described. The presentation then proceeded with a description of the views given by the perpetrators on those measures during the focus groups.

An attempt was made at the workshop to direct discussions to address the following questions:

- Should we implement this measure?
- How should it be implemented?
- What are the main barriers to implementation?
- Who should be responsible for implementing the measure?

In practice, it was difficult to address each of these four questions for each of the topics. Panellists represented a wide variety of backgrounds and interests, and even though a good deal of consensus had been reached through the earlier questionnaires, it was not possible to reach full agreement on the topics at the workshop. However, as time was allocated so that all of the measures could be debated, the issues both for and against each measure were explored.

Discussion

Although full agreement could not always be reached on appropriate countermeasures against unlicensed driving from the workshop, those measures that were considered most important were identified from the earlier questionnaires. The workshop highlighted the main caveats as to the use of such countermeasures. This information will help guide our recommendations to the DTLR.
A wide variety of organisations were able to contribute to the Delphi process, particularly at the earlier questionnaire stage. However, not all invited groups were able to attend the workshop, and this meant that input from some key organisations was missing.

In selecting the measures to take forward to the workshop, additional weighting of responses for effectiveness was considered. This is because some of the measures that were thought effective had low acceptability ratings, but it was thought possible in future to increase the acceptability of some measures. However, the ratings were left unweighted, and instead the importance scale was used. This had the effect of ensuring that measures that merited further discussion were included in the workshop, even if they had a low acceptability rating (for example, mandatory carrying of driving licences).

Conclusions

The Delphi method has proved useful in the development of countermeasures against unlicensed driving. The most effective, acceptable and important measures were highlighted through questionnaires of experts. However, there was little consensus reached at a subsequent workshop, with many measures receiving mixed levels of support. However, the workshop was useful to highlight many of the issues for and against each measure. This information will prove useful in the production of a final report which aims to present recommendations to government as to how to reduce unlicensed driving.

References


Safe mobility for older people

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Ageing – a major triumph

The collective ageing of our populations is one of the major triumphs of modern civilisation. Although all trends suggest that most older people maintain, and will continue to maintain, a substantially greater level of independence than previous generations, in later life various forms of age-related disability begin to increase. The impact of the increase in the proportion of older people on transportation has been studied in three major international reports and transportation over the last three years. The Conference of European Ministers of Transport (CEMT, 2001), the Organization for Economic Cooperation and Development (OECD, 2001), and the United States Transportation Research Board (Committee for the safe mobility of older people, in press) have all arrived at somewhat similar conclusions. These are that the greatest threats to older people are: (a) reduced mobility from a wide variety of sources (unfocussed land use, withdrawal from driving, inadequate public transport systems and hostile traffic environments); and (b) an increase in their vulnerability to serious injury and death when exposed to the traffic environment. All are unanimous that older drivers do not pose an increased risk to themselves or to other road users, a theme that will be further developed in this paper.

Transportation is very important to older people. At the White House Conference on Ageing in 1971, transportation was ranked third in importance after income and health as priorities in later life (Carp, Byerts, Gertman, Guillelmand, Lawton, Leeds and Rajic, 1980). Although environmental and other considerations may not favour increasing use of the motor car, we need to recognise that for many older people driving has become the main form of transportation. Older people do not consider that public transport is adequate or efficient, and it poses problems of security and convenience (Rabbitt, Carmichael, Jones and Holland, 1996). In the US public transport accounts for less than 3 per cent of trips by older people (Eberhard, 1996) and its use by older people has been steadily declining in both Europe and the US.

As a result, there has been an exponential increase in the number of older drivers in the developed world. In the UK there has been an increase of 200 per cent and 600 per cent respectively in the number of men and women drivers over the age of 65 between 1965 and 1985 (Department of Transport, 1991). Only 5.9 per cent of drivers in the US were over 60 in 1940: this had increased to 7.4 per cent by 1952 and to 11.4 per cent by 1960. This trend is expected to continue so that elderly drivers should comprise 28 per cent of the driving population by the year 2000 and reach 39 per cent by 2050 (National Center for Statistics and Analysis: National Highway Traffic Safety Administration, 1995). Just over one third of the population aged over 80 in Ontario, Canada was driving a motor vehicle at least once a year in (Chipman, Payne and McDonough, 1998).

Driving is a skill of huge practical and psychological importance to many older people. Maintaining social contacts, getting to appointments, access to health care and shopping are among the primary functions of driving in older age groups: 77 per cent of drivers over the age of 55 perceive driving as essential or very important (AA Foundation for Road Safety Research, 1988). The psychological importance has been referred to as the ‘asphalt identikit’ and continued driving by the elderly should be welcomed as a sign of integration.
into society (Eisenhandler, 1990). The cost of driving cessation is likely to be high: loneliness, lower life satisfaction and lower activity levels are linked with the loss of driving ability among elderly people (Marottoli, Mendes de Leon, Glass, Williams, Cooney, Berkman and Tinetti, 1997).

Societal and professional prejudice

The significance of the ageing of the driving population is vigorously debated. It could be argued that the greatest risk to older people is societal and professional prejudice, a theme familiar to geriatricians and gerontologists. If driving and adequate transportation is so important, a physician should be deliberating on fitness to drive with a view to correcting any physical or functional deficits and enabling the patient to be more comfortable, secure and safe in their driving. Several societal prejudices and processes militate against this positive approach to driving assessment. As the art/science of driving assessment is relatively young, those asked to test driving competence must appreciate these undercurrents which may impinge on a fair assessment.

The first is that the literature on health and driving is phrased predominantly in negative terms, emphasising the selection of those who should not drive rather than promoting the concept of enabling those who are affected by illness to drive through remediation. This is expressed in its most concrete form in the negative tone of fitness-to-drive regulations in most jurisdictions, despite evidence that various health care interventions can improve driving skills and ease in illnesses such as arthritis (Jones, McCann and Lassere, 1991), stroke (van Zomeren, Brouwer and Minderhoud, 1987) and cataract (Monestam and Wachtmeister, 1997). Many older drivers cease driving for health reasons, and it is possible that remediation strategies have been insufficiently explored in a proportion of this group. In one study, one in four older drivers stopped driving over a six-year period (Marottoli, Ostfeld, Merrill, Perlman, Foley and Cooney, 1993). Medical factors which predicted those who would not drive included neurological disease (Parkinson’s disease or stroke) and cataract, but interestingly not cognitive impairment. In Florida, health factors accounted for about half of decisions to stop (Campbell, Bush and Hale, 1993) and in Europe, medical and financial reasons were rated equal in importance by those who had stopped driving in later life (Rabbitt et al., 1996).

The second is a prejudice that older drivers represent an increased risk to themselves and older drivers. Evans defends older drivers as a relatively safe group (Evans, 1988) and this is supported by crash rates per driver (Figure 1). Carr has shown healthy older drivers to perform better than younger controls (Carr, Jackson, Madden and Cohen, 1992). An increase in the crash rate per miles driven in elderly populations in comparison to middle-aged controls is often quoted by the media and those seeking research grants: it is of academic interest as long as older drivers drive a lower mileage than younger drivers.

![Figure 1: Annual crash involvement per capita basis (NHTSA, 1994)](image-url)
The calculation of risk is highly complex: ironically, some of the protective measures undertaken by older people (low mileage and low speeds) may conspire to present a spuriously high risk per mile driven (Hakamies-Blomqvist and Wahlstrom, 1998). Not only are low mileages intrinsically more risky but a recent study has confirmed that when mileage is controlled, older people are as safe, if not safer than younger people (Hakamies-Blomqvist, Ukkonen and O'Neill, submitted). Also older people are more frail and crashes involving the elderly are more likely to be fatal, by a factor of 3.5 in two-car accidents (Klamm, 1985).

Two opposing viewpoints have been taken on the likely impact of increasing numbers of older drivers on crash trends. The most alarmist viewpoint is that the number of elderly traffic fatalities will more than triple by the year 2030, based on current rates. If this expected increase occurs, the number of elderly traffic fatalities in 2030 would be 35 per cent greater than the total number of alcohol-related traffic fatalities in 1995 (Burkhardt, 1998). A more optimistic approach is a reiteration of Smeed’s law, whereby increasing numbers of new drivers in a population display a diminishing number of accidents over time (Hakamies-Blomqvist and Wahlstrom, 1998).

A third problem is that health care providers are placed in an awkward situation in several states in the US, provinces in Canada and a minority of countries in Europe. In these jurisdictions it is mandatory to report drivers with certain illnesses to driver licencing authorities (Millar, 1995; White and O’Neill, 2000). In the absence of evidence-based guidelines and pathways of remediation after reporting, this process does not represent a health gain for our patients, and may even represent a loss of independence. That doctors have a difficulty with this type of legislation is typified by the effect of the introduction of compulsory reporting of drivers with dementia to the California Department of Motor Vehicles. In the years following the introduction of the legislation, there was no increase in the numbers reported. Although some of this under-reporting may stem from ignorance, it is also likely that doctors are unwilling to commit their patients to judgement by a system which is not evidence-based and seems preoccupied with keeping patients off the road.

Enabling or policing?

The medical literature on medical fitness to drive is relatively recent. It reflects societal bias and two major themes are obvious. These are (a) a relative unawareness among doctors and the rehabilitation disciplines of the functional and medical importance of fitness to drive; and (b) an over-emphasis on selecting those who should not drive rather than on enabling older drivers; Doctors are unaware both of driving habits of their patients when prescribing drugs which may affect driving (Cartwright, 1990) and of fitness-to-drive regulations (Miller and Morley, 1991; O’Neill, Crosby, Shaw, Haigh and Hendra, 1994; Strickberger, Cantillon and Friedman, 1991). Patients who attend glaucoma, syncope or dementia clinics are often not advised appropriately (MacMahon, O’Neill and Kenny, 1996; O’Neill, Neubauer, Boyle, Gerrard, Surmon and Wilcock, 1992). There may also be an element of ageism whereby doctors may assume that older patients do not drive: a review of dementia from the UK seemed to take this attitude (Almeida and Fottrell, 1991), whereas US reviewers were aware of the high number of older drivers (Winograd and Jarvik, 1986). Finally, even in the rehabilitation environment, disabled drivers and stroke victims are not offered appropriate advice and rehabilitation about driving (Barnes and Hoyle, 1995; Fisk, Owsley and Pulley, 1997).

The emphasis on negative rather than enabling aspects of medical fitness to drive is disconcerting. A typical illness with potential for enabling is arthritis. Patients experience many difficulties in driving (Thevenon, Grimbert, Dudenko, Heuline and Delcambre, 1989), despite evidence that appropriate intervention may improve driving ability and comfort (Jones et al., 1991). Many patients do not return to driving after stroke (Legh-Smith, Wade and Hewer, 1986), and rehabilitation and specialised driving re-education may return some of these to driving again (van Zomeren et al., 1987). Less than 5 per cent of the papers in the author’s database of over 1,300 papers relating to older drivers have a significant focus on enabling or rehabilitation. This bias may influence the relationship between the physician and patient. Patients attend their physicians
in the hope of remaining healthy and retaining maximum function, particularly in later life. Ideally, a physician should be considering whether or not patients are fit to drive with a view to correcting any physical or functional deficits and enabling the patient to be independent.

The emphasis of many government manuals on fitness to drive, as well as much of the scientific literature, is on who should not drive, stressing the safety of other people preceding the right of the patient to drive: in effect, conferring a policing role on physicians. From a clinical and ethical viewpoint, this poses a dilemma, and a policing mentality may have a negative impact on attitudes to older drivers. It may also deter patients from attending their physicians if they fear that disclosure of illness may result in limitation of driving.

Models of driving behaviour

There are almost no universally agreed guidelines for fitness to drive for any one illness, and there is an extraordinarily large range of existing guidelines among the states of the US (Retchin and Anapolle, 1993) and the nations of the European Union (White and O'Neill, 2000). For the academic, this represents an unrivalled opportunity to assess the validity or effectiveness of any guidelines by studying cross-national comparisons (Hakamies-Blomqvist, Johansson and Lundberg, 1996). For the clinician, the issue is not so easy. While the geriatrician is aided in the assessment and rehabilitation of problems with balance and gait by an understanding of the underlying mechanisms, driving is a complex task, and there has been a marked lack of progress in developing a comprehensive model of driving behaviour. Michon has outlined some of the criteria for models of driving behaviour, and his emphasis on a hierarchy of strategic, tactical and operational factors is the most helpful theoretical concept for clinicians (Michon, 1985). Strategic performance includes the planning of choice of route, time of day (avoiding rush hour), or even the decision not to drive and to take public transport. Tactical decisions are those aspects of the driving style which are characteristic of the driver and are consciously or unconsciously adopted for a great range of reasons, eg decisions on whether or not to overtake, go through amber lights or signal in good time before turning. Operational performance is the response to specific traffic situations, such as speed control, braking and signalling. Driving a car requires organisation of action at and between all three levels, but clinically the strategic and tactical components are the most important elements of safe driving.

Five main types of model have been explored: psychometric, motivational, hierarchical controls, information processing and error theory. A preliminary emphasis on psychometric measures relating to accident-causing behaviour has been faulted for having been conducted without the benefit of a process model of driving, for focusing primarily on accident-causing behaviours and not on everyday driving, and for relying heavily on post hoc explanations (Ranney, 1994). Some of the problems with using such post hoc research measures are: (a) restricted range of criterion and/or predictor variables, as can arise from the death of the worst drivers before they can be tested; (b) the potential effect of testing on drivers in a special category due to accident involvement; and (c) the questionable assumption that skills or attributes measured by the individual variables do not change over time.

Motivational models which distinguish between drivers’ performance limits and on-road driving offer more promise. For example, a pioneering Swedish study showed that when drivers are asked to remember road signs, the accuracy ranged from 17–78 per cent, depending on the subjective importance of the sign, ie the amount of risk involved in ignoring the sign (Johansson and Backlund, 1970). Early models emphasise transient situation-specific factors and assume risk to be a primary motivating factor.

Second generation motivational models have incorporated a hierarchical control structure which has given emphasis to motives other than risk, ie pleasure in driving, traffic risks, driving time and expense (Rothengatter and de Bruin, 1988). They also allow for concurrent activity at operational, manoeuvring and strategic levels and portray the driver as an active decision maker rather than as a passive responder implicit in
early information-processing models. The driver’s allocation of attention depends on the immediate driving situation and the driver’s motives, which include the level of risk and other motives relating to the purpose of the trip. The main research interest is in identifying factors that influence the driver’s allocation of attention among the tasks of the different control levels.

Much of routine driving is done automatically and as automaticity, which represents fast effortless cognitive processing and can occur at all three levels of control. This contrasts with control processing which is demanding of attention and resources. Automaticity can develop as a response to several types of stimuli and underlies much of experienced driving behaviour until knowledge-based problem solving is required.

Assessment

While the art/science of risk assessment is at such an underdeveloped state, it is better to live with uncertainty and apply a considered individualised clinical approach rather than to prematurely adopt guidelines with apparent face validity. This is not so different from the diagnosis of dementia, where there is no single fail-safe battery of tests: rather we work with a range of assessments, familiarise ourselves with their limitations and make a clinical diagnosis.

Risk assessment in older drivers is affected not only by our understanding of models of driving behaviour and empirical studies of disease and crash risk but also by clinical attributes common to the assessment of function in older patients. Inter-individual variability is extremely important and necessitates a case by case approach. Factors relating to age-related diseases include not only a different spectrum of illness to younger people, but also the presence of multiple illnesses. In any one patient, is it the arthritis, the dementia, the visual acuity or even the multiple medications which is affecting driving? Within the rubric of one illness there may be multiple facets. For example, there is an increased risk of crashes with Parkinson’s disease (Dubinsky, Gray, Husted, Busenbark, Vetere-Overfield, Wiltfong, Parrish and Koller, 1991; Lings and Dupont, 1992). The illness may involve problems of motor function, depression and impaired cognitive function. Rather than stating that Parkinson’s disease is dangerous for driving, it is vital to take a phenomenological approach. The depression and the motor function must be treated and cognitive function assessed and managed before any decisions are made about fitness to drive.

Any broader assessment of group risk due to illness will require careful scrutiny of the relevant literature. The source of information is critical to decision making. Did it come from a specialised clinic or from the community? Was it a large study? What level of risk is implied for our patients? A study on diabetes, epilepsy and risk of crashes (Hansotia and Broste, 1991) is a useful illustration of this. Epilepsy and diabetes are both illnesses that have been very clearly defined in many fitness-to-drive manuals, often with stringent licence restrictions and/or punitive insurance loadings. This large-scale community study demonstrated that the increased risks were in fact quite small. It is probably no coincidence that the UK Driver Vehicle Licencing Agency has subsequently relaxed the restrictions on both diabetes and epilepsy (Medical Advisory Branch, 1994). If more selected groups are studied, for example people over 65 in a Health Maintenance Organisation, the relative risk for diabetes and crashes may be higher (Koepsell, Wolf, McCloskey, Buchner, Louie, Wagner and Thompson, 1994). As in any application of the medical literature, the physician has to relate the sample population to his own practice.

The Insurance Corporation of British Columbia’s studies gives a wider driving population-based perspective of risk of driving and dementia (Cooper, Tallman, Tuokko and Lynn Beattie, 1993), but many studies of driving and illness have originated from specialised clinics in cardiology, dementia or syncope. Studies of dementia and driving which are taken retrospectively from dementia clinics tend to show a high risk, whereas those which are quasi-prospective and which look at the early stages of dementia show a less pronounced pattern of risk. In the first two years of dementia the risk approximates that of the general population (Drachman and...
Safe mobility for older people

Swearer, 1993). This is an important finding because many physicians assume that dementia is an absolute contra-indication to driving. In a UK study of dementia, deterioration in driving skills was a phenomenon of the early stage in 10 per cent of the patients studied (O’Neill et al., 1992). A higher than expected number of tangles and plaques have been found in the brains of drivers who crash (Johansson, Bogdanovic, Kalimo, Winblad and Viitanen, 1997), but subsequent assessment of the families did not reveal significant premorbid deterioration in the subjects’ general function (Lundberg, Johansson, Bogdanovic, Kalimo, Winblad and Viitanen, 1999). The most carefully controlled study of crashes and dementia showed no increase in crash rates for drivers with dementia (Trobe, Waller, Cook-Flannagan, Teshima and Bieliauskas, 1996). Likely causes for this counter-intuitive finding include a lower annual mileage and restriction of driving by the patient, family and physicians.

Medications

An area of increasing debate over the last 20 years has been the potential impact of psychoactive medications on driver safety. This interest has paralleled studies showing an impact on these medications on other injuries (Ray, 1992), notably falls. A number of studies have suggested that physicians should be concerned about diminished driving skills and increased crash risk with these medications (Ray, Thapa and Shorr, 1993; Hemmelgarn, Suissa, Huang, Boivin and Pinard, 1997). In terms of numbers of prescriptions, the main groups implicated are the benzodiazepines (Hemmelgarn et al., 1997) and anti-depressants (Ray, Fought and Decker, 1992). If a true increased risk can be established and quantified by medication type and dosage, restrictions in prescribing and/or driving may be an achievable component of a crash-prevention strategy.

Demonstrating cause and effect has been problematic. Separating the effects of the disease from those of the medications is not easy: depression, anxiety and insomnia may have an impact on driving behaviour that might be ameliorated by pharmacological treatment, although current evidence suggests this is likely to be true for depression only. Studies on volunteers do not replicate clinical experience. There is a mini-industry of reaction/braking time tests comparing psychoactive medications. As we have previously seen, operational or reaction factors are less important than strategical or tactical factors, so it is very difficult to give any significant weight to these tests. There is also a danger of trying to extrapolate from these tests to a real impact on safety.

A parallel here is the theoretical differences between tricyclic anti-depressants (TCAs) and selective serotonergic reuptake inhibitors (SSRIs) and fall risk. Although SSRIs would seem to have theoretical advantages, clinical studies have not been able to show any difference in fall rates between older people on TCAs and SSRIs (Thapa, Gideon, Cost, Milam and Ray, 1998). Similarly, there have been difficulties in epidemiological studies with matching controls with cases, in the exclusion of fatalities (more likely to involve alcohol and possibly psychoactive drugs), and with unreliability in medication recall at interview, lack of diagnostic categorisation prior to the crash, and failure to control for the many variables which affect crash risk.

The use of large prescribing databases has helped to reduce uncertainty about prescribed medications among subjects in epidemiological studies. Hemmelgarn and colleagues showed an increased risk of crash of 1.5 in the first week of use of long-acting benzodiazepines among older drivers compared to 1.29 with chronic use and no increased risk among those on short-acting benzodiazepines (Hemmelgarn et al., 1997). A further methodological refinement is reported in a study of a crash population where just over 1 per cent of drivers in a first-ever crash were current users of benzodiazepines (Barbone, McMahon, Davey, Morris, Reid, McDevitt and MacDonald, 1998). The authors used a technique whereby subjects act as their own controls, eliminating the difficulty of finding matching controls and reducing some of the associated confounding effects. The finding of an almost 50 per cent increase in crash risk in users of benzodiazepines should be interpreted cautiously.
While generally consistent with trends in the literature, the risk was concentrated in younger drivers (under 45), and was increased greatly by the presence of alcohol. The absence of association with increased risk in the elderly, a group who are most sensitive to the effects of benzodiazepines, is noteworthy; if sustained, it suggests that benzodiazepines affect crash-risk by mechanisms other than by those which have been traditionally measured by psychometric tests. The lack of an association with TCAs is also a departure from existing data. The restriction of the study to first-time crashes limits the study of those who may demonstrate risky driving behaviour.

Universal advice against driving while taking benzodiazepines is not yet supported by this study, but it should accelerate both epidemiological and policy interest in the subject, as well as clinical caution. An expansion of this style of study should be encouraged, to include all crashes and injury and death from other forms of mobility, such as pedestrians and cyclists. Prospective studies are also needed, perhaps at the time of peri-marketing clinical trials (Ray, 1992). In the interim, those who dispense benzodiazepines need to recognise that most adult patients are drivers or potential drivers. Active consideration should be given as to whether the illness is likely to affect driving skills and whether the patient has a past crash history. The patient should be advised not to drive if they cannot abstain from alcohol while on treatment with benzodiazepines. Most importantly, they should query whether the patient really needs a benzodiazepine, and if they do, does it need to be long acting.

Assessment strategy

The schedule for the assessment of the older driver is akin to that of the geriatric assessment of older people, a process which is marked by the following qualities: medical and functional assessment, detection and prioritisation of diseases, interdisciplinary assessment and remediation (Table 1). Functional assessments, such as a comprehensive test of visual processing, a falls history, and a review of current medications may be of greater relevance than specific medical conditions in the identification of older at-risk drivers (Sims, Owsley, Allman, Ball and Smoot, 1998). Early specialist referral may prove beneficial for the primary care physician who does not have access to an interdisciplinary team.

<table>
<thead>
<tr>
<th>Table 1: Process of clinical driving assessment</th>
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<tr>
<td>1. History</td>
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<tr>
<td>• Patient, family/informant</td>
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<tr>
<td>• Driving history</td>
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<tr>
<td>• Medications</td>
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<tr>
<td>2. Examination</td>
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<tr>
<td>• Functional status</td>
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<tr>
<td>• Vision</td>
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<tr>
<td>• Mental status testing</td>
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<td>3. Diagnostic formulation and prioritisation</td>
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<td>4. Remediation</td>
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<tr>
<td>5. In-depth cognitive/perceptual testing</td>
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<td>6. ± On-road assessment</td>
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<tr>
<td>7. Overall evaluation of hazard</td>
</tr>
<tr>
<td>• Strategic</td>
</tr>
<tr>
<td>• Tactical</td>
</tr>
<tr>
<td>• Operational</td>
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<tr>
<td>8. Advice to patient/carer</td>
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<tr>
<td>• Driving</td>
</tr>
<tr>
<td>• Insurance</td>
</tr>
<tr>
<td>• Licencing authority</td>
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<tr>
<td>9. If driving too hazardous, consider</td>
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<tr>
<td>alternative mobility strategies</td>
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</table>

A cascade system for interdisciplinary assessment is probably the most cost-effective way to approach the patient (Figure 2). For example, if the physician detects visual acuity below the standard for the jurisdiction, referral to an ophthalmologist and maximal remediation of vision should occur before returning to the assessment cascade. Similarly, should a patient in the European Union have a homonymous hemianopia (one of the few absolute medical contra-indications to driving), then referral to the social worker for developing strategies for alternative transportation is the next step in the cascade.
Safe mobility for older people

Decision making

The high rate of accuracy of test batteries in dementia depends on the care that clinicians take in developing a liaison and familiarity with local occupational therapists and neuropsychologists, so that results can be taken in context, not only of the patients but also of the training and quirks of the assessors. It is likely that the same approach is critical to good assessment practice in driving competency.

To most clinicians, it is relatively easy to detect those patients who represent a low risk and those who represent a high risk for driving. It is those in-between who represent the greatest challenge. If we consider dementia as a paradigm for age-related illnesses which may affect driving, we can glean some interesting information from various components of the assessment and treatment processes outlined above.

Most published assessment papers include a common core (Carr, Schmader, Bergman, Simon, Jackson, Haviland and O'Brien, 1991; O'Neill, 1993; Reuben, 1993). One of the most important final common pathways of concern in driving is obviously cortical function, whether impaired due to syncope, cognitive function, inattention or neglect, personality change, or obvious motor problems. Cognitive and visual parameters appear to carry the highest risk of compromising driving ability (Owsley, Ball, Sloane, Roenker and Bruni, 1991), and it is possible that decrements reported for cardiovascular disease may in fact relate to occult or undetected cognitive impairment.

Another important area of evaluation is the utility and validity of the informant report. At present many of us rely quite strongly on an informant’s report of driving skills. Evaluation of a semi-standardised informant’s report would be very useful in appropriate referral for more specialised testing.

A wide range of tests have been described in relatively small groups of older drivers in community settings and clinics: some have also been correlated with sophisticated simulators and on-road tests. A comprehensive summary was published in 1999 (Staplin, Lococo, Stewart, and Decina, 1999). It is useful to divide these into first level, ie primary care or community screening tools, second level functional screening and finally on-road tests of driving competence. Some tests will be common to the first and second tiers.

Simple screening tests which may be helpful include Road Traffic Identification tests (Carr, LaBarge, Dunnigan and Storandt, 1998). These overcome difficulties with literacy and language differences. At a more clinical level, virtually all cognitive screening tests have a correlation with compromised driving ability. The Short Blessed Test was less sensitive than Trails A or B in predicting crashes in a study based at the time of driving licence renewal (Stutts, Stewart and Martell, 1998). The Mini-Mental State Examination has the
benefit of an (almost) consensus statement (Lundberg et al., 1997) that scores < 10 imply immediate cessation of driving, scores of < 17 require urgent assessment and with scores of > 17 decisions should be based on the functional level of the patient.

At the secondary assessment level, tests which have been found to be helpful are the Trails A and B, tests of visual and auditory attention, Digit Symbol Subscale of the WAIS (Staplin et al., 1999). A number of specific test batteries have been formulated, none of which is sufficiently widely assessed to be relevant for clinical practice (Staplin et al., 1999).

Simulators have not yet gained widespread acceptance for driver testing. Inexpensive simulators are as yet little more than psychometric tests in fancy dress. High-quality simulators will play a valuable role in providing performance parameters against which clinical and functional assessments can be measured. For example, a pioneering study by Rizzo has confirmed the correlation of the Trails test with driving performance (Rizzo, Reinach, McGehee and Dawson, 1997). In the near future, the exponential increases in microprocessor power and decreases in their cost may lead to a more general development of the simulator as an assessment tool.

Several standardised on-road tests have been formulated in recent years (Dobbs, Heller and Schopflocher, 1998; Hunt, Murphy, Carr, Duchek, Buckles and Morris, 1997), and will help to provide a common language for specialist driving assessors. The Forum of Driving Centres, representing the 13 specialist driving centres in Britain and Ireland, has already run educational programmes for its members concentrating on the older driver.

Screening

Screening for medical illness relevant to driving is difficult due to the complex nature of the driving task and underlying societal prejudices. Some European countries have attempted screening by demanding a doctor's certificate at regular intervals after a certain age. A comparison of accident rates between Sweden (where there is no medical control) and Finland (requiring regular medical recertification after age 70) showed no reduction in motor crash fatalities and an increase in pedestrian and cycle fatalities among the over-70s in Finland. This may be as a result of stopping older people driving unnecessarily and forcing them into the much higher risk group of pedestrians and cyclists (Hakamies-Blomqvist et al., 1996). A more enlightened approach is under assessment in the state of Maryland, where the screening process is directed towards a rehabilitation outcome. Those who screen as ‘at risk’ on a simple test battery at the time of licence renewal are offered an assessment by the Geriatric Evaluation System of Maryland State. Preliminary results are awaited with anticipation!

Intervention

A wide range of interventions is possible in older drivers with impairments (Table 2). Access to the full interdisciplinary team, a good working relationship with a specialist driving assessment centre, and the availability of car adaptation services are important factors in offering an appropriate service. If a patient with dementia is judged to be capable of driving, the driver and carer should be advised against driving alone, to return for review in three to six months, or sooner should the carer notice any deterioration in driving skills. This form of restriction makes sense for two reasons. Drivers with medical conditions and restricted driving licences have been shown to have less crashes than those similarly affected but with no restrictions (Vernon, 1999), and drivers with dementia who drive accompanied are also more crash-free (Bédard, Molloy and Lever, 1996).
Safe mobility for older people

When driving is no longer possible

When driving cessation is indicated, it is important to explore alternatives with the patient. A sympathetic social work intervention may be helpful, and can work though the various options available to the patient. Public transport, even if free, is often irrelevant to older, compromised adults. Family members may be able to provide some driving input. The ideal situation is to provide a system of paratransit: affordable, tailored individual transportation. Various models have been developed (an excellent example is the service in Portland, Maine), but the funding remains problematic (Freund, 1991).

Refusal to stop driving occurs in a minority of cases. As these are often (but not invariably) drivers with dementia, it is interesting to note some changes in the literature. Early reviews on the subject suggested that subterfuge and working around the patient was the only strategy. An interesting case report has suggested a possible alternative involving exploring the patient’s feelings and fears about giving up driving (Bahro, Silber, Box and Sunderland, 1995). The intervention was designed with the patient as collaborator rather than patient and by dealing with the events at an emotional rather than at an intellectual level. The patient was able to grieve about the disease and in particular about the loss of his or her car. This in turn enabled the patient to redirect his or her attention to other meaningful activities that did not involve driving. Although this approach may be hampered by the deficits of dementia, it reflects a more wide-spread trend towards sharing the diagnosis of dementia with the patient.

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Table 2: Sample diseases for which appropriate assessment and remediation may be of benefit

<table>
<thead>
<tr>
<th>Neuropsychiatric</th>
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<tbody>
<tr>
<td>Stroke</td>
<td>Driving-specific rehabilitation</td>
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<tr>
<td><em>Parkinson’s disease</em></td>
<td>(van Zomeren et al., 1987)</td>
</tr>
<tr>
<td>Delirium</td>
<td>Maximising motor function, treatment</td>
</tr>
<tr>
<td>Depression</td>
<td>of depression, assessment of</td>
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<tr>
<td><em>Mild dementia</em></td>
<td>cognitive function (Lancet, 1990)</td>
</tr>
<tr>
<td><strong>Cardiovascular</strong></td>
<td>Treatment and resolution</td>
</tr>
<tr>
<td>Syncope</td>
<td></td>
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<tr>
<td><strong>Respiratory</strong></td>
<td>Treatment: if antidepressant, choose</td>
</tr>
<tr>
<td>Sleep apnoea</td>
<td>one with least potential of</td>
</tr>
<tr>
<td><strong>Vision</strong></td>
<td>cognitive/motor effects (Rubinsztein</td>
</tr>
<tr>
<td>Cataract</td>
<td>and Lawton, 1995)</td>
</tr>
<tr>
<td><strong>Metabolic</strong></td>
<td>Assess, treat depression, reduce/...</td>
</tr>
<tr>
<td>Diabetes</td>
<td>eliminate psychoactive drugs, advice</td>
</tr>
<tr>
<td>All arthritides</td>
<td>not to drive alone (O’Neill, 1996)</td>
</tr>
<tr>
<td><strong>Iatrogenic</strong></td>
<td>Advice pending investigation: treat</td>
</tr>
<tr>
<td>Polyparmacy</td>
<td>cause (O’Neill, 1995)</td>
</tr>
<tr>
<td>Psychoactive medication</td>
<td>Treatment of underlying disease</td>
</tr>
<tr>
<td>Benzodiazepines</td>
<td>(Haraldsson et al., 1995)</td>
</tr>
<tr>
<td><strong>Direct therapy to avoid</strong></td>
<td>Surgery, appropriate corrective lens</td>
</tr>
<tr>
<td><strong>Driving-specific</strong></td>
<td>and advice about glare (Monestam</td>
</tr>
<tr>
<td>Rehabilitation programme</td>
<td>and Wachtmeister, 1997)</td>
</tr>
<tr>
<td><em>Polypharmacy</em></td>
<td>Direct therapy to avoid hypoglycaemia</td>
</tr>
<tr>
<td><em>Psychoactive medication</em></td>
<td>(Frier, 1992)</td>
</tr>
<tr>
<td><em>Benzodiazepines</em></td>
<td>Driving-specific rehabilitation</td>
</tr>
<tr>
<td></td>
<td>programme (Jones et al., 1991)</td>
</tr>
<tr>
<td><em>Rationalise medications</em></td>
<td>Rationalise, minimise (Ray, 1992)</td>
</tr>
<tr>
<td><em>Rationalise, minimise</em></td>
<td>Eliminate long-acting (O’Neill, 1998)</td>
</tr>
</tbody>
</table>
References


Safe mobility for older people


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13
Medical aspects of fitness to drive

T Carter, Chief Medical Adviser (Transport Safety), Department for Transport

Introduction

Pre-existing medical conditions can impair driving performance and lead to accidents. Regulatory controls have been in place since the 1930s and have grown in complexity over the years. They are now influenced by European as well as national concerns. Some medical standards are supported by evidence on risk but many are derived from expert judgement unsupported by valid studies. Revocation of a licence because medical standards are not met may have a severe effect on employment, amenity and self-esteem. Those who are affected reasonably expect that decisions are based on valid evidence and this has led to several significant legal and parliamentary challenges to existing standards. This is especially so as medical conditions probably only make a very small contribution to the overall toll of road casualties (Carter, 2001).

In response to the need for more valid standards, a Department for Transport, Local Government and the Regions (DTLR) programme of research on medical aspects of fitness to drive was instituted two years ago. The components of this programme will be described, the projects completed, in progress or planned discussed and the implications of initial findings and the current social and political climate for the future direction of policy on medical fitness and driving considered.

Medical conditions and driving

The commoner forms of performance decrement associated with medical conditions are as follows:

1. Sudden loss of capability. Common causes are seizures, cardiac arrhythmias, hypoglycaemia. The speed of loss is critical to the probability of a crash, being highest for seizures but often with several seconds warning in the case of cardiac events, such that the driver can pull off the road.
2. Fixed impairments. These include visual defects and permanent limitations of movement. They may be assessed at any time and sometimes adaptations can be made to the vehicle. If this is not possible an estimate of the incremental risk from the impairment is needed.
3. Variable impairments. The frequency and severity of deficit can sometimes be assessed, for instance in relation to medication use, but it will often reflect subjective impressions from the driver, as in fatigue from multiple sclerosis, and thus depend on self-modification to driving patterns.
4. Mixed impairments. Among the most complicated of these is the use of insulin in diabetes. Less severe levels of hypoglycaemia are associated with variable deficits in cognitive function, which may in turn reduce self-perception of impending incapacity as well as having an adverse effect on driving. Diabetes itself can carry complications which increase driving risk, such as ischaemic heart disease, loss of vision and reduced sensation of the pedals from the feet.
The evidence of risk required to define valid driving medical standards will depend on the form of impairment and also on the prognosis of the condition causing it.

The research programme

Programme management was contracted following competitive tendering to the Defence Evaluation and Research Agency (DERA), now Qinetiq, with Professor Tony Nicholson as the programme manager. This has given us access to high-level skills in research on medical aspects of human performance and a wide network of academic contacts.

Key elements of the programme were defined in discussion within the DTLR and the Driver Vehicle Licensing Agency (DVLA) and the Secretary of State’s Honorary Medical Panels, which provide advice on driver medical standards and on very complex or novel casework. Political events were also influential, notably the concerns about insulin-using diabetics voiced by the House of Commons Science and Technology Committee (2000). Legal challenges to current standards, particularly those for visual field defects, also helped shape the programme.

Clearly expressed research needs were rapidly defined in relation to the work of the diabetes and vision panels. No specific issues were identified in cardiology, where evidence from other, non-driving related research can frequently be applied to driving risks. Topics common to the neurology and psychiatry panels on cognitive impairment were seen as priorities, as was work on sleep disorders. In all cases the aim of the projects is to help re-define medical standards used by the DVLA. Because of this, one of the other essential pieces of underpinning work was a study of how to make better use of the huge mass of clinical data currently held by the DVLA, but not amenable to use for scientific purposes because databases cannot be searched by diagnostic categories.

The results of studies from this programme may also help influence European Union (EU) and other international decisions on driver medical standards. Some projects will have the potential to provide results relevant to other safety-critical tasks and also to the improved clinical management of certain medical conditions.

As soon as this work commenced two review projects were commissioned to inform future phases of the programme:

- the scope for applying quantitative risk-assessment methods to medical aspects of fitness to drive
- the quality of published information on certain medical conditions and driving risk.

Completed projects

ROLE OF RISK ASSESSMENT IN THE ANALYSIS OF FITNESS TO DRIVE (SPENCER, 2001)

The following framework was used to analyse the quality of available evidence on determinants of risk:

- the exposure to risk (ie the amount of driving that is undertaken)
- the probability of impairment while at the wheel
- the probability of an accident resulting from impairment or incapacity
- the likely outcome of an accident
Data which can be used to quantify these factors were sought and those for cardiac events, epilepsy and hypoglycaemia used as worked examples.

The review notes the limitations of even the best currently available data sets. More significantly, it identifies the lack of any generally accepted common calculus for tolerable risk in relation to accident risk on the roads.

Data on age and accidents are reviewed as a possible benchmark, noting the sevenfold increase in accidents which is tolerated in new drivers. The ‘one per cent rule’, which is used to set the limits of tolerability for cardiac disease recurrence in aircrew, is discussed as a possible approach. This is derived from a judgement on the acceptable contribution of medical and human factors risks to the overall probability of an airliner crash risk estimates used in aeronautical engineering design.

The limits of accident data as a measure of risk are considered, as is the possibility of using simulator or laboratory studies, at least for fixed impairments.

The review concludes that there are major constraints on adopting a formal risk-based approach because of the lack of condition-specific data and the lack of criteria for tolerability of risk in the road safety setting. Both are seen as worthwhile goals to work towards, and to this end a supplementary review project looking at the implications of applying sensitivity analysis to such risk assessment data sets is in progress, to enable the required power of any future investigations to be defined.

A REVIEW OF RECENT LITERATURE CONCERNING THE USEFULNESS OF CLINICAL AND EXPERIMENTAL DATA RELATING TO MILD DEMENTIA, PARKINSON’S DISEASE, DIABETES, EPILEPSY AND VISUAL FIELD DEFECTS (ROBERTSON AND NICHOLSON, 2002).

This review used MEDLINE to search for studies specifically linking the above conditions and driving performance:

- Insulin dependent diabetes – level of blood glucose associated with reduced simulator performance defined. No evidence of excess overall accident risk reported but the need for better data on risk levels in well controlled vocational drivers is identified
- Mild dementia – uncertainty about validity of clinical and neuropsychological tests as predictors. Papers discuss need to correlate tests with on-road assessments
- Epilepsy – little information on accident risks but good data on recurrence risks in range of circumstances
- Parkinson’s disease – no data on accident risk but performance tests claimed to suggest greater risk than age matched controls
- Visual field defects – limited recent data on risk. The need to use comparable methods of field testing make between-study comparisons difficult.

Overall the review shows how little published data are available and notes the recurrent issue of the practicability of using clinical assessment, cognitive and other tests, simulator studies and on-road assessment to predict accident risk in drivers with impairment secondary to medical conditions.

DEVELOPMENT OF A SCIENTIFIC DATABASE TO ENABLE RESEARCH ON DVLA INFORMATION ON HEALTH AND DRIVING

This was an information technology (IT) consultancy project with no immediate results of general interest, but it provides advice on how best to unlock the scientific potential of data held now and in future on the DVLA databases.
Project progress

**STUDY OF HYPOGLYCAEMIA IN DIABETICS (TYPE 2 RECENTLY ON INSULIN)**

The protocol for this study was developed by a steering group set up by the DTLR which represented the major UK diabetic research centres with expertise in hypoglycaemia. This protocol was the basis for a complex competitive tendering exercise to create a multi-centre study with the required central support functions. It was contracted in mid-2001.

The aim of the study is to identify the risks of hypoglycaemia in people with diabetes of varying duration and severity on a range of treatment regimes, so that risk can be stratified among these groups to support valid risk-based decisions on fitness to drive. The techniques to be used include new continuous tissue glucose monitoring devices which participants wear for 48 hours and from which data are then downloaded and analysed. This enables the pattern of glycaemic control over a prolonged period of normal activity to be monitored. Careful calibration using conventional techniques is also required.

Participating centres are Sheffield (overall co-ordinator), King's College, London, Bournemouth, Exeter, Edinburgh and Belfast. The aim is to recruit some 500 patients to the study, which will run for two years. The results should be relevant to activities other than driving and may help determine the optimum treatment regimes to be used in all diabetics who lead active lives.

Originally a parallel study on the relative risks of road accidents in different groups of diabetics was planned and opened to tender, but no methodologically sound proposals capable of stratifying risk in different groups of diabetics were received.

**FUNCTIONAL CORRELATES OF PERIPHERAL VISUAL FIELD DEFECTS**

Two complementary studies, both lasting one year, are in progress. The first, being undertaken by Nottingham Trent University and Moorfields Hospital, is investigating test methods for visual field loss, in particular the use of summated monocular fields rather than a single binocular vision test, as predictors of loss which may impair driving performance. This is an important practical issue as current test methods were designed to assess clinical progression of eye disease rather than its functional consequences.

The other study, at Qinetiq and the Institute of Ophthalmology, will use subjects with known defects and assess their performance in a range of tasks which may be relevant to driving impairment. This will enable the risk attributable to differing sizes, intensities and locations of field defect to be determined and thus make future standards more clearly risk-based than is the case at present.

**Projects being initiated**

**REVIEWS**

Two reviews have been commissioned from existing contractors to extend earlier parts of the programme. One is the sensitivity analysis on quantitative risk-assessment data and the other is a detailed critique of the published papers on visual field defects and accidents. The latter is needed to inform the DVLA in the event of any future legal challenges to licensing decisions.
WORKSHOP ON DRIVING AND MEDICAL ASPECTS OF EXCESSIVE DAYTIME SLEEPINESS

A consensus workshop is being held, at which leading experts on sleep disorders and their effects on performance will review the available information in relation to the practicalities of classifying the probability of accidents occurring in the commoner disorders. The aim is to improve the handling of cases notified to the DVLA, as well as to help refine the way in which cases are investigated by clinicians.

COGNITIVE IMPAIRMENT FROM MEDICAL CONDITIONS AND FITNESS TO DRIVE

A protocol development group will be meeting shortly to develop the details of a study of cognitive impairment arising from conditions such as stroke, head injuries, neurodegenerative conditions and dementias. The aim will be to determine what mix of clinical assessment, cognitive testing, simulator use and on-road testing should be used to determine fitness to drive in this large and growing group of the population. Once the protocol is agreed a tender will be issued to seek participating centres. A multi-centre design is envisaged with a lead institution. Collaboration between clinical groups and organisations able to provide simulator and on-road assessments is likely to be required. It is anticipated that the study will last for two years from the date of contracting.

CENTRAL SCOTOMATA (VISUAL FIELD DEFECTS) AND FITNESS TO DRIVE

This proposal complements the work already commissioned on peripheral field defects and driving. The functional correlates of small defects of vision in the central field will be investigated. It is hoped that proposals will, as in the case of peripheral defects, cover both the validity of test methods and the consequences of defects of various intensities and distributions for fitness to drive.

Future initiatives

It is likely that the increasing concerns about the evidence base for decisions on driver fitness will lead to calls for further studies. In particular, the view that where possible decisions about fitness should be based on individual assessment rather than diagnostic categories will have important consequences in terms of requirements for test methods and protocols which are both valid and have high face value to the person tested.

Health professionals are currently not well informed or motivated to provide sound advice to patients on fitness to drive, and behavioural studies may be needed to determine how best to improve the quality of advice given.

Implementation of research results

The emerging findings of the various projects will be considered by the DTLR and DVLA and with the relevant Medical Advisory Panels. In most cases the end result will be review and modification to the driver medical standards used and published by the DVLA (2001). Results will also be discussed with patient interest groups and published in the open literature.
Medical standards on fitness to drive are, in broad terms, handled at EU level. The results of the programme will be used both to contribute specific proposals on standards and to promote the importance of a risk-based approach to any modifications to EU standards.

The results will in many cases have implications for other modes of transport and for safety-critical tasks in general. Reports will be circulated and reviewed with other regulatory authorities and professional groups. The approach adopted for this programme is in line with the Government-wide initiatives on bringing greater clarity and validity to risk regulation and results will be presented to the various inter-departmental policy groups.

Conclusions

A significant programme of work is now in progress in an area which has been neglected for some while. The results of this work should help to improve the quality and openness of decision taking in a sensitive area where public safety has to be balanced against the benefits both for individuals and society of maintaining mobility through driving.

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Introduction

Due to the contemporary increase of illicit drugs consumption (and notably cannabis) in many European countries (Britain, France and Scandinavia, for example), an increasing number of studies are dealing with the prevalence of licit and illicit drugs in various countries and among various populations of drivers (road surveys, weekend drivers, suspected drivers, drivers involved in accidents). A European research structure (the Pompidou Group) has been initiated to compare the magnitude of the problem in each country. Since 1999, France has enacted the so-called ‘Gayssot Law’, stipulating that testing for illicit drugs should be mandatory in every fatal accident (for all persons involved in the accident).

Traffic safety studies in this field may be categorised in two main and complementary approaches, experimentation and epidemiology; both have tried to apply the ‘alcohol model’ to illicit drugs and we will see that this is not necessarily entirely relevant.

In fact, legal levels of Blood Alcohol Concentration (BAC) have been set after sound epidemiological works, the pharmacokinetics of alcohol allowing this precision (the Breath Alcohol Concentration [BrAC]/[BAC] relationship remaining relatively constant), but the pharmacological characteristics of illicit drugs are different and generate several methodological problems.

Drug use data

The first inquiries on drug use in France were done at the end of the 1970s, but it was mainly during the 1990s that large-scale epidemiological work (Choquet and Ledoux, 1994) was conducted.

Since then, the creation of the European Observatory of Drugs and Toxicomania and of the European Monitoring Centre for Drugs and Drug Addiction and the development of the European School Series Project on Alcohol and Drugs (ESPAD) study on 95,000 young Europeans (16-year-olds) allow us to compare drug use, supply, problems and policies in our different countries.
GENERAL POPULATION STUDIES

Two main and common observations in our countries are that cannabis is the most frequently used product and that cannabis use (experimentation as well as regular use) is increasing in the present day.

The prevalence of cannabis use varies between 10 per cent in Finland and 25 per cent in Denmark, whereas the prevalence of amphetamine use varies generally between 1 per cent and 4 per cent (except in the UK where it reaches 10 per cent), of cocaine between 1 per cent and 3 per cent and heroin between 0 per cent and 1 per cent.

For example, the latest French figures show clearly the importance of alcohol use and, among illicit drugs, the importance of cannabis (Table 1).

<table>
<thead>
<tr>
<th>Experimentation</th>
<th>Alcohol</th>
<th>Tobacco</th>
<th>Licit drugs</th>
<th>Illicit drugs:</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occasionnal use</td>
<td>43 million</td>
<td>36 million</td>
<td>9.5 million</td>
<td>1.5 million</td>
<td></td>
</tr>
<tr>
<td>Regular use</td>
<td>14 million</td>
<td>13 million</td>
<td>3.8 million</td>
<td>1.7 million</td>
<td></td>
</tr>
<tr>
<td>Daily use</td>
<td>8.9 million</td>
<td>13 million</td>
<td>2.4 million</td>
<td>220,000</td>
<td></td>
</tr>
</tbody>
</table>

Nowadays, epidemiological studies in most EU countries show that:

- illicit drug use increases with age from 15 to 25 years, then decreases (young figures are twice the adult ones)
- tobacco and licit drugs are more frequent among girls, alcohol, cannabis and ecstasy among boys, but sex differences are decreasing
- cohort effects are: increase of tobacco among girls, stabilisation of alcohol use, increase of cannabis use, regular use of which sometimes becomes more important than alcohol
- illicit drug use is more important in urban regions of Europe than in rural ones, probably because of substance availability – this correlation might explain discrepancies between national figures.

One may notice that these correlations with these variables (age, sex and rurality) are important for traffic safety because these are the three variables strongly associated with accidents.
During the 1990s, cannabis use increased in most European countries, and rather logically the increase has been more important in countries where prevalence was initially low (Greece, Finland and Sweden, for example) than in countries where prevalence was high (Denmark, Germany and the UK, for example). Main trends concern mainly cannabis due to the small number of other illicit drug users.

**STUDIES OF YOUNG PEOPLE**

Among young Europeans generally, one may notice a 'harmonisation' phenomenon, analogous to the 'alcohol harmonisation' (increase of beer consumption in the south of Europe, increase of wine consumption in the north). Discrepancies are being reduced: some countries with a high prevalence of some products may observe a saturation, some with a weak prevalence, a compensation.

**Experimental studies: the effects of illicit drugs on driving**

Various effects of illicit drugs on driving have been noted when compared to a placebo. Owing to its wide prevalence, cannabis has been the most frequently studied drug. Experimental models elaborated for alcohol in the past have been used to study the effects of various blood concentrations of tetrahydrocannabinol (THC). Laboratory tests, simulation or real-traffic tests have been used; syntheses have been published (Moskowitz, 1985; Smiley, 1998; Ward and Dye for the DETR, 1998).

**LABORATORY TESTS**

Driving performance under the influence of cannabis has been studied for various tasks: motor co-ordination, reaction time, tracking, attention.

It is clear that cannabis alters performance in these various domains, and that there is a dose-effect alteration. Information processing seems to be the key mechanism of cannabis alteration (for example, simple reaction times are not affected but complex ones are). Nevertheless, a recent study by Sexton et al. (2000) did not detect an influence of cannabis on hazard perception with videos.

**SIMULATION AND ROAD TESTS**

Aspects of driving performance usually studied are lateral position control, gap acceptance, decision taking in emergency situations, driving style and risk taking.

Cannabis mainly increases the variability of lateral position control (similarly to the way alcohol does); the reason for this is that lateral position control is basically an automatised treatment of information, more sensitive to internal factors (like the effect of cannabis) than to external ones; comparatively, gap acceptance is less automatised and so more sensitive to the compensation processes of impairment.

Generally, and contrarily to alcohol use, risk taking is noted as diminished by cannabis use; cannabis users would be aware of the alterations and would compensate with more cautious driving behaviour (less hazardous overtakings, slower speeds, larger gaps).

Therefore, in urban driving, cannabis seems to have an opposite, symmetrical effect to alcohol: overall driving performance under the influence of cannabis is not altered, although drivers feel that it has been, whereas for alcohol, driving performance is altered even at low BAC, although drivers feel that their performance is unaffected.
Cannabis and alcohol
Additive and interactive effects of the combination of alcohol and cannabis have been clearly noted.

To conclude on the effects of cannabis on driving, they seem to be limited in real traffic situations, except in some situations: emergency manoeuvres, long and tiring trips, interaction with alcohol.

Detection and prevalence of illicit drugs among various populations of drivers

METHODOLOGICAL PROBLEMS OF DETECTION DUE TO CANNABIS METABOLISM AND HETEROGENEITY OF STUDIES

D9-THC is a psychoactive agent, its blood concentration increases and decreases rapidly, and its metabolites (D9-THC-COOH) may be present for several weeks in urine.

On a juridical level, blood analysis is essential for the attribution of responsibility, but on an epidemiological level, urine analysis is still of interest (for example, when analysing the accident involvement of chronic users).

The ROSITA (ROadSIde Testing Assessment) European Project tries to categorise and evaluate various toxological measures: urine, saliva, sweat, hair.

The collecting mode and delays in transporting samples affect the measure observed: saliva samples may be too dry at arrival, urine test refusal or impossibility may be significant, so for the moment the various prevalences observed in EU countries are not comparable (see Table 2).

Cannabis is the most often detected illicit drug on the road; this reflects two main causes:

1. as shown above, cannabis users are much more numerous than users of other types of illicit drugs
2. like alcohol, cannabis is more often associated with driving episodes than other types of illicit drugs.

The only thing we can say for the moment (because of methodological discrepancies) is that cannabis prevalence does not seem more important in countries where cannabis is quasi-legalised (Spain, Belgium, Switzerland and the Netherlands).

Increasing prevalence may be observed in France and in the UK.

In the UK:

- in 1985, alcohol was present in 35 per cent of fatalities, licit drugs in 5 per cent and illicit drugs in 3 per cent
- in 1999, alcohol was still present in 35 per cent of fatalities, licit drugs in 6 per cent and cannabis in 17 per cent.

ROAD SURVEYS

Road surveys indicate proportions varying between 1 per cent and 5 per cent of drivers driving after having smoked cannabis; these proportions are less than proportions detected during accidents (between 5 per cent and 17 per cent). Before jumping to the conclusion of a risk factor, one may notice that the
Table 2: Prevalence of cannabis among various populations of drivers

<table>
<thead>
<tr>
<th>Country</th>
<th>All drivers (road surveys)</th>
<th>Weekend drivers</th>
<th>Suspected drivers</th>
<th>Drivers involved in accidents (including killed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>Rissler (1998)</td>
<td></td>
<td>69%</td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>Longo, (2000)</td>
<td></td>
<td></td>
<td>11%</td>
</tr>
<tr>
<td>Belgium</td>
<td>Meulemans (1997)</td>
<td></td>
<td></td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td>Charlier (1998)</td>
<td></td>
<td></td>
<td>6%</td>
</tr>
<tr>
<td>Denmark</td>
<td>Worm (1996)</td>
<td></td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Steentoft (1997)</td>
<td></td>
<td>17%</td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>Schermann (1993)</td>
<td></td>
<td></td>
<td>6.6%</td>
</tr>
<tr>
<td></td>
<td>Pelissier (1996)</td>
<td></td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>Marquet (1998)</td>
<td></td>
<td></td>
<td>12%</td>
</tr>
<tr>
<td>Germany</td>
<td>Möller (1994)</td>
<td></td>
<td>8%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Krüger (1995)</td>
<td></td>
<td>0.6%</td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>Ferrara (1990)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Zancaner (1995)</td>
<td></td>
<td>&lt;1%</td>
<td>5.5%</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Mathijssen (1998)</td>
<td></td>
<td></td>
<td>5%</td>
</tr>
<tr>
<td>Norway</td>
<td>Gjerde (1991)</td>
<td></td>
<td></td>
<td>56%</td>
</tr>
<tr>
<td></td>
<td>Gjerde (1993)</td>
<td></td>
<td></td>
<td>8%</td>
</tr>
<tr>
<td></td>
<td>Skurtveit (1996)</td>
<td></td>
<td></td>
<td>26%</td>
</tr>
<tr>
<td></td>
<td>Christophersen (1995)</td>
<td></td>
<td></td>
<td>7.6%</td>
</tr>
<tr>
<td>Spain</td>
<td>Alvarez (1997)</td>
<td></td>
<td></td>
<td>1.5%</td>
</tr>
<tr>
<td></td>
<td>Sancho (1997)</td>
<td></td>
<td></td>
<td>2%</td>
</tr>
<tr>
<td>Sweden</td>
<td>Sjögren (1997)</td>
<td></td>
<td></td>
<td>3%</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Augsburger (1997)</td>
<td></td>
<td></td>
<td>57%</td>
</tr>
<tr>
<td></td>
<td>Staub (1994)</td>
<td></td>
<td></td>
<td>8.9%</td>
</tr>
<tr>
<td></td>
<td>F-Koch (1994)</td>
<td></td>
<td></td>
<td>46.7%</td>
</tr>
<tr>
<td>UK</td>
<td>Turnbridge (2000)</td>
<td></td>
<td></td>
<td>17%</td>
</tr>
<tr>
<td></td>
<td>DETR (1998)</td>
<td></td>
<td></td>
<td>8%</td>
</tr>
<tr>
<td>Canada</td>
<td>Dussault (2000)</td>
<td>5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mercer (1995)</td>
<td></td>
<td></td>
<td>13%</td>
</tr>
<tr>
<td></td>
<td>Stoduto (1993)</td>
<td></td>
<td></td>
<td>14%</td>
</tr>
</tbody>
</table>
proportions of missing data are superior to the prevalence rates: drivers refusing the urine tests may be the cannabis users.

**SUSPECTED DRIVERS**

Rates of cannabis detection are not surprisingly higher among suspected drivers; these rates depend essentially on selection by police officers, which is not a scientific experiment. Moreover, the search for illicit drugs is generally decided in the case of a legal BAC, which constitutes a sample bias.

Norwegian rates mainly reflect police activity, as the Norwegian accident prevalence is no greater than in other countries.

**CONCLUSION ON CANNABIS**

**Alcohol and age, two confounding factors**

Cannabis is more often detected among young drivers (except in the UK, where cannabis use remains relatively prevalent between 40- and 60-year-olds).

An important proportion of cannabis positive drivers had also been drinking (between 24 per cent and 60 per cent in the Turnbridge (2000) study).

As alcohol and age are two well-known risk factors, they act as confounding factors in the evaluation of the cannabis risk factor.

Preventative and educational actions should be directed towards young drivers, as cannabis use increases, because of their inexperience, because of alcohol-cannabis mixed use and its potentialisation effect, and because this target group is still not aware of the effects of cannabis on driving.

This issue is of course ideologically ‘contaminated’ by the more general debate on de-criminalisation: proponents of it will tend to minimise the influence of cannabis on traffic safety, opponents to maximise it.

Benzodiazepine use is increasing (see Table 3); three main secondary effects have been studied, each of which may impair driving:

- psychological dependency
- potentialisation of alcohol effects
- various psychomotor and cognitive impairments.

Experimental work (as in Groningen by Borgman and Brookhuis, 1986) indeed indicates that benzodiazepines impair driving style in a simulator. The effect of this impairment in real-traffic situations is not so clear.

Prevalence in accidents is around 10 per cent, but this is not greater than prevalence among the general population.

If one considers all types of accidents, some studies indicate a relationship between benzodiazepines and accident responsibility (see for example Longo, 2000, in Australia).
<table>
<thead>
<tr>
<th>Country</th>
<th>All drivers (road surveys)</th>
<th>Weekend drivers</th>
<th>Suspected drivers</th>
<th>Drivers involved in accidents (including killed)</th>
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</thead>
<tbody>
<tr>
<td>Austria</td>
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<tr>
<td>Risser (1998)</td>
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<td>France</td>
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<td>Girre (1998)</td>
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<td>Stoduto (1993)</td>
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</table>
Two questions remain:

- is benzodiazepine the causal factor or is it the psychological trouble that has motivated benzodiazepine use? This question translates also on the methodological level into the difficulty to create a valid control group when one looks forward to show an over-involvement of benzodiazepines users in accidents: the therapeutetic effect of benzodiazepines is a problem; unlike alcohol, a valid control group should not only be composed of subjects not using benzodiazepines, but with subjects presenting the same kind of psychopathology and not using benzodiazepines, which is difficult to find.
- what is the sense of causality: is benzodiazepine use an accident factor, or do accidents produce psychological sequelaes which can lead to benzodiazepine use?

Prevalence of opiates among various populations of drivers

Opiate prevalences seem to be important in France and Canada (Table 4).

THE QUESTION OF METHADONE AND SUBSTITUTIVE TREATMENTS

Methadone, used in the treatment of opiate dependency, itself creates a dependency, so we must consider its effects on driving.

In effect, driving may be important for the social reintegration of addicts.

Results on the effects of methadone are for the moment contradictory (see Brieler, 1993); German experts suggest the creation of a probationary licence for drivers under methadone.

Prevalence of amphetamines among various populations of drivers

The prevalence of amphetamines in accidents is well below the prevalence of cannabis; the only significant prevalence is among suspected Norwegian drivers, mainly revealing police activity. Even in the UK, where amphetamine use is high, its prevalence in accidents is low.

THE QUESTION OF ECSTASY AND RAVES

In several European countries, there are questions about raves (the heritage of the hippie festivals of the seventies), the ‘electro’ or ‘techno’ culture and ecstasy.

While ecstasy seems to be clearly more dangerous than cannabis in a public health perspective, it seems to be less dangerous for traffic safety.

Several factors may explain this: being an amphetamine, ecstasy does not produce sleepiness like cannabis or alcohol but energy and alertness, ecstasy is less often associated than cannabis or alcohol with driving episodes, and the danger of substance use is perceived more clearly by ecstasy users.
<table>
<thead>
<tr>
<th>Country</th>
<th>All drivers (road surveys)</th>
<th>Weekend drivers</th>
<th>Suspected drivers</th>
<th>Drivers involved in accidents (including killed)</th>
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<td>Dussault (2000)</td>
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<td>Stoduto (1993)</td>
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</tbody>
</table>
If the tendency among rave-goers is to wait for the dissipation of ecstasy effects before driving away, police intervention in and shutting down of raves may create traffic dangers by impelling ecstasy-affected drivers to take the wheel immediately.

In this context, traffic safety should be a consideration when deciding policy on raves.

<table>
<thead>
<tr>
<th>Country</th>
<th>All drivers (road surveys)</th>
<th>Weekend drivers</th>
<th>Suspected drivers</th>
<th>Drivers involved in accidents (including killed)</th>
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</thead>
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<td></td>
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<td>1%</td>
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<tr>
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<tr>
<td>Denmark</td>
<td></td>
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<tr>
<td>Germany</td>
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<td>2%</td>
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<tr>
<td>Canada</td>
<td></td>
<td></td>
<td>14%</td>
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</tr>
</tbody>
</table>
Prevalence of cocaine among various populations of drivers

Cocaine prevalences are less important than the other illicit drugs, except for Spain (where the situation is the opposite of that for cannabis) and the USA (which reflects the importance of cocaine use in this country).

<table>
<thead>
<tr>
<th>Country</th>
<th>All drivers (road surveys)</th>
<th>Weekend drivers</th>
<th>Suspected drivers</th>
<th>Drivers involved in accidents (including killed)</th>
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<tr>
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<td>0.7%</td>
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<tr>
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<td>1%</td>
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<tr>
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<tr>
<td>Marquet (1998)</td>
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<td>1.8%</td>
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<tr>
<td>Möller (1994)</td>
<td>0.01%</td>
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<tr>
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<td>0.5%</td>
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<tr>
<td>Zancaner (1995)</td>
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<td>0.7%</td>
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<td>Mathijsen (1998)</td>
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<tr>
<td>Alvarez (1997)</td>
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<tr>
<td>Mercer (1995)</td>
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<td>Stoduto (1993)</td>
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<tr>
<td>Marzuk (1990)</td>
<td></td>
<td></td>
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<td>20%</td>
</tr>
<tr>
<td>Brookhoff (1994)</td>
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<td>25%</td>
</tr>
</tbody>
</table>
Psychoactive substances and the type of road user

Only one British work has published disaggregated data, shown in Table 7; alcohol seems to be more prevalent among pedestrians, cannabis among car passengers and multiple drug use among two-wheel drivers.

<table>
<thead>
<tr>
<th>Table 7: Substances prevalence in 619 traffic fatalities (DETR, 1998)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td>Licit drugs</td>
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<td>Illicit drugs</td>
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<tr>
<td>Of which:</td>
</tr>
<tr>
<td>cannabis</td>
</tr>
<tr>
<td>amphetamines</td>
</tr>
<tr>
<td>opiates</td>
</tr>
<tr>
<td>cocaine</td>
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<tr>
<td>methadone</td>
</tr>
<tr>
<td>multiple drugs</td>
</tr>
<tr>
<td>BAC &gt; 0.8</td>
</tr>
</tbody>
</table>

Conclusion of prevalence studies

1. It is hard to reach a conclusion, because sample selection is different from one country to another and from one study to another, and because THC concentrations in blood or urine are not predictive of the impairment level.
2. Despite methodological problems, it is clear that alcohol (associated with 30 per cent of traffic casualties) still constitutes a traffic safety problem which is more significant than that due to illicit drugs.
3. If cannabis is the most frequently detected illicit drug, the frequent co-occurrence of drinking and the absence of a clearly demonstrated relationship between cannabis use and accident responsibility should not lead to an unequivocal and rapid conclusion. It is obvious that epidemiological work must continue on larger populations of drivers responsible for accidents and on control groups, in order to go further than the descriptive point. For example, good and valid control groups are still missing: we need blood samples of control subjects, which are very hard to obtain because of ethical and legislative aspects. Saliva seems the most promising biological fluid in this respect, as has been shown in Quebec. For the moment, accident responsibility attribution is still biased by confounding factors like alcohol or age and so is not independent from these.
4. Concerning accident responsibility, odd ratios for cannabis-alcohol do not seem superior to odd ratios for alcohol alone; maybe because of the inhibition of risk taking, cannabis use reduces the severity of accidents and the probability of being responsible (however, impairment could increase the probability of less severe accidents). Responsibility would only be associated with very high concentrations of THC (for chronic users, for example). Cannabis could be considered as a marker of excessive drinking, and cannabis detection could be preventive in this perspective (excessive drinking being the main causal factor of accidents). In a public health perspective, we should be able to determine the developmental paths: does excessive drinking lead to cannabis use? Does cannabis use lead to excessive drinking? In any case, the prohibition of cannabis on the road would surely not produce important safety gains, because young 'drinkers-smokers' would continue to drink, 'coming back' from cannabis to alcohol or to other illicit drugs.
Illicit drug users’ attitudes and representations about road risk

“Law does not forbid to drink but forbids to drive when one has drunk … on the other hand, for cannabis, law forbids to smoke but does not forbid to drive after having smoked … so it is different.”

(one subject quoted in Esterle-Hedibel, 1999).

This ironic formula sets out well the paradoxical outlook of society on alcohol and drugs.

Very few studies have been conducted on drug users’ attitudes: one French (Esterle-Hedibel, 1999) on 50 drug addicts, and one British (Albery, 2000) on 210 drug addicts just out of treatment.

What do they say?

1. Once again, the importance, not of the product in itself, but of the mode of consumption: chronic users of cannabis or heroin will minimise the risk more than occasional users; the absence of a law or of a detection test reinforces the denial of danger. This denial of danger is not specific to drug users, we have often observed it with drinkers or speed maniacs: optimism bias and self-superiority bias will lead drug users to consider that the main danger on the road is alcohol and not illicit drugs. As we know, people who are dangerous on the road are always somebody else but not me.

2. On the effects of illicit drugs on driving style, drug users’ statements reflect experimental works: risk of sleepiness for cannabis or heroin, risk of impulsiveness or irritability for cocaine, risk of hallucinations for LSD, risk of speed perception for ecstasy.

3. Drug users do not really feel they are committing a transgression: cannabis and ecstasy users feel that their consumption does not present any risk, opiate users feel that they commit in other domains of life much riskier transgressions than driving under influence. Indeed, this is one of the main discoveries of modern social psychology: starting from their behaviour, and in order to reduce the tension produced by cognitive dissonance, people will re-structure their knowledge and attitudes – it is not what people know or think that determines what they do, it is what they do that determines what they know or think.

4. Of course, these psychological mechanisms underlying danger denial do not explain totally drug users’ behaviour; another important factor is exposure to media campaigns – we have communicated a lot on the risks of drinking in the last 50 years, and still very little on the risks of other psychoactive substances, so it is logical that drug users perceive more clearly the risk of drink-driving.

This means that there is here a field wide open for prevention.

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**Alcohol and traffic safety**

**Licit drugs and traffic safety**


**Illicit drugs and traffic safety**


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Driver sleepiness: can devices based on reaction time help?
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Introduction

A driver's response time in applying the brakes in an emergency is commonly thought to be impaired by sleepiness. Thus, reaction time (RT) given as a task secondary to driving has been seen to be a valid method for monitoring sleepiness, measured by means of the driver pushing a steering-wheel or foot-operated switch in response to stimuli generated within the vehicle. However, driving studies indicate that sleepy drivers will either respond normally to an emergency or not at all; that is, driver response time is disrupted by sleepiness rather than reflecting a gradual decline (Riemersma, Sanders, Wildervanck and Gaillard, 1977). Research outside the field of driving has demonstrated that the deterioration in RT performance with sleepiness is reflected in only a portion of responses being impaired, often through momentary lapses, as the majority of responses remain within normal parameters (Dinges and Kribbs, 1991). However, as such studies usually involve 24 hours of sleep deprivation, little is known about what might be expected with RT as a secondary task under less extreme but more typical conditions, such as during the afternoon 'dip': following a night of disturbed or restricted sleep.

Another issue concerning the application of RT as a secondary task during driving, is that with monotonous roads the very act of responding to the RT stimuli could have an arousing effect, particularly if the stimuli are frequent. Whilst this might seem to be beneficial, it masks underlying sleepiness. Moreover, too frequent a stimulus rate (eg averaging every 30 seconds) might even be counterproductive in distracting (even momentarily) the driver from attending to the road, which is why Mackie and Wylie (1991) advocated caution about such techniques. On the other hand, an infrequent stimulus (eg averaging 4–5 minutes) is unlikely to have such an effect, and could be more sensitive to sleepiness. Unfortunately, the infrequency makes it of less use in detecting sleepiness, as a critical stimulus might come too late to avoid an accident. Ideally, one might undertake a frequency-response study to determine an optimal stimulus presentation rate between these two extremes, but this would be a costly and time-consuming procedure.

With these issues in mind, we evaluated the application of simple RT using an auditory stimulus, given with inter-stimulus intervals averaging $\frac{21}{2}$ minutes, within the context of moderate and known levels of sleepiness, and using our standard driving protocol. In these respects we wished to see whether RT reflects this sleepiness, and/or otherwise affected driving behaviour.
Study design and methodology

Most sleep-related vehicle accidents occur in young adults (Horne and Reyner, 1995) and we targeted this age group. Participants selected for the studies comprised 10 people, equal men and women, aged 20–29 years, healthy (medication-free), experienced drivers (driving for >2 years averaging >3 hours per week), good sleepers, sleeping regular hours and infrequent daytime nappers (<once a month), and were recruited by advert. None complained of daytime sleepiness, or indicated potential sleep disorders in a screening questionnaire. Their Epworth Sleepiness Scores (Johns, 1991) were within the normal range 0–10. They had the procedures fully explained to them, signed consent forms, and were paid to participate.

On an initial day following a normal night’s sleep, participants had an afternoon two-hour baseline practice drive on the simulator (see below). A week later they underwent two treatment conditions, a week apart, with both conditions having sleepiness enhanced by sleep restricted to five hours (delayed bed-time) the night before. Driving was between 14:00 and 17:00, when daytime sleepiness tends to increase due to the circadian ‘afternoon dip’ and sleep-related accidents increase (Åkerstedt, Czeisler, Dinges and Horne, 1994; Horne and Reyner, 1999). Participants slept at home, with sleep monitored by wrist-actimeters. Both conditions comprised an initial ‘warm-up’ 30 minutes drive followed by a 30-minute break and then a two-hour continuous drive (see below). In the RT condition participants also had to respond to an audible stimulus by pressing, as soon as possible, a thumb-activated microswitch on the steering wheel. Stimuli were randomised with an inter-stimulus range of 50 to 300 seconds, averaging 150 seconds. RT began during the initial 30-minute period. We used this simple form of RT in order to minimise practice effects and distraction from driving. The second condition was ‘normal’, without RT. The order of these two conditions was counterbalanced.

The driving simulator comprises an immobile car with an interactive full size computer-generated bending, dull and monotonous roadway projected on to a 2.0m × 1.5m, screen located 2.3m from the windscreen. There are two ‘up’ and two ‘down’ lanes, hard shoulder and simulated auditory ‘rumble strips’. Participants sit in the driving seat and drive at their normal cruising speed within white lane markings. Lane drifting is the usual manifestation of sleepy driving, which was automatically detected by the computer data-logger from continuously recorded steering data. A car-wheel crossing a lateral lane marking is the criterion for this detection, and identified as an ‘incident’. An unobtrusive infrared camera films the driver’s face, which is recorded with the roadway using a split-screen video display. The video data are further analysed by a skilled assistant ‘blind’ to the experimental conditions, whereby all the automatically identified incidents are checked to see whether: (i) these are due to driver distraction (looking elsewhere), which are discounted, or (ii) to episodes associated with sleepiness (ie eye ‘rolling’ or vacant staring ahead). The electroencephalography (EEG) (see below) during (i) shows little alpha and theta activity, whereas during (ii) either or both activities are present, often with slow ‘eye rolling’ on the electrooculogram (EOG) (see below). Additional quality checks on these video, EEG and EOG data are undertaken ‘blind’, by one of us (LA Reyner).

Every 200 seconds, participants are asked to respond verbally with a number from the 9-point Karolinska Sleepiness Scale (KSS, Åkerstedt and Gillberg, 1990): 1 = extremely alert, 2 = very alert, 3 = alert, 4 = rather alert, 5 = neither alert nor sleepy, 6 = some signs of sleepiness, 7 = sleepy, no effort to stay awake, 8 = sleepy, some effort to stay awake, 9 = very sleepy, great effort to keep awake, fighting sleep. The scale and descriptors were printed on the car’s dashboard, within easy view of the driver.

Electrodes were attached for one channel of EEG (C3-A1). To identify ‘eye-rolling’ two channels of EOG were also recorded (electrodes 1cm lateral to and 1cm above left outer canthus, and 1cm lateral to and 1cm below right outer canthus; both referred to A2). The EEG was digitally recorded using the ‘EMBLA’ system (Flaga, Iceland), and spectrally analysed in four-second periods. High and low band-pass filtering of the EEG at >15Hz and <4Hz removed slow eye movements and muscle artifact. There was some unavoidable eye blink contamination on the EEG, which was mostly filtered out, and does not bias the EEG outcomes (Horne and Reyner, 1996). Increases in EEG power in the alpha (8–11Hz) and theta (4–7Hz) ranges indicate increasing sleepiness (eg Horne and
Reyner, 1996; Kecklund and Åkerstedt, 1993). We (Horne and Reyner, 1996) have found that under these conditions summation of alpha and theta (i.e., slower EEG activity in the range 4–11 Hz) showed more consistent EEG findings in relation to driver sleepiness than either alone. For example, some sleepy subjects display alpha surges, others show little alpha but much theta (c.f. Horne and Reyner, 1996; Rechtschaffen and Kales, 1968). EEG power in this frequency range, for the four-second periods, was averaged in one-minute epochs and standardised (to remove individual differences in mean EEG power levels) for each participant by the following transformation (Horne and Reyner, 1996) before averaging across participants:

\[
\text{Transformed epoch} = \frac{\text{Difference from mean of first 30 minutes}}{\text{Standard deviation of first 30 minutes}}
\]

For the two-hour continuous drive, incidents, EEG and subjective sleepiness data were averaged into four 30-minute periods per subject and condition, and two-way (condition x time) repeated measures ANOVAs (analysis of variances) were applied (using the Huynh-Feldt epsilon adjustment to degrees of freedom). In the case of the RT data over the two-hour period, these were analysed in 15-minute blocks, using a one-way repeated measures ANOVA (i.e., for a time effect only).

**Results**

Figure 1 presents mean KSS scores over the two hours of driving for both groups and sleep conditions. When assessed in 30-minute periods, subjective sleepiness was significantly less with RT (F=7.89 [1, 9] p<0.02; Huynh-Feldt ε=1). The effect of time was also significant (F=12.61 [1.5, 13.5] p<0.02; df corrected by ε=0.51). This time effect also showed a significantly quadratic (‘inverted U’) trend, with an increase in sleepiness during the mid-afternoon circadian dip, followed by an improvement in alertness. There was no significant interaction between condition and time.

![Figure 1: Mean subjective sleepiness data](image-url)
Figure 2 gives the mean numbers of driving incidents. Although there was a trend for these to be lower with RT, this failed to reach significance. Again, there was a significant effect of time ($F=6.31 \ [2.5; 22.2] p<0.004$; $df$ corrected by $\varepsilon=0.82$), that was also significantly quadratic. There was no significant interaction.

![Figure 2: Lane drifting incidents related to sleepiness](image)

With regard to the EEG, Figure 3 shows both conditions to have similar trends for the first hour or so, with RT leading to a less sleepy EEG thereafter. However there were no overall significant effects for either condition or time.

![Figure 3: Standardised EEG power for normal and RT conditions](image)
The mean RT data for the RT condition can be seen in Figure 4. These levels remained fairly stable throughout the two-hour drive, with the fluctuations across the 15-minute epochs being small and non-significant.

Figure 5 is compiled from Figures 1 and 4 and compares both KSS and RT trends over time. The correlation between these values over the two hours was non-significant at $r=0.08$ ($df=9$). RT data were checked for possible 'lapses', i.e. response times in excess of two seconds. These occurred for only three out of a total of 480 RT responses (48 responses for each participant). Although each was also associated with a driving incident, the reverse was not true. That is, for the great majority of driving incidents which were indicative of lapses, there was no apparent RT lapse to be seen in the nearest RT response, either preceding or following the incident.

**Discussion**

Under these driving conditions and levels of sleepiness, the auditory RT method we adopted was not sufficiently sensitive to sleepiness and lapses in driving ability, even though there were manifest signs of sleepiness in the form of increased lane weaving (incidents). However, inasmuch that the RT provided more activity and 'stimulation' for the sleepy driver during a monotonous drive, it reduced subjective sleepiness and somewhat improved driving ability as measured by incidents. It could be argued that had we used more participants, then RT might have shown small but statistically significant effects. However, in terms of practical use such statistical criteria are not appropriate.

There are various reasons for the disparity between driving incidents and RT performance. The RT stimuli only occurred on average every two minutes, whereas the average interval for the incidents was approximately seven minutes. As each event (incident or RT response) only occupied a second or so, it is unlikely that both would coincide, especially as the RT task was an externally paced event, whereas the incidents were caused by the driver. Also, both types of event could alert the driver for a while, and facilitate normal behaviour with respect to the next RT stimulus or potential for lane drifting.
On the other hand, lapsing detected by these RT methods may be too late for a speeding driver to avoid a collision, as the vehicle may already be running off the road during the lapse. A further issue is that even during stage 1 sleep, a person has about a 50 per cent chance of responding normally (with a microswitch) to an auditory signal (Ogilvie, Wilkinson and Allison, 1989) without fully awakening. Such findings suggest that even during a lapse, a sleepy person could still respond to an auditory stimulus; that is, not all lapses are detected by RT.

We have shown previously (Reyner and Horne, 1998) that sleepy drivers have good insight into their level of sleepiness. The present findings further confirm this, as shown by increasing sleepiness reflected by the KSS data. The failure of the RT data to reflect this, given that sleep-related incidents also increased, as did EEG determined sleepiness, indicates that subjective sleepiness provides a better gauge to sleepiness than does RT.

What must seem to be ill-conceived commercial RT devices aimed at sleepy drivers are coming on to the market. We (Reyner, Barrett and Horne, 1999) examined one of these, that was claimed by the manufacturers to help maintain or improve driver alertness. Although based on auditory RT, it was more demanding of the driver’s attention than was the case here. Alert drivers could cope adequately with both driving and the RT system, but when they became sleepy the device distracted them from the immediate driving task, and led to more incidents. This made them realise that they were having difficulty coping, which in turn heightened their perception of sleepiness. However, the RT responses showed no clear or consistent changes, indicating that the sleepy drivers put more compensatory effort into the RT device (perhaps in order to avoid triggering the loud and rather aggravating warning tone), at the expense of driving ability. In sum, an RT system demanding effort and attention by the sleepy driver may lead to unwanted distraction from driving, whereas a less demanding RT system of the type we used here may be beneficial in improving overall alertness. That is, the ‘inverted U’ concept for arousal and performance applies here. Nevertheless, neither system was effective in detecting sleepiness.

Together, all these factors illustrate some of the difficulties with RT as a secondary task to detect driver sleepiness. Maycock (1998) in his recent unpublished, comprehensive review of this topic concluded that many aspects of this area require further investigation, and it cannot be said with any confidence that RT as a
fatigue monitoring method could be made both effective and reliable. Above all, and as Maycock pointed out, we do not really know what is being monitored by RT within the context of driving.

In summary, under this experimental protocol, RT did not provide a useful guide to driver sleepiness. Seemingly, it was merely a mechanism for increasing task load and reducing monotony. The drivers’ own insight into their sleepiness had more validity as a tool for assessing sleepiness.

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The Accidents And Behaviours of Bus Drivers

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Introduction

Vehicles that are being driven during the course of work activities cause a significant number of road traffic accidents, with estimates being as high as 30 per cent of all accidents. Given that in the UK there are over 156,000 bus and coach drivers driving approximately 80,000 vehicles over 4.1 billion vehicle km every year, according to the Confederation of Passenger Transport (www.cpt-uk.org/cpt), it is likely that the passenger services industry is making a contribution to the high number of work-related accidents. Indeed, in 2000, there were 149 people killed and 16,412 people injured in an accident involving a bus or coach. Reducing accident rates will not only improve road safety but also increase revenue for bus companies. Yet, efforts by bus companies to take a more active role in reducing bus accidents have been largely piecemeal. An exception to the rule is the commitment ARRIVA Passenger Services Ltd (APS Ltd) has made to improve safety through its core strategy. As well as other company initiatives, APS Ltd have introduced a wide-scale research programme based at Cranfield University aimed at reducing bus accident rates. As a major player in passenger services with a fleet of 6,700 buses, their investment helps to support the Government’s road safety strategy to significantly reduce accident rates by 2010. The research, administered by the TCD (Teaching Company Directorate) and jointly funded by the Economic and Social Research Council, the Department for Trade and Industry and APS Ltd, began in September 2001. The researchers are working on three related projects. The first is concerned with the development of a bus-driving simulator to support driver training. The second project involves the design of a psychometric measure to help select drivers who may require additional driver training. The third project aims to underpin a commitment to an organisational safety-oriented culture.

Bus driver health and accident involvement

Driving a bus is potentially stressful and yet it also involves paying strict attention to the traffic environment and processing a vast array of different incoming potentially hazardous signals. A large number of studies have indicated that bus driving is a high-strain occupation characterised by high demands, low control and low support, leading to a high risk of physical and mental occupational ill-health. The effects of stress are cumulative. Negative reactions to stressors gradually develop after continued exposure with insufficient time for recovery. The bus driver’s mental well-being has also been shown to suffer. Evans (1994) reported that 13 per cent of the sample of drivers in his study scored in the range equivalent to hospitalised psychiatric patients as a consequence of work-related stress (Kompier and di Martino, 1995; Winkleby, Ragland, Fisher and Syme, 1988). Research into bus driver health has highlighted the prevalence of physiological stress (Carrere, Evans, Palsane and Rivas, 1991; Evans and Carrere, 1991; Raggatt and Morrissey, 1997; Gobel, Springer and Scherff, 1998) and how this is mediated by external demands such as traffic density (Netterstom and Hansen, 2000);
size of the bus being driven (Duffy and McGoldrick, 1990) and the need to be on time to pick up passengers (Meijman and Kompier, 1998). Netterstrom and Hansen (2000) found that perceived control on the job mediates the stress response; the higher the exposure to traffic congestion and the less control perceived by bus drivers, the more pronounced their psychophysiological stress response.

There are several reasons why bus drivers may be vulnerable to stress. Work overload, time pressures and responsibility for people’s lives are possible sources of stress arising from factors intrinsic to the job of being a bus driver. For example, when drivers have to cope with traffic congestion and the boredom of routes, it is likely that they become increasingly apprehensive, frustrated or angry and respond to traffic conditions with increasing aggression or fatigue (see Matthews and Desmond, 1997). Bus driver stress, then, may be a matrix of feelings of aggression, irritation, anxiety, worry, impatience, fatigue and concerns about the behaviour of other drivers, and can be explained by reference to the transactional theory of driver stress. Here, problematic outcomes can be predicted by interactions between personality and perceived environmental demands.

Within the transactional process, bus driving involves a balance between coping with time pressures and traffic situations and passengers’ needs. Bus drivers have to respond to schedules, rotating shift work and have little opportunity for autonomy or control over their pace of work. Furthermore, bus drivers face contradictory demands, for example the need to drive safely and the need to be on time. In response to bus driver stress, there are likely to be significant individual differences in the choice of driver coping strategy. Coping strategy selection depends on the driver’s motivation and beliefs about the driving task. Performance impairment is associated with the downgrading of the goal of maintaining performance efficiency in favour of other competing goals such as sticking to a schedule and maintaining safety. In this way, the bus driver’s appraisal of job and driving-related events is likely to determine the level of stress experienced.

Previous research has suggested a link between stress and accident involvement. The occurrence of stressful life events requires psychological readjustment and, during this process, driving performance may be impaired and lead to accidents. For example, Finch and Smith (1970) found that 80 per cent of 25 drivers killed in road traffic accidents had experienced one or more significant stressors within a 24-hour period prior to the accident. Furthermore, McMurray (1970) demonstrated that the accident rates of people involved in divorce doubled during the six months before and after the divorce date, and Selzer and Vinokur (1974) found that life changes and subjective stress were significantly correlated with accident rates. Hartley and Hassani (1994) compared driver stress scores with accident involvement rates between truck and car drivers in Australia. About one-third of the truck drivers’ and about 40 per cent of the car drivers’ accident and conviction rates were predicted by self-reported driver stress. Among bus drivers, Evans and colleagues (Evans and Courtney, 1985; Evans, Palsane and Carrere, 1987) found that emotional stability and personality-based stress responses are related to accident frequency and increased absenteeism.

Measuring Bus Driver Stress

Since the late 1980s, research on the development of a measure of driver stress has culminated in the design of the Driver Stress Inventory (DSI), which aims to measure an individual’s vulnerability to commonplace stress reactions during driving, such as frustration, anxiety and boredom. Often, such stress is relatively mild, but more severe stress reactions may disrupt driver performance and reduce safety (Dorn and Matthews, 1995). Matthews, Dorn and Hoyes (1992) proposed that driver stress vulnerability relates to cognitive processes of appraisal and coping specified by the transactional models of stress (Lazarus and Folkman, 1984). There are five dimensions of driver stress: Aggression, Dislike of Driving, Hazard Monitoring, Thrill Seeking, and Fatigue Proneness. Aggression and Dislike of Driving are broad stress syndromes associated with differing cognitive reactions to driving. Aggression is characterised by negative appraisals of other drivers and Confrontive Coping, expressed through intimidation or competing with other drivers. These cognitive processes tend to generate, first, feelings of anger, and, second, dangerous driving behaviours, which reduce safety. Aggression, Thrill Seeking and low scores in Hazard Monitoring are all associated with accident
involvement (Matthews, Dorn and Glendon, 1991). While Aggression and Thrill Seeking have risk-taking overtones, Hazard Monitoring has been shown to deliver a safety benefit in driving performance. Fatigue Proneness and low Hazard Monitoring were also associated with higher error rates, with Thrill Seeking and Aggression more strongly related to more dangerous errors than to minor lapses in on-road driving (West, Elander and French, 1993). Matthews, Dorn, Hoyes, Davies, Glendon and Taylor (1998) found that Aggression was associated with speed and risk taking in a driving simulator. In contrast, Dislike of Driving is associated with negative self-appraisal and use of emotion-focused coping strategies such as self-blame. These cognitions generate negative mood states and worries, which tend to interfere with task performance and may result in accidents, albeit for different reasons from those high in Aggression and Thrill Seeking. Finally, of particular interest in the present studies is the Fatigue Proneness dimension, given that bus drivers are required to drive for long hours under demanding conditions (Desmond, Matthews and Hancock 1997).

The DSI also incorporates the Driving Coping Questionnaire (DCQ), designed to identify the cognitive appraisals and coping strategies that a driver brings to the driving task. Cognitive appraisals are both situation and person specific. Examples of situation-specific cognitive appraisals might concern traffic density or time urgency. Also, people differ in their predisposition to evaluate a driving scenario as threatening. Therefore, coping is the opportunity afforded by both the situation and the person. A change in driving performance, as a result of an external stressor, is a complex outcome of the person/environment transaction. Some drivers choose a risky strategy while some are distracted by their own negative cognition. In addition, self-knowledge and beliefs about personal competence and generic plans for coping are critical in the manifestation of the driver stress response. There are five basic coping mechanisms appropriate to the driving context measured using the DCQ: Task-focus Coping, Emotion-focused Coping, Confrontive Coping, Reappraisal and Avoidance. Emotion-focused Coping refers to self-criticism. Confrontive Coping involves mastery of the driving challenge through self-assertion or conflict. Task-focus Coping refers to active attempts to change the external environment via a behavioural response (eg reducing speed when driving conditions are dangerous). Conversely, Reappraisal Coping attempts to deal with the stressor by reappraising one’s emotional and cognitive reactions by looking on the bright side, whereas Avoidance is the attempt to ignore the stressor, often through self-distraction.

Jacobs, Conte, Day, Silvia and Harris (1996) have reported on the selection of safe bus drivers on the basis of scores on a set of personality and cognitive-based measures. However, multiple assessments are time consuming so the focus for the present research programme is to develop a single psychometric measure. Although previous investigations of personality correlates of accident involvement have been unfruitful, a psychometric measure tailored specifically to personality-based aspects of driving behaviour may be more beneficial in predicting accidents. This would be useful not only in the profiling of bus drivers but also for selection purposes to target those drivers who need additional driver training.

This paper reports two pilot studies to investigate whether a bus driver risk assessment and the DSI are able to discriminate between safe and unsafe bus drivers. The first is a driver assessment method designed to identify bus drivers who may require additional driver training. The second investigates whether dimensions of bus driver stress (as measured by an adaptation of the DSI) are associated with accident involvement.

Method

PILOT STUDY 1: PARTICIPANTS AND PROCEDURE

Seventy-three male bus drivers aged between 20 and 63 (mean age = 43) participated, of which 14 drivers in the sample had been involved in a blameworthy accident and seven had been involved in a non-blameworthy accident in the last two years. The average number of years since gaining a PCV (Passenger-Carrying Vehicle) licence was seven. The participants took about an hour to give responses to each section of the driver risk
assessment and their scores for the four sections were recorded. Information relating to accident frequency over the last two years, including blameworthiness, road type and conditions and weather and vehicle manoeuvres at the time of the accident was also recorded. An accident was defined as all incidents including collisions with other vehicles or objects and passenger falls inside the bus. Accident blameworthiness is categorised on the basis of settled insurance claims.

**MATERIALS: CD ROM-BASED DRIVER RISK ASSESSMENT**

APS Ltd risk managers developed the driver risk assessment questionnaire to measure aspects of driver safety. The items were based on the DSA theory test and presented on a CD ROM in four sections. In section one, Driver Attitude is measured with the presentation of 12 statements such as ‘talking to a passenger whilst driving will not affect my driving ability’. Respondents were asked to agree or disagree with these statements. For the remaining three sections, a video recording of a bus journey through a built-up area is presented to the participants. The video is halted at particular scenes and the respondents are asked to select from a list of possible answers with regard to the remaining three sections referred to as Driver Knowledge, Driver Behaviour and Hazard Perception. For section two there were 15 Driver Knowledge items in which respondents were asked questions relating to their knowledge of the Highway Code and road safety. For section three, 10 Driver Behaviour items were presented. Here, respondents were asked to select from a series of possible behaviours that would be the most appropriate course of action to take next in a given scene. The fourth section contained 20 items and was referred to as Hazard Perception. For the first two items in this section, respondents were given 10 seconds to click on the potential hazards in a photograph of a road scene. For the remaining 18 items, respondents were given a choice of answers designed to assess perception of hazards at particular points during the video recording. Those drivers scoring below 85 per cent for any of the sections are deemed to require further training.

**Results**

Preliminary analysis indicates a significant positive correlation between Driver Attitude and Hazard Perception ($r=0.35, p<0.01$) and Driver Attitude and Driver Knowledge ($r=0.57, p<0.01$) suggesting that more positive attitudes to driving are related to improved assessment of risk and increased knowledge of driving. A significant positive association was also found between Driver Behaviour and Driver Knowledge ($r=0.31, p<0.01$), with increased knowledge of road safety being associated with higher scores on the Driver Behaviour measure. Further analysis also found that drivers who held a more positive Driver Attitude also scored higher on Hazard Perception ($F=9.18, df=1, 71, p<0.01$). Clearly, there are associations between the driver risk sections, suggesting that they may be measuring a common underlying attitudinal and behavioural orientation towards driver safety.

The analysis of accident blameworthiness revealed that drivers who had been involved in a blameworthy accident scored lower on the Driver Behaviour measure compared with drivers who had been involved in a non-blameworthy accident ($F=8.87, df=1, 19, p<0.01$) (see Figure 1). There were no further significant findings with respect to accident involvement measures among any of the other measures of driver risk.
PILOT STUDY 2: PARTICIPANTS AND PROCEDURE

Forty-five male bus drivers and two female bus drivers participated in Study 2. There were 32 accident-involved drivers, of which 13 had had a blameworthy accident and 19 had had a non-blameworthy accident. The age of the participants ranged from 28 to 62 and the average age was 43. Participants had held their PCV licence on average for 10 years. Participants completed the adapted DSI and scores on the dimensions of driver stress and driver coping were recorded. Information relating to the drivers’ accident involvement in the last two years was also collected as in Pilot Study 1.

Results

An analysis of blameworthiness and Fatigue Proneness found a significant difference between drivers who had had a blameworthy accident compared with those that had been involved in a non-blameworthy accident (F = 11.28, df 1,29, p<0.01). It appears that blameworthy accident-involved drivers report greater levels of Fatigue Proneness than non-blameworthy accident-involved drivers (see Figure 2).
There was also a tendency for drivers who have been involved in an accident (blameworthy or non-blameworthy) under wet road conditions to report higher levels of Aggression than those drivers who have been involved in an accident when the roads are dry \((F = 3.48, df, 1,25, p<0.07)\) suggesting that increased Aggression when driving in dangerous conditions may contribute to increased accident risk (see Figure 3).

Analysis of the DCQ also revealed some significant differences between accident involvement measures and two measures of driver coping. Firstly, results showed a significant difference between drivers who have had an accident in wet conditions compared with drivers who have had an accident in dry conditions on the Reappraisal Coping strategy \((F = 6.81, df, 1,27, p<0.01)\) (see Figure 4). Secondly, there was a tendency for drivers who had been involved in a collision to report increased levels of Task Focus Coping \((F = 3.73, df, 1,29, p<0.06)\) compared with drivers who had been involved in a passenger fall accident. Perhaps after a collision, drivers make increased efforts to stay focused on the driving task (see Figure 5).
In addition, a comparison of accident-free drivers with drivers who had had one accident and drivers who had had at least two accidents on the Task Focus coping measure found that drivers who have had one or more accidents report increased levels of Task Focus ($F = 4.84, \ df = 2, 45, p < 0.01$) (see Figure 6).
Discussion

For Pilot Study 1 there is an indication that the Driver Behaviour component of the CD ROM-based driver risk assessment instrument may be useful in discriminating between blameworthy and non-blameworthy accident-involved drivers. These findings can be interpreted in the light of previous findings showing the link between behavioural intention and accidents. However, caution should be exercised in determining which drivers are categorised as safer drivers, given that all accident-involved drivers scored above 85 per cent on this measure. Moreover, the individual measures of driver risk appear to show considerable overlap. A closer inspection of the items for each section reveals that it is difficult to determine on what basis each item has been selected for a particular section. Further research is needed to evaluate the driver risk-assessment method, especially given the small number of bus drivers on which this study was based.

For Pilot Study 2 a more consistent pattern of results has emerged from the analysis of measures of bus accident involvement and the adapted DSI and the DCQ. The results show that blameworthy accident-involved bus drivers score higher on Fatigue Proneness than non-blameworthy accident-involved drivers. Previous research has identified the Fatigue Proneness dimension of the DSI to be the best single predictor of task-induced fatigue (Matthews and Desmond, 1998) compared with other measures employed in their study. Fatigue Proneness has also been found to be associated with higher error rates in studies of on-road driving (West et al., 1993). When driving on familiar routes and monotonous journeys, perhaps fatigue prone bus drivers pay less attention to processing hazardous stimuli.

The finding with respect to a tendency towards increased Aggression and accidents in wet conditions can be supported by previous research showing a link between Aggression and risky behaviours (Dorn and Matthews, 1995). Furthermore, West et al., (1993) found that Aggression was more strongly related to dangerous errors than to minor lapses in on-road driving. The results for the DCQ show that drivers who have had an accident in dry conditions report increased levels of Reappraisal Coping compared with drivers who had had an accident in wet conditions. One possible interpretation is that when accidents happen under favourable conditions and the weather cannot be blamed for its occurrence, drivers are more likely to reappraise emotional and cognitive approaches to the driving task and try to evaluate what went wrong and learn from their experience. For Task Focus, findings show that collision-involved drivers scored higher than drivers who had had a passenger fall inside their bus. Analysis also revealed that drivers who have had at least one accident
The accidents and behaviours of bus drivers

report increased Task Focus Coping. Perhaps accident-involved drivers make an increased effort to stay alert after experiencing a collision.

Conclusion

The results from Pilot Study 1 reveal that further research on the validity of the risk assessment method used by APS Ltd needs to be undertaken. Pilot Study 2 has helped to identify some potential avenues of research for future large-scale studies. Future work will attempt to identify the relationship between bus driver stress and accidents and ways of reducing driver stress if this relationship is established. There are three possible options to reduce stress among bus drivers. Either we could focus on modifying the stress-producing circumstances, or we might consider changing the work to fit the characteristics of the bus driver. For example, fatigue prone drivers might be encouraged to only drive certain schedules and routes. Alternatively, we might design training materials that help to strengthen the driver's coping responses.

Acknowledgement

We would like to thank Lynne Beale, Group Risk Manager of APS Ltd for her contributions to this paper.

References


DBQ in disguise: confirmatory factor analyses on a four-factor model

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Abstract

The aim of this paper is to investigate the feasibility of a four-factor solution of a Swedish version of the Driver Behaviour Questionnaire (DBQ-SWE). Previous studies on the British DBQ, as well as the DBQ-SWE, have used an exploratory factor analysis (EFA) technique. The present study is the first using confirmatory factor analysis (CFA). In EFA one explores data to tease out eventual links between the variables included and obtain a smaller number of factors. In contrast, in CFA a hypothesised model is imposed on the data in terms of limited parameters. The latter technique allows testing of how well the model fits data obtained on a single sample or data from several samples.

Responses on the DBQ-SWE were obtained from more than 6,000 Swedish male and female drivers. Several individual samples were formed representing different age spans. The DBQ-SWE model was shown to be an approximate fit relative to four of the individual study samples. In addition, the model was an approximate fit relative to the gender of the respondents in these four samples. The model did not perform well with respect to data from relatively older drivers. The discussion includes methodological issues connected to DBQ-related investigations.

Introduction

In a line of studies, Reason, Manstead, Stradling, Baxter and Campbell (1990) were the first to investigate unsafe driving behaviour using a self-assessment questionnaire known as the Driver Behaviour Questionnaire (DBQ). It has been used in many subsequent studies, mostly addressing quite large samples, in Britain and in other countries (eg, Meadows, 1994; Lawton, Parker, Manstead and Stradling, 1997a; Lawton, Parker, Manstead and Stradling, 1997b; Parker, Lajunen and Stradling, 1998; Parker, McDonald, Rabitt, and Sutcliffe, 2000; Åberg and Rimmö, 1998 (in Sweden); Blockey and Hartley, 1995 (in Australia).

The DBQ questionnaire has a rather simple form, depicting erroneous behaviour in a variety of traffic-related situations. The respondents are instructed to indicate how often they have experienced each situation on a six-point scale ranging from ‘never’ to ‘very often’. A typical question would be of the form; ‘how often do you’ followed by a description of a traffic-related situation. For example, ‘how often do you’ ... ‘deliberately exceed the speed limit on main roads during low traffic’, ... ‘try to shift into a higher gear although you’re already in the highest gear’, or ... ‘misjudge the road surface and when braking find the distance required to stop to be longer than you expected’.

The 50-item DBQ was administered in an initial study (Reason et al., 1990) to about 500 British drivers representing a broad age range. In a subsequent study, Parker, Reason, Manstead and Stradling (1995) administered a shorter version of the DBQ that included 24 marker items (eight items for each of the three
This self-assessment questionnaire was given to nearly 2,200 (1,600 responding) respondents sampled from a national pool of drivers. They successfully replicated Reason et al.’s (1990) three-factor solution on the 24 marker items derived from the first study.

Despite the fact that drivers’ self-reports are only approximate estimates, the three-factor solution of the DBQ has shown a remarkable stability. One exception, however, is the Blockey and Hartley (1995) replication study in Australia, in which a somewhat dissimilar factor structure was observed. However, it is reasonable to assume that this dissimilarity might have been obtained because of differences in sample size (only 135 respondents in the Blockey and Hartley study versus over 500 respondents in the British studies).

The DBQ studies have been based upon Reason’s Generic Error Modelling System (GEMS; Reason, 1987). GEMS is a framework of cognitive biases that can result in predictable human errors and includes Norman’s (1981) distinction between mistakes and slips. According to Norman (1981), mistakes are planning failures, whereas slips are execution failures. For instance, a driver would make a mistake in deciding to brake in a situation where the appropriate action would have been to accelerate. In contrast, it would have been a slip to accelerate if the actual intention was to brake. Thus, a mistake is an effect of an intention, and a subsequent correct action, which, however, is inappropriate in the sense that it does not meet the goal initially intended. A slip is a deviation in action from what was meant which results in a faulty performance. A variant of execution error is a lapse, a deviation in execution due to memory failure (e.g., omitting an action). Hence, slips and lapses are often referred to as one type of error (Reason et al., 1990).

Reason (1990) refers to a number of well-known disasters in which human errors have been attributed as the main causal factor and stresses the importance of violations, defined as deliberate deviation from safe practices. With this extension, violations, mistakes and slips and lapses are thought of as instances of human unsafe actions in a hazardous system.

<table>
<thead>
<tr>
<th>Table 1: <strong>Marker items of the DBQ-SWE</strong> (abbreviates text)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Violations factor</strong></td>
</tr>
<tr>
<td>1. Deliberately disregard speed limits.</td>
</tr>
<tr>
<td>2. Disregard speed limit to follow traffic flow.</td>
</tr>
<tr>
<td>3. Deliberately speed when overtaking.</td>
</tr>
<tr>
<td>4. Illegal parking to perform an errand.</td>
</tr>
<tr>
<td>5. Accelerate at green/yellow phase.</td>
</tr>
<tr>
<td>6. Overtake vehicle just before low speed area.</td>
</tr>
<tr>
<td>7. Illegal parking: cannot find parking lot.</td>
</tr>
<tr>
<td>8. Drive close to car in front.</td>
</tr>
<tr>
<td><strong>Mistakes factor</strong></td>
</tr>
<tr>
<td>1. Misjudge interval when turning left.</td>
</tr>
<tr>
<td>2. Misjudge speed of oncoming vehicle.</td>
</tr>
<tr>
<td>3. Misjudge gap when overtaking.</td>
</tr>
<tr>
<td>4. Turn left into the path of an oncoming vehicle.</td>
</tr>
<tr>
<td>5. Enter road in front of other vehicle.</td>
</tr>
<tr>
<td>6. Misjudge speed exiting from main road.</td>
</tr>
<tr>
<td>7. Cut the bends when view is limited.</td>
</tr>
<tr>
<td>8. Misjudge stopping distance.</td>
</tr>
<tr>
<td><strong>Inattention errors factor</strong></td>
</tr>
<tr>
<td>1. Misread sign and find yourself lost.</td>
</tr>
<tr>
<td>2. Fail to notice ‘green arrow’.</td>
</tr>
<tr>
<td>3. Fail to notice green traffic signal.</td>
</tr>
<tr>
<td>4. Fail to notice sign about closed road.</td>
</tr>
<tr>
<td>5. On usual road by mistake.</td>
</tr>
<tr>
<td>6. Miss your exit on a motorway.</td>
</tr>
<tr>
<td>7. Fail to notice new sign.</td>
</tr>
<tr>
<td>8. Forget where car is in a car park.</td>
</tr>
<tr>
<td><strong>Inexperience errors factor</strong></td>
</tr>
<tr>
<td>1. Have to check gear with hand.</td>
</tr>
<tr>
<td>2. Shift into the wrong gear when driving.</td>
</tr>
<tr>
<td>3. Try to shift into gear already in.</td>
</tr>
<tr>
<td>4. Driving in too low gear.</td>
</tr>
<tr>
<td>5. Forget parking brake.</td>
</tr>
<tr>
<td>6. Wrong gear trying to reverse.</td>
</tr>
<tr>
<td>7. Switch on wrong appliance in car.</td>
</tr>
<tr>
<td>8. Forget to dip the lights.</td>
</tr>
</tbody>
</table>
Replication study

In a study on a random sample of more than 1,400 Swedish drivers between 18 and 70 years we included 44 of the British situations in an attempt to replicate the British three-factor solution (Åberg and Rimmö, 1998). In addition, we included 60 new situations, which were generated by some 20 drivers who were asked to describe situations in which a driver might act erroneously. The results confirmed the tripartite typology when we submitted the British item pool to a principal components factor analysis. However, when all 104 situations were submitted, a four-factor solution (DBQ-SWE) was deemed more appropriate (see Table 1). This factor solution was found to be very much in line with the British. However, there was a non-trivial difference between the factor solutions. The violations and the mistakes factors were both identified; however, the slips and lapses factor was interpreted as being split into two distinct factors. Whereas one of these (inexperience errors) was quite similar to the slips and lapses factor with respect to the reports by gender and age, the other factor (inattention errors) was shown to increase by age of the respondents, but was experienced equally often by females and males (see Figure 1).

Aim

In an interesting review on self-rating scales, Rabbitt, Maylor, McInnes, Bent and Moore (1995), apart from discussing several aspects of self-rating scales, suggested an approach to compare factor structures of data obtained from younger and older people. In an article by Blockey and Hartley (1995) they suggested that their slightly dissimilar factor solution relative to Reason et al. (1990) at least partly was dependent on sample differences with respect to age and gender.

The aim of this paper is to shed some light on the following question: is it correct to apply the DBQ-SWE four-factor model irrespective of the age and gender of the respondents?

This was investigated by establishing how well the model fits several data sets. In contrast to the DBQ studies that have been performed on EFA, the present study uses confirmatory factor analyses (CFA). Briefly, one main difference between EFA and CFA is that through the former the aim is to reduce the number of variables to obtain relatively few factors. All variance of a particular measure may be relevant (a particular item may load on all factors). In a CFA one has a hypothesis about the relations between the measurement variables and the latent variables. A particular measure is thought of as a measure indicative of only one (or few) latent variable(s).
Method and results

STATISTICAL ANALYSES

With respect to the subsequent analyses, data were prepared with PRELIS2 to obtain the correlation matrices and asymptotic covariance matrices. The model fit was established with LISREL8 using the weighted least squares (WLS) estimation method.

An exact model fit is established when the \((c^2)\) \(p\)-value is over 0.05. However, a model can be useful even if it does not fit data exactly. According to Jöreskog (1993) it may even be unrealistic to expect a particular model to hold exactly in the population. Browne and Cudeck (1993) suggest a measure of an approximate fit, the Root Mean Square Error of Approximation (RMSEA). This fit measure is not as dependent on sample size as Chi-square. Basically, RMSEA takes into account both sampling error and model error. They suggest that a RMSEA value below 0.05 is indicative of a ‘close fit’ and values between 0.05 and 0.08 (‘fair fit’) represent reasonable errors of approximation in the population. A Poisson regression analysis was performed with the GENMOD procedure of SAS8.

Study 1

For an extensive presentation of Study 1 the reader is referred to a forthcoming article in Ergonomics (Rimmö, accepted). In this study four study samples were formed representing different age spans. The first sample comprised more than 2,200 19-year-old drivers and the second included almost 1,300 respondents, all 21 years old. The third sample consisted of more than 700 respondents between 22 and 27 years old and the final sample comprised almost 1,000 respondents aged between 28 and 70 years. In additional analyses these samples were combined and then again split into male and female sub-samples.

The basic four-factor model was imposed on all study samples and submitted to CFA. The analyses were performed in two steps, of which the first explored the model fit in the respective samples. In the second step, the overall model fit was established.

Step 1

The measurement model was first imposed on the data of each sample. The model was specified such that only the eight relevant measurement variables (see Table 1) were indicators of a particular latent variable (e.g., violations), whereas these measurement variables were set unrelated to the other latent variables. Data were submitted to LISREL8 and the results showed that an exact fit criterion was not reached for any of the data sets. However, the model did meet the ‘close fit’ criterion in two samples (RMSEA = 0.038; 90 per cent confidence intervals \([CI = 0.036–0.040]\) and \(0.047\) \([CI = 0.045–0.049]\), for the data obtained on 19- and 21-year-olds, respectively) and the ‘fair fit’ criterion in the other two samples (RMSEA = 0.075 \([CI = 0.072–0.078]\) and \(0.050\) \([CI = 0.047–0.053]\) for the data obtained on 22–27- and 28–70-year-olds, respectively). Hence, following these criteria the model was an approximate fit with respect to data of all four samples.

Additional analyses were performed, after first combining the data and then split with respect to gender. The results of these analyses showed that the model was a ‘close fit’ relative to data obtained on both males and females (RMSEA = 0.039 \([CI = 0.037–0.040]\) and \(0.037\) \([CI = 0.035–0.038]\) for female and male sub-samples, respectively).

Step 2

The model was then imposed on all four data sets to obtain the overall model discrepancy (i.e., did the model fit all data sets similarly?). This analysis was constrained with respect to equal factor loading and between latent variable correlation, over all data sets.
Data from all samples were submitted to LISREL8.50 using the group facility. The results indicated that the model was a ‘fair fit’ relative to different ages ($D_{df} = 114; D_{c2} = 841.2; \text{RMSEA} = 0.070 [CI = 0.065–0.074]$).

The result of an additional analysis of the overall discrepancy with respect to gender indicated a ‘close fit’ ($D_{df} = 38; D_{c2} = 107.78; \text{RMSEA} = 0.026$).

**CONCLUSION TO STUDY 1**

These results suggest that the DBQ-SWE four-factor solution is an approximate fit to data irrespective of the age and sex of the respondents.

**Study 2**

The previous analyses were performed on respondents between 18 and 70 years. For the purpose of this paper additional model fit analyses were performed on another data set obtained on respondents between 70 and 92 years. This was however not possible to compute. Only after the inclusion of respondents between 60 and 92 years old was it possible to establish the model fit. The result indicated that the model did not fit to the data ($\text{RMSEA} = 0.110; \text{CI} = 0.110–0.120$).

An inspection of the raw data gave the impression that in the oldest sample (60–70 years) the respondents had a tendency to indicate that they had never experienced own errors on the roads (ie tended to tick the ‘never’ alternative). Therefore, data obtained on two samples (one of which was partly used in Study 2) were analysed with respect to how the respondents had responded to the DBQ-SWE. The responses obtained in these drivers between 18 and 92 years ($n = 1,498$) were analysed with respect to their tendency to answer that they had never experienced any own erroneous actions under two consecutive years. The six DBQ-SWE response alternatives range from ‘never’ to ‘very often’. Data were rearranged such that if the respondent had ticked the ‘never’ alternative on all eight items of a particular factor this was scored as one, whereas any other alternative rendered a zero score. Hence, the final scores ranged between zero (had at least one item score above ‘never’ in each of the four factors) and four (scored ‘never’ on all items in each of the four factors). This tendency was assumed to be Poisson distributed (and statistically controlled for 1/annual km, that is, low annual km drivers were assumed to be more likely to have responded ‘never’). Data were submitted to a Poisson regression using the GENMOD procedure of SAS8. The percentage of the respondents who had ticked the ‘never’ alternative and the result of the Poisson regression are shown in Table 2. Table 2 shows that, compared to the reference group (drivers between 35 and 54), the relatively younger drivers did not differ with respect to their tendency to respond ‘never’. However, older drivers were between two to three times more likely to tick the ‘never’ alternative to all items of a factor.

### Table 2: Tendency to tick the ‘never’ alternative, on all eight items of a DBQ-SWE factor (per cent and incident ratio (IDR). Drivers between 35 and 54 were selected as the reference group

<table>
<thead>
<tr>
<th>Age</th>
<th>$n$=</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>IDR*</th>
</tr>
</thead>
<tbody>
<tr>
<td>65–92</td>
<td>459</td>
<td>64</td>
<td>19</td>
<td>9</td>
<td>4</td>
<td>3</td>
<td>1.9†</td>
</tr>
<tr>
<td>55–64</td>
<td>253</td>
<td>79</td>
<td>15</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>2.7†</td>
</tr>
<tr>
<td>35–54</td>
<td>438</td>
<td>92</td>
<td>6</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>25–34</td>
<td>180</td>
<td>92</td>
<td>6</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1.0</td>
</tr>
<tr>
<td>18–24</td>
<td>168</td>
<td>93</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>6</td>
</tr>
</tbody>
</table>

* Poisson regression; controlling for 1/annual kilometres.
† $p<.0001$
CONCLUSION TO STUDY 2

These results suggest that the DBQ-SWE four-factor solution might not fit data obtained on older respondents. In addition, relatively older respondents were more likely to indicate that they had no problems compared to the relatively younger, even after control for the distance driven.

Conclusions

This paper investigated the applicability of a four-factor model of aberrant driving behaviour. Whereas previous studies have used exploratory factor analysis, these analyses were confirmatory factor analyses. The data were taken from five different samples varying in age and additional analyses were performed with respect to gender differences.

The paper addressed the question: is it appropriate to apply the DBQ-SWE four-factor model irrespective of the age and gender of the respondents?

These results suggest that the model is an approximate fit, both with respect to age and gender, provided the respondents are relatively young. Although the model did not meet an exact fit criterion, the results indicated that the model is approximately correct to apply to the relatively younger respondents. Bearing in mind that the model investigated is based on self-reports, assumed to be based on the rather general impressions a driver gets from experiences of own erroneous actions on the roads, the model performed surprisingly well. However, in the relatively older respondents the four-factor model was found insufficient. In addition, the latter age group was also more prone to indicate that they had never experienced own erroneous actions. One reason for this might possibly be a diminishing monitoring capacity by age (Rabbitt, 1990). Hence, it might simply be more difficult for the elderly to report on their own behaviour. Therefore a more careful use of a model such as the DBQ might be warranted when investigating elderly drivers than when studying younger drivers.

Provided an instrument like the DBQ-SWE performs well, it is a definitive advantage. However, it is important to investigate what the boundaries for its usefulness are.

References


Combating car dependence

SG Stradling, Transport Research Institute, Napier University, Edinburgh EH10 5BR

Introduction

In the most recent annual RAC Report on Motoring (RAC Motoring Services, 2002), launched in February 2002, 83 per cent of a large sample of UK motorists report that they are personally affected by congestion on the roads, but 83 per cent also agree ‘I would find it very difficult to adjust my lifestyle to being without a car’. In a recent study of Scottish motorists (NFO System Three Social Research and Napier University Transport Research Institute, 2001) 31 per cent report that they would like to use their car less ‘in the next twelve months’ but only a fifth of these (6 per cent of the sample) think they are likely to.

Organisms maximise under constraint (Dunbar, 2001) and were the automobile an organism we would deem it as having been remarkably successful in carving out an environmental niche and in adapting the behaviour of its host to its requirements. In little over a century cars have colonised the planet. Future historians may well characterise the twentieth century as the century of the car, during which around one billion cars were manufactured (Urry, 1999) of which over half a billion (Shove, 1998) are currently occupying the streets, garages, car parks and grass verges of the world.

Of course there are large differences in the market penetration that the automobile has achieved, from Luxembourg where there is one car for every 1.6 persons, to Bangladesh with one car per 2,274 persons. Private car ownership in Britain in 2000 stood at 23.2 million vehicles (DTLR, 2002) and the most recent figures show 27% of households with no car, 45 per cent with one, 23 per cent with two and 5 per cent with three or more (DTLR, 2002). There is however substantial variation between rural and urban areas, with only 16 per cent of households in rural areas not owning a car, compared to 36 per cent of households in Greater London and other metropolitan areas. Thus while Great Britain is a highly motorised society, levels of motorisation vary considerably from place to place.

We may distinguish, analytically at least, from out of the dense fabric of contemporary life, between car dependent places, car dependent trips, and car dependent people (Stradling, 2002a). Litman (1999, pages 1,2) lists the characteristic features of car dependent places as: high per capita motor vehicle ownership, high per capita motor vehicle use, low land use density, single-use land development patterns, large amounts of land for roads and parking, road designs favouring automobile traffic, large-scale signage for high speed traffic, and reduced pedestrian environments.

High levels of car use are seen as bringing high environmental, social and economic costs, such as pollution, road casualties, noise, congestion, social isolation, damage to wildlife and the countryside, and resource depletion (Transport 2000 Trust, 1997). In motorised countries there is concern that planning for the car has created urban areas which are more dispersed, anonymous and dangerous and less child-friendly (Adams, 1999). Mobility provides access (Adams, 1999) and in rural areas ‘isolation from services appears to be the strongest determinant of car ownership, with even the least affluent in the remotest areas running a car’ (Farrington, Gray, Martin and Roberts, 1998, page1). And across the planet cars have the potential for even further growth. As Adams (1999) asks, rhetorically, ‘What would be the result should China and the rest of the Third World sustain their growth rates in motorization and succeed in their aspirations to catch up with the developed world?’ (Adams, 1999, page 109).
Aggregate levels of car use in Great Britain

In the second half of the last century the car established itself as the dominant mode of travel in Great Britain. Figures 1 and 2 (from DTLR, 2002) show the incessant increase in GB land travel and the inexorable rise in the proportion of travel by car during this period.


Table 1 collates together figures on modal split from the most recent GB National Travel Survey update (DTLR, 2001; Tables 3.1, 3.2, 3.4). In the period 1998–00 the average GB resident, in a year, travelled almost 7,000 miles, made 1,030 trips and spent 360 hours travelling. Thus, on average, each day they travelled almost 20 miles, for an hour, making (nearly) three journeys.

<table>
<thead>
<tr>
<th>Mode</th>
<th>Distance (Miles per person per year)</th>
<th>Frequency (Trips per person per year)</th>
<th>Duration (Trip time per person per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car driver</td>
<td>3405</td>
<td>411</td>
<td>138</td>
</tr>
<tr>
<td>Car passenger</td>
<td>1950</td>
<td>228</td>
<td>80</td>
</tr>
<tr>
<td>Motorbike</td>
<td>30</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Bus</td>
<td>346</td>
<td>60</td>
<td>33</td>
</tr>
<tr>
<td>Train</td>
<td>371</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>Taxi</td>
<td>62</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>Bicycle</td>
<td>38</td>
<td>16</td>
<td>5</td>
</tr>
<tr>
<td>Walk</td>
<td>186</td>
<td>271</td>
<td>70</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6,843 miles</strong></td>
<td><strong>1,030 trips</strong></td>
<td><strong>360 hours</strong></td>
</tr>
</tbody>
</table>

Separate figures for journeys by private hire bus, van or lorry, other private vehicles, London Underground, and other public vehicles including air, ferries, light rail, etc. are not listed here but their contribution is included in the total figures. Together they contributed 455 miles, 17 trips and 13 hours of annual travel.

Recalculating the figures as percentages of the total distance, frequency and duration, Table 2 shows that 60 per cent of the travel time, 62 per cent of the trips made, and 78 per cent of the miles travelled were spent in a car, either as driver or passenger. That the proportion of travel time is lower than the proportion of travel distance illustrates one of the attractions of the car, that it is fast – more distance in less time – compared to (most) other travel modes.

<table>
<thead>
<tr>
<th>Mode</th>
<th>Distance (Miles per person per year)</th>
<th>Frequency (Trips per person per year)</th>
<th>Duration (Trip time per person per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car driver</td>
<td>50</td>
<td>40</td>
<td>38</td>
</tr>
<tr>
<td>Car passenger</td>
<td>28</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>78%</strong></td>
<td><strong>62%</strong></td>
<td><strong>60%</strong></td>
</tr>
</tbody>
</table>

Thus the car is currently the dominant travel mode in the UK, whether measured by distance, frequency or duration of travel. Even so, these figures, showing the car being used for an average 60 per cent of the average one hour daily travel time, suggest that the average car is idle for over 23 hours out of 24, consuming parking space and inexorably depreciating in value, but not actually moving. But while stationary for over 95 per cent of the day, the car, while waiting in some convenient location, embodies the potential for travel – ‘I could just jump in the car and go, if I wanted to’ – and this potential for spontaneous travel is one of the psychological attractions of the car (Stradling, Meadows and Beatty, 1999; Stradling, Meadows and Beatty, 2000; Stradling, 2002b).
Combating car dependence

Individual levels of car use in Scotland

Are motorists mono-modal transport users? Table 3 shows figures for car drivers from our recent study of a large, representative sample of Scottish adults (NFO System Three Social Research and Napier University Transport Research Institute, 2001) who indicated how often they utilised eight different transport modes.

Table 3: Distance, frequency and duration of travel by mode, GB 1998–00

<table>
<thead>
<tr>
<th>[Row per cents]</th>
<th>Most days</th>
<th>Once or twice a week</th>
<th>About once a fortnight</th>
<th>About once a month</th>
<th>Several times a year</th>
<th>About once a year or less</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car driver</td>
<td>84</td>
<td>14</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>0</td>
</tr>
<tr>
<td>Car passenger</td>
<td>13</td>
<td>37</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>4</td>
<td>19</td>
</tr>
<tr>
<td>Motorbike</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>2</td>
<td>2</td>
<td>95</td>
</tr>
<tr>
<td>Bus</td>
<td>4</td>
<td>9</td>
<td>6</td>
<td>7</td>
<td>16</td>
<td>15</td>
<td>44</td>
</tr>
<tr>
<td>Train</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>6</td>
<td>23</td>
<td>20</td>
<td>43</td>
</tr>
<tr>
<td>Taxi</td>
<td>1</td>
<td>9</td>
<td>10</td>
<td>12</td>
<td>26</td>
<td>12</td>
<td>31</td>
</tr>
<tr>
<td>Bicycle</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>6</td>
<td>10</td>
<td>4</td>
<td>70</td>
</tr>
<tr>
<td>Walk (at least 10 minutes)</td>
<td>55</td>
<td>25</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>8</td>
</tr>
</tbody>
</table>

From Table 3 it may be seen that:

- half of those who drive also travel as a passenger in a car once a week or more often (13 + 37 = 50 per cent), though one in five car drivers (19 per cent) say they ‘Never’ travel in a car as a passenger
- While approaching half of the car drivers ‘Never’ use a bus (44 per cent) or a train (43 per cent) over half therefore make regular or occasional use of each.
- 10 per cent (1 + 9) of the car drivers also take a taxi once a week or more often, though one third of car drivers (31 per cent) ‘Never’ use a taxi.
- 30 per cent (100 – 70) of the car drivers cycle, with 16 per cent (2+5+3+6) doing so ‘once a month’ or more often.
- Over half (55 per cent) of car drivers say they undertake a walk of at least 10 minutes ‘Most days’, and only 8 per cent (1 in 12 drivers) say they ‘Never’ do so.

Those who drive cars tended to travel – by whatever mode – more frequently than non-drivers. This ‘amplifier’ effect of the car on personal mobility has also been noted by Begg (1998). But most of the car drivers also undertake travel other than by car. Counting up the number of modes used by each individual found less than one per cent of car drivers (0.8 per cent: 1 in 125 drivers) using only one mode of travel, and thus being fully car dependent in the sense of doing all their travelling only by car. Four in five Scottish drivers (80 per cent) used between four and eight of the eight different transport modes. And two-thirds (68 per cent) of the non-drivers used four or more modes. Most adults, including motorists, are multi-modal transport users, using different transport modes at different times to meet their trip needs.
Substituting for the car

Are some drivers more able or more willing than others to substitute for some of their current car use? Respondents in the Scottish study (NFO System Three Social Research and Napier University Transport Research Institute, 2001) were also asked about the viability of alternative, more sustainable, travel modes to accomplish eight core lifestyle activities. Those who undertook each activity by car were asked to indicate whether or not ‘it would be practical for you’ to undertake those trips by bus, by train, by walking or by cycling. In addition, they were specifically asked to indicate if ‘None of these’ provided a practical alternative for their trip.

Table 4: ‘Which, if any, of these forms of transport would be practical for you to use for the following activities?’ (Those drivers who do each activity by car)

<table>
<thead>
<tr>
<th>[Row per cents]</th>
<th>Bus</th>
<th>Train</th>
<th>Walk</th>
<th>Cycle</th>
<th>None of these</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take children to/from school</td>
<td>16</td>
<td>&lt;1</td>
<td>59</td>
<td>3</td>
<td>28</td>
</tr>
<tr>
<td>Town centre shopping</td>
<td>43</td>
<td>13</td>
<td>23</td>
<td>2</td>
<td>31</td>
</tr>
<tr>
<td>Visit friends/relatives</td>
<td>28</td>
<td>11</td>
<td>39</td>
<td>9</td>
<td>35</td>
</tr>
<tr>
<td>Evenings out for leisure purposes</td>
<td>34</td>
<td>9</td>
<td>26</td>
<td>1</td>
<td>42</td>
</tr>
<tr>
<td>Leisure activities during the weekend</td>
<td>27</td>
<td>12</td>
<td>21</td>
<td>9</td>
<td>48</td>
</tr>
<tr>
<td>Take children to leisure activities</td>
<td>27</td>
<td>4</td>
<td>29</td>
<td>4</td>
<td>49</td>
</tr>
<tr>
<td>Go away for a weekend</td>
<td>20</td>
<td>40</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>53</td>
</tr>
<tr>
<td>Travel to work</td>
<td>28</td>
<td>9</td>
<td>15</td>
<td>10</td>
<td>55</td>
</tr>
<tr>
<td>Supermarket shopping</td>
<td>26</td>
<td>&lt;1</td>
<td>19</td>
<td>3</td>
<td>57</td>
</tr>
</tbody>
</table>

Rows sum to more than 100 per cent as for some respondents it would be practical to undertake the activity by more than one alternative to the car.

Table 4 shows which are the least and most car dependent trips. Taking children to school is the most amenable, and supermarket shopping the least amenable, to transport alternatives other than the car.

Walking is the single most frequent practical alternative for taking children to school, visiting friends and relations, and taking children to leisure activities. Making the journey by bus was the most frequently endorsed practical alternative for town centre shopping, evenings out for leisure purposes, weekend leisure activities, travel to work, and supermarket shopping. Travel by train was the most frequently endorsed practical alternative mode for weekends away.

Counting up the number of ‘None of these’ responses given by each of the car drivers in the sample found 11 per cent of the car drivers indicating that for all the core activities they undertook there was no other transport mode that they regarded as a practical alternative to car use. At the other end of the spectrum, 9 per cent of car drivers indicated that for all of the activities they undertook out of the set of nine there was at least one alternative to the car that, they deemed, ‘would be practical to use’. Farrington et al. (1998) distinguished structural dependence on the car, ‘those who are dependent on the car because there are no viable alternatives’, and conscious dependence ‘those who rely on their vehicle but could realistically undertake their journeys by alternative modes’ (Farrington et al., 1998, page 3). On these definitions, one in nine Scottish drivers showed perceived structural dependence in so far as they saw no alternatives to their current car use to accomplish access to activities, while one in 11 exhibited full conscious car dependence in so far as, despite acknowledging viable transport alternatives for each of the activities, they continued to travel to them in their cars.
Readiness for change

Are some car drivers more ready for change than others? Tables 5 and 6 show that 33 per cent of English drivers (Stradling et al., 1999, 2000) and 30 per cent of Scottish drivers (NFO System Three Social Research and Napier University Transport Research Institute, 2001) ‘would like to use the car less over the next 12 months’, though only 7 per cent of the English and 6 per cent of the Scottish drivers think they ‘are likely to’.

Table 5: Cross-tabulation of ‘In the next 12 months I would like / I am likely to use the car less, the same or more’ (English drivers)

| [Total %] | n = 791 | Like to use car | | | |
|---|---|---|---|---|
| | | Less | Same | More | Total |
| Likely Less | 7% | 1 | 1 | 9% |
| to use Same | 23 | 47 | 5 | 75% |
| car More | 3 | 6 | 7 | 16% |
| Total | 33% | 54% | 13% | 100% |

Table 6: Cross-tabulation of ‘In the next 12 months I would like / I am likely to use the car less, the same or more’ (Scottish drivers)

| [Total %] | n = 603 | Like to use car | | | |
|---|---|---|---|---|
| | | Less | Same | More | Total |
| Likely Less | 6% | 2 | 1 | 9% |
| to use Same | 21 | 53 | 3 | 77% |
| car More | 3 | 4 | 7 | 14% |
| Total | 30% | 59% | 11% | 100% |

One influence on this readiness for change is the current amount of car use, metricated in Table 7 as annual mileage. Scottish drivers indicated a mileage band, and the proportion wanting to use the car less rose with increased mileage. English drivers gave a numerical estimate of their current annual mileage. Intriguingly, a figure of around 10,000 miles per annum proved to be the pivot point, with the mean for those wanting to use their cars less being significantly above, and the mean for those wanting to use their cars more being significantly below, the mean mileage of around 10,000 miles per annum for those wanting to use their cars ‘the same’ ‘over the next 12 months’.

Table 7: Which, if any of these forms of transport would be practical for you to use the following activities? (Those drivers who do each activity by car.)

| ‘Would like to use car ...’ | Scottish drivers: Annual Mileage Bands | | | More |
|---|---|---|---|
| | 5,000 or less | 23% | 61% | 16% |
| | 5,001–15,000 | 32% | 58% | 10% |
| | More than 15,000 | 44% | 51% | 5% |
| English drivers: Estimated Annual Mileage (in km) | 11,860 | 9,780 | 8,590 |
Psychological attachment to the car

What are the psychological benefits that car driving confers? Driving is a skilled activity with a threshold level of required competence – the initial driving test; it is a social activity requiring real-time negotiation of non-intersecting trajectories with co-present transient others; and it is an expressive activity where what you drive and the manner in which you drive it on the theatre of the streets manifests a displayed identity (Parker and Stradling, 2001). Research has recently begun to look in some detail at the expressive dimension of car use (Garling, Garling and Loukopulous, 2002; Hiscock, Macintyre, Kearns and Ellaway, 2002; Lajunen, Parker and Stradling, 1998; Parker, Lajunen and Spradling, 1998; Steg and Vlek, 1997; Steg, Geurs and Ras, 2001a; Steg, Vlek and Slotegraaf, 2001b; Stradling 2002a, 2002b; Stradling, Meadows and Beatty, 1998, 1999, 2001; Tertoolen, van Kreveld and Verstraten, 1998).

The automobile promises autonomy as well as mobility. ‘Autonomy’ is from the Greek autonomos, the freedom to live by one’s own laws, and refers to a sense of being in control of one’s own life. In the qualitative phase of our study of English motorists (Stradling et al., 1998, 1999) many respondents spoke of this sense of being in control as a prime attraction of driving and as a reason for preferring car use over public transport use. For example (Stradling et al., 1998):

- “One of the reasons I like driving is because I’m in control” [female; age group 36–45; drives 100+ miles per week]
- “The problem I have with public transport is that I don’t feel in control” [female; age group 26–35; drives 100+ miles per week]
- “You don’t feel in control at all on public transport and you’re worried about connections all the time so you’re having to be aware of what the time is every moment” [female; age group 26–35; drives 10–50 miles per week]
- “Last year I came in by public transport for about two weeks. It was hell. Freezing to death on platforms waiting for trains that were late. You’re not in control of your life – that’s the only way I can describe it, you’re just not in control. If you know the traffic jam’s there then there are ways to get around it” [female; age group 26–35; drives 100+ miles per week].

In the same study, drivers rated their agreement with a set of 25 statements on the benefits and disadvantages of driving a car. Two statements received the endorsement of over 90 per cent of the sample:

- ‘Driving a car gives me freedom to go where I want when I want’ (95 per cent Agreed) and
- ‘Driving a car is a convenient way of travelling’ (93 per cent).

But half of the sample deemed driving stressful, whether ‘… because of congestion on the roads’ (53 per cent) or ‘… because of the behaviour of other drivers’ (53 per cent).

Factor analysis produced four distinct factors (Stradling et al., 1999, 2001). Table 8 shows the rotated component matrix.

The first two factors differentiated two sources of psychological benefit from driving, while the final two factors separated out two kinds of disbenefits from driving. The items concerning control, confidence and safety loaded on both of the first two factors, suggesting that these concerns are core components of a driver’s sense of the autonomy obtained from driving a car.
Scores on the first two factors, labelled as Identity (F1) and Independence (F2) had different demographic correlates. The young (17–20 years) and, among the over twenties, the relatively poor were the two groups obtaining the greatest sense of personal identity – projection, pride, power and self-expression – from driving in their car, while older drivers (> 40 years) and, among these, female drivers, scored highest on the independence factor. Thus different kinds of persons obtain different kinds of psychological benefit from car use. Driving a car is particularly attractive to the young and the poor because of the sense of displayed personal identity it conveys. Driving is particularly attractive to females over 40 because of the sense of independence it conveys. The factors concerned with the disadvantages of driving were labelled discomfort (F3) and distress (F4) and showed little demographic variation, suggesting that they are enduring characteristics of the person.

Do these psychological benefits and disbenefits contribute to drivers staying in or wanting out of their cars? Table 9 shows that drivers who would like to reduce their car use also showed less psychological attachment to their vehicles: they scored significantly lower on the measures of both Identity and Independence (Stradling et al., 1999, 2001) while those who scored high on these two factors wanted to use their cars more.

Table 8: Rotated component matrix for benefits and disbenefits of driving a car

<table>
<thead>
<tr>
<th>‘Driving a car...’</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is a way of projecting a particular image of myself</td>
<td>0.76</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gives me a feeling of pride in myself</td>
<td>0.72</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gives me the chance to express myself by driving the way I want to</td>
<td>0.71</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gives me a feeling of power</td>
<td>0.70</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gives me the feeling of being in control</td>
<td>0.68</td>
<td>0.40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gives me a feeling of self confidence</td>
<td>0.67</td>
<td>0.41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provides the opportunity for me to practise my skills as a driver</td>
<td>0.63</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provides me with my own space to be myself</td>
<td>0.57</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provides me with solitude to be able to think</td>
<td>0.56</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gives me a wider circle of friends</td>
<td>0.49</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is a convenient way of travelling</td>
<td>0.71</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gives me a feeling of independence</td>
<td>0.68</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provides a smooth way of travelling</td>
<td>0.68</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gives me a spontaneous way of making a journey</td>
<td>0.61</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is a way of meeting my family responsibilities</td>
<td>0.57</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gives me freedom to go where I want when I want</td>
<td>0.47</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gives me a sense of personal safety</td>
<td>0.34</td>
<td>0.42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is uncomfortable because of the driving position</td>
<td></td>
<td></td>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>Gives me a headache, back pain or car-sickness</td>
<td></td>
<td></td>
<td>0.72</td>
<td></td>
</tr>
<tr>
<td>Gives me a feeling of isolation from other people</td>
<td></td>
<td></td>
<td>0.64</td>
<td></td>
</tr>
<tr>
<td>Gives me a feeling of guilt</td>
<td></td>
<td></td>
<td>0.51</td>
<td></td>
</tr>
<tr>
<td>Is just a task to get me to my destination</td>
<td>-0.34</td>
<td></td>
<td></td>
<td>0.42</td>
</tr>
<tr>
<td>Is stressful because of the behaviour of other drivers</td>
<td></td>
<td></td>
<td></td>
<td>0.84</td>
</tr>
<tr>
<td>Is stressful because of congestion on the roads</td>
<td></td>
<td></td>
<td></td>
<td>0.75</td>
</tr>
<tr>
<td>Is dangerous because of other drivers</td>
<td></td>
<td></td>
<td></td>
<td>0.68</td>
</tr>
</tbody>
</table>
A series of analyses were conducted using ANCOVA. Age, Mileage and Sex were entered first as covariates, to statistically control for any differences between groups on these variables. Table 9 shows that drivers who would like to use their car less showed less psychological attachment to their vehicles: they scored significantly higher on Discomfort and Distress and significantly lower on Identity and Independence. Those who scored high on Identity and Independence and low on Distress (but not Discomfort) also wanted to use public transport (PT) less.

The personal costs of making a journey

Undertaking any journey makes demands upon the traveller. Meeting demands requires resources. Making transport choices – deciding whether and how to travel – involves reconciling the anticipated demands of the journey with the resources available to the traveller. Travellers may be viewed as having a set of personal resources that they draw upon in making a journey. These personal resources include not only the time and money they will need to invest in completing the journey, but the amounts of physical effort, cognitive effort and affective effort they will have to expend.

Physical effort may be expended on a journey in walking, waiting, carrying, escorting and maintaining body posture. Comfortable seating, both while waiting and while travelling, will reduce the amount of such effort expended. Having to negotiate an awkward transport interchange while burdened with infants and luggage will increase it. And the prospect of additional physical effort can form part of an individual’s ‘mode choice equation’. As a respondent noted in one of our recent studies (Wardman, Hine and Stradling, 2001), justifying their car commute, “Any bus that I would get to work would take twice the length of time … and I would still have to walk after I got the bus”.

Cognitive effort is expended on a journey in information gathering and processing for route planning, navigation, progress monitoring and error correction. Route familiarity will reduce the amount of mental effort expended on a journey. If the journey needs detailed pre-planning, constant monitoring of progress, and the seeking out, processing and interpretation of information, this will tend to increase the amount of cognitive effort involved. Some avoid this effort: ‘... “maybe I should plan it, maybe find out the times of the buses. But I don’t usually bother, I just go and wait”’ (Wardman et al., 2001).

Affective effort is the emotional energy expended on a journey in dealing with uncertainty about safe and comfortable travel and timely arrival at intermediate and final destinations. Uncertainty about connection and arrival – “I don’t enjoy it. I’m in a rush and worry [whether] the bus will be on time, to get [me] to work” (Wardman et al., 2001) – or personal vulnerability – “I wouldn’t like to be there after dark – the bus station has a reputation” (Wardman et al., 2001) – will tend to increase the amount of emotional effort expended on a journey.
‘Service reliability’ typically comes top of the public transport user’s ‘wish list’ of desirable characteristics. Indeed, of a sample of English drivers asked to rate the importance of a range of factors in considering using public transport for a journey, 97 per cent rated reliability as ‘extremely’ or ‘very’ important (Stradling et al., 1999). An unreliable transport service entails

- uncertainty and worry, and thus additional affective effort
- making remedial plans, and thus additional mental effort
- undertaking remedial actions, and thus additional physical effort

and may also involve the expenditure of additional time and money, further inflating the personal resource costs of the journey.

**Anticipated affective load as a barrier to modal shift**

But while time and money costs have typically been the focus of studies of transport choices, it may be that prospective affective costs are the biggest psychological barrier to preferring public to private transport.

When interchanging bus travellers in Edinburgh were asked to rate the acceptability of the amounts of physical, cognitive and affective effort expended on their journey (Wardman et al., 2001), it was affective effort (‘uncertainty’) that proved the most taxing (Table 10).

<table>
<thead>
<tr>
<th>[Column %s]</th>
<th>Physical effort</th>
<th>Cognitive effort</th>
<th>Affective effort</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than I would like</td>
<td>27</td>
<td>27</td>
<td>46</td>
</tr>
<tr>
<td>About right</td>
<td>67</td>
<td>67</td>
<td>46</td>
</tr>
<tr>
<td>Less than I would like</td>
<td>7</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

While around a quarter (27 per cent) rated the amount of physical and mental effort involved as ‘More than I would like’, approaching half (46 per cent) rated the uncertainty involved with the journey as excessive.

All journeys show a pattern of personal resource expenditure. Few current car commuters working at an Edinburgh edge-of-town location (Wardman et al., 2001) rated their drive to work as involving much physical effort (7 per cent), though substantial minorities rated the mental effort (41 per cent) and affective effort (47 per cent) as more than they would like (Table 11). However, these respondents were selected for study because they would have to take two buses, and thus interchange, if they did not drive to work. When asked to rate this alternative many more (54 per cent versus 7 per cent) viewed the two-bus commute as involving too much physical effort. Equivalent numbers (35 per cent versus 41 per cent) saw the bus and car commutes as involving too much mental effort. But most – and almost twice as many (84 per cent versus 47 per cent) – saw the bus commute as involving too much worry and uncertainty.

<table>
<thead>
<tr>
<th>[Row %s]</th>
<th>Physical effort</th>
<th>Mental effort</th>
<th>Affective effort</th>
</tr>
</thead>
<tbody>
<tr>
<td>My current car commute involves too much ...</td>
<td>7</td>
<td>41</td>
<td>47</td>
</tr>
<tr>
<td>My 2-bus commute would involve too much ...</td>
<td>54</td>
<td>35</td>
<td>84</td>
</tr>
</tbody>
</table>

Thus despite their current car commute being seen as taxing, these respondents viewed the additional personal cost – especially the emotional effort – of taking and changing buses as being even greater, and they remain in their cars.
Conclusions: combating car dependence

Reducing car dependence will not be easy. In motorised places the infrastructure maintains and reproduces the continued use of the car – “The whole country is geared for the car” complained one respondent interviewed in Stradling et al. (1998, 1999). Land use planning decisions over the location of origins (eg homes) and destinations (eg work, school, retail and entertainment opportunities) may even be seen as requiring car travel – “Nice house on an estate, but the nearest shop is four miles away, the school is three-quarters of a mile away; the nearest pub is certainly a car drive” (respondent interviewed in Mitchell and Lawson, 1998). And many appreciate the autonomy as well as the mobility that the car conveys – “I just like driving . . . I only go places when I can drive”, “One of the reasons I like driving is because I’m in control” (respondents interviewed in Stradling et al., 1998, 1999).

Individual travel and transport decisions – whether and where to travel, and by what transport mode – are driven by the interaction of three broad factors: the individual’s perceptions of their

- obligations (‘What journeys do I have to make?’)
- opportunities (‘How could I make these journeys?’) and
- inclinations (‘How would I like to make these journeys?’).

Current lifestyle patterns generate travel needs. Transport economists refer to these as derived mobility needs and what they derive from are a person’s present formal and informal social and personal obligations. Persons with jobs are generally obliged to attend their place of work in order to discharge that obligation; parents of school-age children are obliged to contrive their safe and timely arrival at school. Larders and wardrobes need to be stocked so retail outlets and cash machines must be visited and, with the consumer acting as the final link in the retail distribution chain, purchases transported home. Relatives and friends need to be visited, leisure opportunities attended. Transport joins up the places where people go to lead their lives (Stradling et al., 2000) and meet their obligations to self and others (Stradling, 2001b). Which transport mode is chosen to meet obligation access needs will depend firstly on which modes are available or, rather, which are perceived as available by the potential user – a bus route or timetable not known about will not find a place in the individual’s decision set – and second on which modes they are more inclined to use, which they judge attractive by virtue of, among other factors, not making inappropriate demands on their personal resources (Stradling et al, 2000; Stradling, 2001b).

To reduce car use and provoke modal shift to more sustainable modes of travel, should we be tough on car dependence or tough on the causes of car dependence? Table 12 shows that English motorists think that coercive (‘push’) measures (Steg and Vlek, 1997) to reduce car use would be less effective than facilitative (‘pull’) measures in cutting their car use (Stradling et al, 1999, 2000).

Punitive (‘push’) measures to reduce car use by being tough on car dependence would have most success in displacing the old, the poor and urban dwellers from behind the wheel (Stradling et al., 2000). Most motorists would prefer ‘pull’ measures to persuade them out of their cars – though those living out of town, driving medium and large cars, driving high annual mileage and required to drive as part of their work are likely to prove the least susceptible to both push and pull measures (Stradling et al., 2000).

Car dependence can be reduced:

- by modifying the opportunities for travel through improving the availability and accessibility of alternative modes
- by modifying the inclinations and preferences towards travel by alternative modes, for example by marketing public transport (Stradling, 2002b) or de-marketing the car (Wright and Egan, 2000) and
- by modifying the lifestyle patterns that generate obligations to travel from current origins to present destinations.
Table 12: How effective would each of the following measures be in getting you to reduce your use of the car?

<table>
<thead>
<tr>
<th>Measure</th>
<th>Very effective</th>
<th>Fairly effective</th>
<th>Not at all effective</th>
</tr>
</thead>
<tbody>
<tr>
<td>'Pull' measures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More reliable public transport services</td>
<td>59</td>
<td>23</td>
<td>18</td>
</tr>
<tr>
<td>Much cheaper transport</td>
<td>42</td>
<td>29</td>
<td>29</td>
</tr>
<tr>
<td>Shorter overall journey times on public transport</td>
<td>41</td>
<td>35</td>
<td>24</td>
</tr>
<tr>
<td>Shorter interchange times on public transport</td>
<td>37</td>
<td>36</td>
<td>27</td>
</tr>
<tr>
<td>A ticketing policy so that 1 ticket covers different forms of transport</td>
<td>37</td>
<td>33</td>
<td>30</td>
</tr>
<tr>
<td>More readily available information about public transport</td>
<td>27</td>
<td>41</td>
<td>33</td>
</tr>
<tr>
<td>Vouchers from employers to subsidise the cost of season tickets</td>
<td>27</td>
<td>27</td>
<td>47</td>
</tr>
<tr>
<td>Better cycling facilities</td>
<td>19</td>
<td>24</td>
<td>58</td>
</tr>
<tr>
<td>'Push' measures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The closure of city centres to cars</td>
<td>29</td>
<td>28</td>
<td>43</td>
</tr>
<tr>
<td>Fewer places to park the car</td>
<td>14</td>
<td>33</td>
<td>53</td>
</tr>
<tr>
<td>More expensive petrol</td>
<td>13</td>
<td>25</td>
<td>62</td>
</tr>
<tr>
<td>Road tolls</td>
<td>10</td>
<td>31</td>
<td>59</td>
</tr>
<tr>
<td>Public information campaigns about negative effects of car use</td>
<td>5</td>
<td>21</td>
<td>74</td>
</tr>
</tbody>
</table>

Persuading people out of their cars or even persuading them to vary the amount and proportion of car use in their quotidian multi-modal travelling sounds initially like an unwelcome imposition on an unwilling populace, but in Scotland today:

- 31 per cent of drivers would like to use their car less
- 40 per cent of drivers are interested in reducing their car use
- 44 per cent of drivers agree that reducing their car use would make them ‘feel good’ and
- 62 per cent say they would like to reduce their car use but feel constrained by the lack of practical alternative ways to meet their current transport needs (NFO System Three Social Research and Napier University Transport Research Institute, 2001).

So, we might ask, how much more mandate do the politicians need to put in place large-scale, imaginative measures which deliver both autonomy and mobility to assist substantial numbers of willing drivers in reducing their unwanted car dependency and facilitate sustainable changes that people can integrate into their pattern of lifestyle obligations and derived transport needs?

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Attitudes to driving in pre-17-year-olds

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Introduction

In 1998, almost 13 per cent of male drivers and 8 per cent of female drivers killed or seriously injured in Great Britain were novice drivers aged 19 or under (DETR, 1999).

Considerable research has been carried out on this group of drivers, which highlights individual characteristics such as sensation seeking (Arnett, 1992), anti-social tendencies (West, Elander and French, 1993) and behaviours such as speed choice (Wasielewski, 1984) and propensity to commit violations (Parker, Reason, Manstead and Stradling, 1995) as being predictive of accident involvement. Younger drivers are more likely to be accident involved than drivers who are older even when differences in mileage and exposure are accounted for (Jonah, 1986).

Sex differences in the attitudes and behaviours mentioned above (which are associated with risk taking in general) are also considered to be associated with the sex differences seen in accident involvement – males report more anti-social behaviour (West et al., 1993), they are more concerned with sensation seeking (Zuckerman, 1979; Arnett, 1992), they choose faster speeds (Wasielewski, 1984) and they report being more likely to commit driver violations (Reason, Manstead, Stradling, Baxter and Campbell, 1990). Male drivers are also over-involved in car accidents as drivers across the age range (McKenna, Waylen and Burkes, 1998).

Associations between each of these variables and age and sex have been observed for learner and novice drivers as well as for more experienced drivers. What seems to be missing from the research literature is whether this sex difference for risky behaviour in driving is a result of being able to drive (ie whether it originates when people get behind the wheel of a car) or whether it is something which is more general to being male or female per se. Another alternative is that novice drivers are simply attempting to model the attitudes and behaviour they have been exposed to, eg the behaviour of their parents/older siblings and friends. Ferguson, Williams, Chapline, Reinfurt and De Leonidis (2001) report that children whose parents have had at least three crashes in their driving career are 22 per cent more likely to experience a crash themselves as drivers than children whose parents have a clean licence. Hartos, Eitel, Haynie, and Simons-Morton (2000) report another relationship between parenting practice and adolescent driving: reduced levels of parental monitoring and fewer restrictions on driving are associated with increased violations and crashes for adolescents.

In New Zealand (where the legal driving age is 15) patterns of risk-taking behaviour and accident involvement observed in older drivers can also be seen in very young drivers (Harré, Field and Kirkwood, 1996; Harré and Field, 1998; Harré, Brandt and Dawe, 2000). More generally, Gullone, Moore, Moss and Boyd (2000) reported age and sex differences in adolescent risk-taking behaviour which was reported as being ‘consistent with reported trends in accident data’ (p.231) – boys were more likely to be involved in risk-taking behaviour, older adolescents were more involved than those who were younger. Data such as these need to be taken seriously: while it is accepted that the majority of novice drivers avoid being involved in an accident, as...
Attitudes to driving in pre-17-year-olds

a group their overall involvement in risky behaviours can be considered to be disproportionately high. As far as driving behaviour is concerned, the consequences (either to the individual or to other innocent victims) can be devastating and such risky behaviours on or near roads need to be investigated with a view to explaining and developing successful interventions. It is generally accepted that risky behaviour does not happen in a vacuum. Instead, together with individual characteristics, social context and social environment also have a role to play when one is trying to define factors associated with young drivers and their accident involvement. An example of this is the fact that young drivers are more likely to be involved in a car accident if they have peer passengers with them.

The current research consists of a study carried out with school-pupils aged between 11 and 16, ie young males and females who have not yet learnt to drive. The aim was to see whether attitudes and behaviours associated with accident involvement in drivers (sensation seeking, anti-social behaviour, speed choice and violations) can also be measured in those who are too young to drive in the UK. We were also interested to know whether such individual characteristics were associated with other forms of risky road use (eg pedestrian/cyclist behaviours).

Sex and age differences have been reported in the beliefs/attitudes of road users other than drivers. Peterson, Brazeal, Oliver and Bull (1997) measured the responses of child and adult males and females to simulated bicycle collisions shown on film. Their results show that females and younger participants anticipated more fear, more serious consequences and less exhilaration than males, older children or adolescents. The students in the current study were also asked about their attitudes and behaviour concerning cycling and pedestrian activities.

**Method**

The current study asked students (aged 11 to 16) in England (where the legal driving age is 17) to complete questionnaires about their attitudes and behaviour as far as road use and anticipated driving was concerned. Altogether 567 school pupils were recruited from secondary schools in the Reading area. Headteachers were approached by letter initially and were told about the proposed research and its aim to investigate sex differences in accident involvement. Of nine schools approached in this way, three agreed to take part. No fee was paid to the students or the schools.

Questionnaires were delivered to schools and administered by tutors within 50-minute tutorial sessions. The questionnaire asked for basic demographic information and included self-report questions on sensation seeking (Arnett, 1994), competitiveness (Smither and Houston, 1994), social motives (West et al., 1993) and risk perception. The violations questions from the Driver Behaviour Questionnaire (DBQ) (Reason et al., 1990) were adapted for the purposes of this study: rather than asking “how often do you (eg) run red lights?” we asked the students “is it ok for drivers to (eg) run red lights?”. The responses to these questions were used to provide a measure of condonement of violations. The responses to two questions about speed choice were aggregated to provide a single item about affinity for fast speeds: the questions were “will it be fun to learn to drive fast?” and “is driving fast exciting?”. There were also questions about the anticipated experience of driving and other aspects of road use. Students were also asked about their involvement with sport, in an attempt to further examine the competitive aspect of these behaviours. For example, we asked students how good they were at cycling and also how good at sport they thought they were. Completion of the questionnaires was anonymous.
Results and discussions

As stated in the introduction, the aim of this study was to investigate the characteristics (which are associated with accident involvement in drivers) of those who do not yet drive (ie boys and girls aged 16 and under) and to examine how they differ according to age and sex.

To begin with, students were asked ‘who will teach you to drive?’. 86 per cent of students stated that they would receive formal instruction from a qualified instructor and at least 51 per cent said they would receive instruction from their parents. While it is important for learner drivers to receive as much practice as possible, there is an issue about whether it is desirable for parents to facilitate such practice. As stated in the introduction, there are associations between the driving style/attitudes of parents and the risk of being accident-involved for their children (Ferguson et al., 2000; Hartos et al., 2000).

Students were asked ‘do you think you know how to drive?’ There was a highly significant main effect of sex such that males were more confident about their knowledge of driving (before learning to drive) than girls were. There was no age effect and no interaction. The sex difference is consistent with previous research which suggests that males have greater estimations of their skill and ability in driving than females (McKenna and Crick, 1991). Slovic, Lichtenstein and Fischhoff (1988), cited in Miller and Byrnes (1997), suggest that such over-confidence in one’s abilities can result in individuals taking too many risks – this may, in part, be associated with young males’ over-involvement in accidents.

We also asked ‘will learning to drive be easy?’. There was a main effect of sex indicating that, overall, boys anticipate that learning to drive will be easier than girls do. However, there was also a significant interaction such that there is no sex difference for students aged between 11 and 13. From age 14 upwards, boys reported that learning to drive would be significantly easier than girls did.

McKenna et al., (1998) suggested that there was evidence of some sort of peer effect in their observations of younger drivers. Both male and female drivers in the presence of a male passenger were observed to choose faster speeds than either those drivers travelling alone or those in the presence of a female passenger. In the current study of pre-drivers, we asked whether students felt that they would drive according to their friends’ expectations. This gave a significant effect of sex and a significant effect of age. Boys reported that they would be more inclined to be influenced by the expectations of their friends than girls did. As students get older, the less influenced by their peers they report that they will be.

In a similar vein, we asked ‘does driving make you popular?’. Here, there was a significant main effect of sex but no effect of age. However, the interaction between sex and age is significant. Boys report a greater perception of popularity as a result of driving than girls do overall but this difference increases as the students get older. Age effects are only present for girls – the idea that driving makes you popular becomes less plausible the older girls get.

It can be seen then that there are sex and age differences in attitudes towards driving, even when that driving is only anticipated and respondents have had no experience of driving on normal roads. In people who actually drive, there are two behaviours which can be used to predict accident involvement: speed choice and violations. Obviously, these direct measures cannot be used with pre-drivers but we asked questions about these behaviours in a way which, we, believe, can be used as analogues of the actual behaviours. This gives us two measures: one for an affinity for speed (or speed choice) and another for hypothetical violations.

As far as speed choice is concerned (affinity for speed) it was found that there was a main effect of sex and also a main effect of age. The interaction between age and sex is not significant. The results show that boys have a
greater affinity for fast speeds than girls and that students (both male and female) aged between 12 and 15 (inclusive) are those most enamoured by speed.

In the current study, for the violations questions both boys and girls responded with mean scores indicating that they do not, overall, condone driving violations, i.e., that it was never or only rarely acceptable for violations to be committed. Despite this, there is a significant effect of sex such that boys accept violations to a significantly greater extent than girls. Even with adults though, responses are at the lower end of the scale for most drivers – most people admit to either committing no violations or committing them only rarely.

In adult drivers, there are various individual characteristics which are directly associated with risky driver behaviours such as speed choice and violations and indirectly associated with accident involvement. These include sensation seeking and anti-social behaviour. We asked our pre-drivers about these attitudes and we also asked them about competitiveness.

The current study found a significant sex effect (such that boys are higher in sensation seeking than girls) together with a significant age effect. The age effect shows that sensation-seeking behaviour is reported to rise in adolescents until 14 years of age and then it begins to decline towards levels measured in adults even in those who are too young to drive. There was a positive relationship between sensation-seeking behaviour and both affinity for speed and violations. Those who enjoyed fast speeds and/or found violations to be more acceptable were also more likely to report that they enjoyed novel/thrilling experiences.

West et al., (1993) found an association between anti-social behaviour and accident involvement in adult drivers. They also reported that males are more prone to anti-social behaviours than females are. In the present group of pre-drivers, there was a significant sex effect such that males are more prone to anti-social behaviour than females are. There was also a significant age effect: post hoc tests indicate that 11- and 12-year-olds display less anti-social behaviour than the rest of the sample. Once again, associations existed between anti-social behaviour, violations and affinity for speed – those who were more anti-social were more likely to condone violations and enjoy fast speeds.

The results from the competitiveness questions showed that there was a significant effect of sex: boys were more competitive than girls. There was also a significant effect of age and a significant interaction. Further analysis shows that there were no age effects for girls (i.e., their levels of competitiveness do not change with age) whereas boys aged 16 were more competitive than boys of any other age. An association was also shown to exist between competitiveness, affinity for speed and violations: the more competitive an individual, the more likely it is that he/she will report enjoying fast speeds/acceptance of violations.

For each of the associations between sensation seeking/anti-social behaviour/competitiveness and affinity for speed/violations, the relationships were stronger for males than for females. The same is true for qualified drivers.

We asked these pre-drivers about other aspects of their road use, such as cycling and pedestrian behaviours, in order to see whether risky attitudes towards road use are general or domain specific. Boys rated their sporting ability more highly than girls rated themselves but there was no age effect. When asked about their ability as cyclists, boys were more positive about their cycling ability than girls were and there was also a significant age effect such that people reported that their cycling skill declined as they got older. Those aged 15 and 16 reported that their level of cycling skill was significantly lower than any other age group.

Competitiveness was associated with subjective skill at sport for both boys and girls but it was not associated with cycling skill. Sensation seeking was associated with sports skill for both boys and girls. It was also strongly associated with perceived cycling skill, but only for boys. Anti-social tendencies are associated with each of these variables, but only for girls.
It can be seen that characteristics such as sensation seeking, social motives and competitiveness are associated with potential accident predictors (speed choice and violations) in pre-drivers and also that they are associated with activities such as cycling and sports ability. Associations between these ‘scholdays’ variables and various questions about driving also exist: for girls, there are associations with all of the driving questions, such that those who perceive themselves to be good at sport also have a more confident perception about learning to drive. They appear to have a greater affinity with speed and there are also associations between perceived cycling ability and confident perceptions about learning to drive. For boys, the strongest associations are between perceived cycling ability and perceived driving ability/affinity with speed. These associations are interesting because they suggest potential ways of identifying those students who may adopt risky driving styles at a very early age.

This study has so far shown that there are sex and age differences in various behaviours/characteristics which might be associated with potential accident involvement when these pre-drivers become drivers. We were interested in their perceptions of the dangers they were exposed to in their various experiences of road use (ie as pedestrians/cyclists/car passengers or potential drivers). In the current study, we asked students to rate how dangerous various driving, cycling and walking activities were. Overall, they rated walking to be less dangerous than cycling, which in turn was considered to be less dangerous than driving. There were no sex or age differences for the walking activities. Both sex and age differences were found for dangerous cycling activities (doing ‘wheelies’, ‘backies’ and cycling through red lights) and age differences were found for dangerous driving activities (eg speeding, running red lights, drink-driving, not wearing seat belts). Each of these results was in the direction one would expect from Peterson et al.’s (1997) work: girls and younger children thought that cycling was more dangerous than boys/older children thought it was and older children thought that driving was less dangerous than younger children did.

Conclusions

It seems then, that there are sex and age differences in attitudes to driving behaviour (even though it is only anticipated behaviour) and cycling behaviour and road use in general in both boys and girls from 11 years old. In almost all of these areas there are sex differences such that males are indicating riskier attitudes/behaviours than girls. Given that this is the case it seems that education about safe driving should not be held in reserve until people start to drive at 17. Their attitudes are being formed long before then and may influence other types of accident involvement such as cycling or pedestrian accidents. Given that this is the case, driver training/education specifically and road user training/education in general need to be initiated at an age much younger than 17 (in the UK) if safe attitudes and behaviours in road use are to be instilled in young people. Such training/education might be in the form of parent-driver contracts (an unofficial form of graduated licensing). Alternatively, parent education regarding the potential accident involvement of children and strategies to try and deal with this might be developed. However, care needs to be taken that any intervention is carefully monitored and evaluated: Vernick, Li, Ogaitis, MacKenzie, Baker and Gielen (2000) conclude that, if anything, some well meaning pre-driver education programmes have actually been associated with a worsening of adolescent accident rates. The current study shows that as individuals approach the age at which they can learn to drive, they already have an abundance of beliefs and ideas about what driving will be like and also about the impact that driving will have on their lives. In many instances, these beliefs and ideas indicate that the next cohort of young drivers to be trained will be demonstrating risk-taking behaviour and attitudes as drivers that they have acquired either before or during adolescence. Does this mean that safe driver training happens too late?
References


Evaluation of the effectiveness of a dramatic presentation on attitudes to road safety

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Abstract

Previous research indicates that driver education programmes have had limited success, sometimes even producing undesirable results. In an alternative approach to road safety education, the Road Safety Unit of Dublin City Council Office of the Director of Traffic commissioned a theatre company to tour 11 schools in Dublin and Donegal with a drama *Never Saw the Day*, which focused on the aversive consequences of road accidents. The effectiveness of this drama in promoting positive attitudes towards road safety among the sample of secondary school students (n=519) was evaluated using a Likert-scale questionnaire. In phase one of the study, this was administered to the experimental group (n=439) three times: pre-test (1–2 days prior to exposure to the drama), post-test (5–10 days after viewing) and re-test (8–10 weeks later). The control group (n=80) were not exposed to the drama but completed the questionnaires at the same three testing points as the experimental group. The main finding was that exposure to the drama led to significantly increased awareness of the potentially negative consequences of road accidents in the experimental group. A consistent gender effect also emerged, with females expressing more positive attitudes towards safety issues than males. In phase two at one year follow-up, the effects of the drama on the critical attitude measure appeared to have disappeared, however the experimental group showed a significantly greater increase in positive attitudes following exposure to a set of media messages which included an item with key properties shared with the original drama. This apparent ‘ground preparation effect’ and the gender results in the first phase of the study have clear implications for the direction of future road safety educational campaigns and their evaluation.

Introduction

In common with other developed countries, young people in Ireland between 17 and 24 years are disproportionately over-represented in road accident statistics. Among the 15 member states of the EU, Ireland ranks eighth highest in its young driver (15–24 years) fatal accident rate. Within Ireland there are also large regional differences. For young driver fatalities, for example, fatal accidents per 100,000 population are seven times higher in County Donegal compared with County Dublin (NRA, 2000).

Previous research indicates that driver education programmes have had limited success, sometimes even producing undesirable results (eg OECD, 1986). However, in an attempt to modify young driver attitudes towards greater concern for safety, the Road Safety Unit of Dublin City Council Office of the Director of
Traffic commissioned the Walking Forward Theatre Company to tour post-primary schools in Dublin and Donegal with a drama, *Never Saw the Day*. This 50-minute drama centres on five young characters whose lives are totally changed after one of them is paralysed in a car accident caused by speeding. The drama deals candidly with the depiction of the destructive consequences of road accidents and is both emotionally charged and moving. Consequences depicted include devastatingly negative effects on personal relationships and career and employment opportunities. After the dramatic presentation the audience is given an opportunity to discuss issues raised by the drama with the cast. The purposes of this study were to evaluate the effects of the drama on students’ attitudes towards aspects of road safety and to explore attitudes of students to key elements of the Government Strategy for Road Safety, 1998–2002.

## Method

### PARTICIPANTS

A total of 519 secondary school students participated in phase one of this study, 350 male (67 per cent) and 169 female (33 per cent), ranging in age from 15–19 years (mean=15.9, SD=0.89). The experimental group consisted of 439 students who were exposed to the drama *Never Saw the Day*, while the control group was comprised of 80 students who did not see the drama (see Table 1). The 11 schools which participated were a combination of both mixed and single sex schools, nine of which were located in County Dublin and two in County Donegal. The schools involved in Dublin were situated both in the inner city and surrounding suburbs. The schools in Donegal were large comprehensive schools. Thus, it could be argued that the sample is reasonably representative of secondary school students in Counties Dublin and Donegal.

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>289</td>
<td>150</td>
<td>439</td>
</tr>
<tr>
<td>Control</td>
<td>61</td>
<td>19</td>
<td>80</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>350</td>
<td>169</td>
<td>519</td>
</tr>
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</table>

### MATERIALS

A Likert-scale questionnaire was developed to measure the attitudes of participants towards road safety issues. A large item pool was initially generated, focusing on three main themes: speeding, drink driving and use of safety belts. Speeding and drink driving were recently identified in a report of the National Roads Authority (NRA, 1998) as the two major causes of road accidents in Ireland involving physical injury. The non-use of seatbelts was also highlighted as a major cause of concern. Therefore the questionnaire aimed to investigate attitudes towards these most relevant road safety factors in an adolescent Irish group. While the researchers generated the vast majority of items independently, some items were based on those from other relevant questionnaires (eg SARTRE, 1994).

The majority of items took the form of statements to which respondents were required to rate their level of agreement or disagreement. These ratings were made on a five-point scale, ranging from Strongly Agree (SA) to Strongly Disagree (SD). For example:
Evaluation of a dramatic presentation on attitudes to road safety

• Only front seat passengers and small children need wear seat belts.
• It’s OK to speed if traffic conditions allow you to do so.
• It is highly important that the problem of unsafe driving is tackled.

Ten scenario items were also devised, in which various driving situations were described and participants rated the extent of their agreement or disagreement with the actions taken by the main actor in each situation. For example:

Jack was driving to the match on Sunday morning. He could see the amber light up ahead but, with his friends cheering him on, he drove faster and got through as the light turned red. (Please indicate the degree to which you agree with Jack’s driving.)

PILOT STUDY

To ensure that participants were comfortable with the format of the questionnaire and had no difficulties with the items, a small pilot survey was conducted with six students in a Dublin secondary school. The pilot survey indicated the need for change in certain areas of the questionnaire. These included improving the clarity of several statements, removing inappropriate items and shortening the length of the questionnaire to 40 items in order to make it more acceptable. Using the pre-test and post-test scores of the control group, Cronbach’s alpha test of reliability of the 40 items on the questionnaire yielded an alpha coefficient of \( \alpha = 0.89 \).

PROCEDURE

The questionnaire was administered to participants in the experimental condition on three occasions: pre-test, 1–2 days prior to viewing the drama, post-test, 5–10 days after viewing and re-test, 8–10 weeks after exposure to the drama. The questionnaire was similarly administered to participants in the control condition on three occasions, concurrent with the experimental group. At each testing point, participants were asked to read each item carefully and to indicate their level of agreement or disagreement, according to the five-point scale. They were also asked to provide (optionally) some personal details on the inside cover of the questionnaire for the purposes of follow-up research.

The data were analysed using SPSS Version 10.0. For certain related items, scores were averaged.

Results

EFFECTS OF THE DRAMA ON ATTITUDES

To investigate whether the drama produced any significant differences in attitude between the control and experimental groups, a three-factor factorial analysis of variance (ANOVA) with conditions (experimental and control), gender (male and female) and time samples (pre-, post- and re-test) as main factors, and repeated measures on the last factor, was performed on each of the items in the questionnaire.

Of all of the items, only two showed a significant conditions x time-sample effect. These were items 8.3 (It’s OK to speed if traffic conditions allow you to do so) and 13 (Do you agree that the injury sustained through road accidents can have a negative effect on the following areas of life [each rated separately]: Staying in employment; Being able to stay fit and active; Enjoying a social life; Driving a car; Meeting new friends easily; Pursuing further education?). Respective F ratios were \( F(2, 748) = 3.03, p = 0.049 \) (Q. item 8.3) and
F (2, 748) = 4.78, p = 0.009 (Q. item 13). The means for these interactions are presented in Figures 1 and 2 below.

For the first of these questions – It is OK to speed if traffic conditions allow you to do so – the pattern of results indicates that while the experimental group were relatively stable in their attitude to this item over time, the control group showed a significant deterioration in the post-test period. For the second question – Do you agree that the injury sustained through road accidents can have a negative effect on the following areas of life [each rated separately]: Staying in employment; Being able to stay fit and active; Enjoying a social life; Driving a car; Meeting new friends easily; Pursuing further education? – there is a significant improvement in attitude in the experimental group when tested after exposure to the drama and this improved attitude is still evident at re-test. In contrast, there was no real change in attitude over time in the control group.

Apart from these differences there were no other interactions between conditions and samples over time. However, what is notable about the above results is that a significant change has been found as a result of exposure to the drama on the key questionnaire item, which directly related to the content and theme of the drama itself.
DONEGAL SAMPLE

In a separate comparison of responses from the sample of participants from two Donegal schools with the control sample, it was found that the significant effects for questions 8.3 and 13 disappeared. Exposure to the drama in the Donegal sample was not associated with an improvement in safety attitudes as found in the Dublin sample.

GENDER DIFFERENCES

A striking feature of the results is that on 19 questionnaire items there was a reliable main effect for gender (in all cases \( p < 0.05 \)). In all of these, females expressed more positive (ie safer) attitudes than males. The road-user safety items, which demonstrated this difference, are listed in Table 2 below.

STABLE ATTITUDES OF THE PARTICIPANTS

The sample of 519 second level students sampled over three occasions enables determination of the prevalence of stable attitudes regarding road safety issues. Responses to questionnaire items were analysed to identify those items on which the average response of participants was stable over the three samples and at a level indicating a positive safety attitude. This was defined as an average score of 2.1 or less (scores of 2 = agree and of 1 = strongly agree). A similar procedure was adopted to identify those items that revealed a stable negative safety attitude, defined as an average score of 3.0 or greater (3 = neither agree nor disagree, 4 = disagree, 5 = strongly disagree). Results of these analyses are presented in Tables 3 and 4 below.

<table>
<thead>
<tr>
<th>Table 2: Road-user safety questionnaire items on which females demonstrated reliably safer attitudes than males (continued overleaf)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Speeding</strong></td>
</tr>
<tr>
<td>It’s OK to speed if traffic conditions allow you to do so</td>
</tr>
<tr>
<td>The best drivers are safe drivers</td>
</tr>
<tr>
<td>It’s safe to drive faster than the speed limit on motorways</td>
</tr>
<tr>
<td>The speed limit is important when deciding the speed at which you should drive</td>
</tr>
<tr>
<td>Weather conditions are important when deciding the speed at which you should drive</td>
</tr>
<tr>
<td>The national maximum speed limits on Irish roads are too low</td>
</tr>
<tr>
<td>To what extent do you agree with Jack’s action?</td>
</tr>
<tr>
<td>Jack was driving his friends to the match on Saturday morning. He could see the amber light up ahead but, with his friends cheering him on, he drove faster and got through as the light turned red</td>
</tr>
<tr>
<td>To what extent do you agree with Tim’s action?</td>
</tr>
<tr>
<td>Tim accelerated to 70mph as he drove along the empty roads, but Lucy begged him to slow down. He told her it was perfectly safe as they were on a deserted country road</td>
</tr>
<tr>
<td><strong>Drinking and driving</strong></td>
</tr>
<tr>
<td>There should be zero tolerance (in the law) of people who drink and drive</td>
</tr>
<tr>
<td>To what extent do you agree with Joe’s action?</td>
</tr>
<tr>
<td>Joe and Paul were out on Friday night in town with friends. Paul was driving his father’s car and had five beers. Joe refused to get into the car to go home with Paul driving. The others thought Joe was being stupid and laughed at him as they drove past him in the queue at the taxi rank</td>
</tr>
</tbody>
</table>
Table 2: **Road-user safety questionnaire items on which females demonstrated reliably safer attitudes than males (continued)**

**Seatbelt wearing**
The fastening of seatbelts is a personal choice
Parents should ensure that their children are always securely restrained by seatbelts
The Gardaí should strictly enforce seatbelt laws
Seatbelts are uncomfortable and unnecessary
Often people are better off because they had not worn their seatbelt in an accident
Compulsory seatbelt wearing infringes on an individual’s rights
Only front seat passengers and small children need wear seatbelts
It’s important that every passenger in a car fastens their seatbelt

**Other**
Road accidents can have a negative effect on the following areas of life: staying in employment, being able to stay fit and active, enjoying a social life, driving a car, meeting new friends easily, pursuing further education
Driving aggressively is dangerous to your health and safety
Road rage is dangerous to your health and safety
Bad weather is a major cause of road accidents
It’s highly important that the problem of unsafe driving is tackled

Table 3: **Questionnaire items on which there was a stable positive safety attitude over time**

**Drinking and driving**
There should be zero tolerance (in the law) of people who drink and drive
Drink driving is a serious offence
Drinking and driving is a major cause of road accidents
To what extent do you agree with Joe’s action?
Joe and Paul were out on Friday night in town with friends. Paul was driving his father’s car and had five beers. Joe refused to get into the car to go home with Paul driving. The others thought Joe was being stupid and laughed at him as they drove past him in the queue at the taxi rank
To what extent do you agree that Mary was unable to drive safely?
Mary had never tried Ecstasy before and loved the buzz it gave her. She began to feel a little sick and left the club and drove home

**Speeding**
Speeding is a major cause of road accidents
It is not safe to drive faster than the speed limit in built-up areas
The speed of other traffic is important when deciding the speed at which you should drive

**Other**
It is highly important that the problem of unsafe driving is tackled
Each individual road user has responsibility for road safety
An Garda Síochána have responsibility for road safety
Drivers under 21 should not drive without experienced supervision
It is safe to drive faster than the speed limit on motorways
The speed limit is an important factor when deciding the speed at which you should drive
Discussion

EFFECTS OF VIEWING NEVER SAW THE DAY

The most important finding revealed by analysis of the data from phase one was that exposure to the drama led participants in the experimental condition to become more aware of the potentially aversive consequences of road accidents, compared with the control group. This effect was still evident at re-test (8–10 weeks later) thus providing a good indicator of the strength of the influence which the drama exerted on participants’ attitudes towards the potential costs involved in driving recklessly. It appears that the drama’s depiction of the events following on from a car crash enabled the audience to recognise the potentially diverse and devastating consequences of risky driving behaviour.

It has been reported in previous research (Central Research Unit: The Scottish Office, 1991) that young people fear the prospect of living with the long-term consequences of involvement in a car accident more than anything else, and this may explain why this particular aspect of the play had such a powerful affect. After the drama, one of the actors recounted to the audience a story about his friend who had suffered serious injuries in a road accident, just like the character in the play. This revelation added a sense of realism to the drama and may have helped participants recognise the applicability of this threat to themselves. Kohn, Goodstadt, Cook, Sheppard and Chan (1982) report that threat appeals presented in a fictional manner may invoke a type of denial. Yet denial does not appear to have been in evidence here, and this may well be the result of the real-life element introduced at the end of the play.

Parker, Manstead, Stardlens and Reason (1992) have stressed the need for educational programmes which strive to make the negative consequences of risky driving more salient to younger drivers. They found that younger drivers in general are less aware of, or concerned with, the negative outcomes of committing driving violations than older drivers, and place more value on the positive outcomes of certain situations (eg arriving at one’s destination quicker). The results here indicate that Never Saw The Day has succeeded in its aim of making the reality of road accidents more salient to its audience. However, and perhaps not surprisingly, this effect does not generalise to participants’ attitudes towards many other questionnaire items, such as the use of seatbelts.

It should be noted that the results revealed one further difference in attitudes over time between the experimental and control groups. This was with respect to an item concerned with speeding (Q. item 8.3 – It’s OK to speed if traffic conditions allow you to do so). Further analysis revealed that this difference was due to a deterioration over time in the attitude of the control group which was not reflected in the experimental group. Thus, exposure to the drama may have helped to maintain the experimental group’s relatively negative view of speeding. However, the size of the difference involved suggests that one should interpret this evidence with some caution.

<table>
<thead>
<tr>
<th>Table 4: Questionaire items on which there was a stable negative attitude over time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drivers under 21 should not drive without experienced supervision</td>
</tr>
<tr>
<td>It is safe to drive faster than the speed limit on motorways</td>
</tr>
<tr>
<td>The speed limit is an important factor when deciding the speed at which you should drive.</td>
</tr>
</tbody>
</table>
BEHAVIOURAL RESEARCH IN ROAD SAFETY: 12th SEMINAR

DONEGAL SAMPLE

A surprising element that emerged from a comparison of the participants in the Donegal sample and the control group was that the main effects found within the entire sample were not present in the Donegal group. The shifts in attitude revealed in particular in Q. item 13 as a result of watching the drama were not in evidence among this group. This is particularly interesting in the context of the NRA (2000) figures for young adult fatalities through RTA (road traffic accidents) for County Donegal (8.6/100,000 population) compared with County Dublin (1.2/100,000 population). The rate in Donegal is seven times higher. While one cannot conclude that there is a relationship between these data and the absence of the main effect found for the entire sample in the Donegal group, nevertheless the coincidence does merit some consideration. It must be stressed that the regions are not entirely comparable. The restricted speeds associated with congested urban driving in Dublin contrast with the more rural environment found in Donegal. Notwithstanding this, the disproportionate rate of young adult fatalities in Donegal makes them a high-risk group. It becomes all the more desirable that safety interventions such as that explored in this research should improve attitudes in this group. It is a source of concern that the significant and positive effect found for the entire sample is not apparent in the Donegal group.

STABLE ATTITUDES OF THE ENTIRE SAMPLE

In order to understand fully the results of this study it is important that they be put in context. Although the analysis failed to find any other significant changes in attitudes over time between the experimental and control groups, examination of sample means demonstrates that participants already held positive safety attitudes towards many of the items addressed by the questionnaire (see Table 3 above). On these items, participants were clearly road safety conscious at pre-test, therefore leaving relatively little scope for major improvement in their attitudes. This is especially true of female participants, who generally expressed more positive attitudes than males (see Table 2 and below).

While the result in Tables 2 and 3 offer quite encouraging evidence, there were three items on which there was a stable negative attitude over time. One of these is perhaps not too important in that it indicates a reluctance to endorse a requirement to drive accompanied by an experienced driver while under 21 years. This is not a requirement in Ireland under current regulations and may well be seen as unnecessarily inhibiting the freedom of car use. What is potentially far more serious is the attitude to speed limits. Excepting in built-up areas, there appears to be a stable disregard for speed limits, especially on motorways. This result suggests that this is one area of road safety which should be targeted by educational and other strategies.

GENDER DIFFERENCES

The results of this study also revealed a significant difference between the attitudes of males and females towards many of the road safety issues addressed by the questionnaire. Where these reliable differences were found, they invariably showed females to have more positive safety attitudes than males. This result appeared to be a consistent gender effect and was independent of exposure to the drama, which did not differentially influence females more than males. Although this result is not directly related to the primary aims of this study, it is a finding which has implications for future road safety education programmes and other road safety interventions.

SEATBELT WEARING

A significant gender effect was found in relation to the items concerning the use of seatbelts, with males exhibiting a consistently less positive attitude towards wearing seatbelts than females. This observation has
been reported by other researchers (e.g., De Joy, 1992). Recent National Roads Authority statistics (NRA, 1998) illustrate the discrepancy in seatbelt wearing rates between the sexes. During the period 1991–99 it was reported that while female driver wearing rates increased from 60 per cent to 68 per cent, the equivalent rates in male drivers actually decreased slightly, from 49 per cent to 48 per cent. This discrepancy in the seat belt usage rates of males and females is reflected in the attitudinal scores of male and female participants in this study.

**DRINKING AND DRIVING**

Drink driving was another source of gender difference and again males had consistently less negative attitudes to this offence than females. Although males did not express favourable attitudes towards drink driving, they still maintained a less safety conscious attitude than their female counterparts. Recent statistics illustrate how this gender attitude difference may translate into road accidents and fatalities: a staggering 90 per cent of serious and fatal drink-related crashes in Ireland are caused by males, two-thirds of them aged between 17–34 years (NRA, 2000).

**SPEEDING**

The attitudes expressed by male participants were also consistently more permissive of speeding than those of females. This result is in line with those of Parker et al. (1992), who concluded that males evaluate the outcomes of violations less negatively than females, have significantly weaker intentions not to commit violations and see negative outcomes as less likely to result from committing violations, such as speeding. The major implication of this clear and consistent gender difference is that while young people in general are over-represented in accident statistics (Evans 1991; Jonah 1997), all young drivers are not necessarily equivalent risk takers. Young males have emerged as a subgroup of young drivers who warrant special attention from the agencies responsible for road safety education and intervention.

**LONG-TERM EFFECTS**

No matter how compelling the theatrical production proved to be, it remains to be demonstrated that it alone can provide sufficient impetus to produce lasting attitude change. Contemporary social psychology emphasises the importance of assessing participants’ cognitive responses to a persuasive communication, as it is now recognised that lasting attitude change is dependent upon the elicitation of a thoughtful reaction in the audience, rather than just a simple rote learning of the desired attitudinal position. This line of thought advocates the view that real attitude change is heavily reliant upon learning processes.

Allport (1935) compared a person’s attitudes to a storehouse of all of their past experiences, implying that attitudes are formed over a lengthy period of time as a result of accumulated learning experiences. He postulated that it is extremely difficult to attain lasting attitude change without direct experience of the subject matter. This underlines the huge task faced by interventions such as Never Saw The Day in attempting to engender more positive attitudes towards road safety.

Meaningful learning takes place when it is consolidated over time and is assimilated into existing cognitive structures. It has been reported that educational road safety programmes that are based on conventional exercises or on occasional interventions by outside agencies are of limited value (OECD, 1986). Thus, ideally the drama should not be viewed as a one-off, separate activity, entirely removed from other mainstream subjects, but as part of a wider programme, which has been integrated into the rest of the curriculum.

The provision of appropriate follow-up material would be one step towards ensuring that potential benefits of exposure to a theatrical performance do not dissipate quickly. Research on theatre-in-education has often
stressed the importance of allowing students ample time to discuss the issues and topics raised by the drama. McEwan, Bhopal and Paltom (1991) refer to the benefits gained from providing students with the opportunity to participate in a forty-five minute workshop following the play *Body Talk*, about HIV and Aids. Likewise, Blakey and Pullen (1991) advocate the use of discussion groups to enhance the meaning and effectiveness of a drama. Due to time constraints and production design, there was opportunity for a 30-minute review after *Never Saw The Day*, involving some audience participation, but this may not have provided the audience with sufficient time to ask questions, express their opinions and explore in-depth the topics addressed by the play. The effectiveness of other drama-based education programmes has involved full exploitation of workshops and discussion groups: it seems that this might be an area in which the current dramatic production could enhance its efficacy. Thus the persistence of the effects found here is an open question, and the relationship between attitudes and behaviour is far from clear-cut.

To explore this issue further, the original attitude questionnaire was completed again in phase two of the study, approximately one year later, by 173 of the original experimental (drama) group and 84 of the original control group (gender ratios were approximately maintained). The results of this one-year follow-up are presented in Figure 3 below. This reveals that the attitudes of the experimental group have dropped significantly (F, 28.63, p<0.001) to the level of the control group, with which it no longer differs. It is apparent that the original effect of the drama intervention has now disappeared.

However, participants were also shown, subsequent to completing the questionnaire, an eight minute safety video compilation of eight highway safety message elements prepared for television broadcast (five from VicRoads, Victoria, Australia and three from the National Safety Council Ireland). One of these elements showed the physically disabling consequences of collision involvement. Following on from the media presentation, participants completed a new questionnaire which was also given to a new control group of 45 participants who did not see the safety video (again, the gender ratio was approximately maintained). Results for the critical questionnaire item are presented in Figure 4 below.
Evaluation of a dramatic presentation on attitudes to road safety

It may be seen from Figure 4 that both groups shown the safety video reveal an increase in positive safety attitude, with the increase in the experimental group being significantly greater than in the two control groups on two of the items contributing to the attitude measure (employment: F (2, 296) = 10.8, p<0.002; social life: F (2, 296) = 4.37, p<0.01) and significantly greater than in the no video control group on three of the remaining items (independence: F (2, 296) = 7.35, p<0.002; fitness: F (2, 296) = 5.02, p<0.02; driving: F (2, 296) = 4.96, p<0.02). What we may be witnessing here is a phenomenon described as the so-called 'ground preparation effect'. This effect is interpreted cognitively in terms of an established existing cognitive structure facilitating assimilation of new information. On the other hand, it might be argued that we may rather be seeing the prompting of original learning or a saving in re-learning. Whatever the precise explanation of the phenomenon, the fact of the matter is that the experimental group responded significantly more positively to the new media message, and this feature was also revealed in the group’s response to an item on drink driving. This suggests a hidden feature of the initial effect of the drama on the experimental group, a latent change that is not revealed in surface responding. This is heartening for proponents of the value of continued media and other ‘educational’ interventions and surely argues for longitudinal studies of the potential cumulative effects of media presentations on attitudes.

Conclusions

The results of this study speak for themselves, in that the drama dealt directly with the consequences of a road accident and attitudes towards this item shifted in the intended direction. The drama did not openly confront issues such as road rage or speeding and no significant attitude changes were observed in relation to these topics. One year subsequent to seeing the drama, it was found that the attitudes of the drama group had ‘slipped’ back to those of the control group. However, it was also found that the drama group responded more positively to new safety information which included one element with similar attitude-shaping properties to the original drama. Taken as a whole, the results are encouraging for the effectiveness of drama in road safety education in both the short and medium term.
Theatre-in-education has been described as having a promising future provided dramatic productions are of a high standard and are performed by young actors with whom the audience can easily identify (McEwan et al., 1991; Powny, Glissov and Hall, 1995). It is also likely that the effects of such initiatives will be strengthened if they can be incorporated into the school curriculum. Such integration will require a relatively low investment of resources by the appropriate authorities and would be a small price to pay for any reduction in the number of teenagers and young adults killed on the roads each year.

Ultimately, of course, the goal of any road safety project is to influence safer road-user behaviour. Although the persistent positive attitudes expressed by many of the participants in this study are a step in the right direction, they are not necessarily predictive of behaviour. The answer to that question is a matter for further research.

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References


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Introduction

Previous applications of the Theory of Planned Behaviour (TPB) model to speeding behaviour have shown that it is able to account for significant amounts of variance in intentions to speed (eg Parker, Manstead, Stradling, Reason and Baxter, 1992; Stradling and Parker 1996; Parker, Manstead and Stradling, 1995) – that is, it is effective both in predicting speeding and in identifying the specific attitudinal and other factors which contribute to speeding. Although the potential of the TPB to assist in the design of behaviour change interventions, as well as in the prediction of behaviour, has been noted (eg Parker, Stradling and Manstead, 1996), few studies have assessed the effectiveness of interventions based on the TPB. One such study suggested that TPB-based advertising had the potential to bring about significant desired changes in attitudes (Parker et al., 1996).

The Scottish Road Safety Campaign’s Foolsspeed campaign used the TPB model, together with insights from previous applications of the model, to design a media-based intervention which would influence speeding by targeting the psychological mechanisms known to be predictive of speeding.

THE THEORY OF PLANNED BEHAVIOUR

The TPB is an extension of Fishbein and Ajzen’s (1975) Theory of Reasoned Action (TRA), which posits that the best determinant of a particular behaviour is behavioural intention. Intention is the decision to perform or not perform the behaviour, and is in turn predicted by attitude to the behaviour (whether the behaviour is seen as good or bad, enjoyable or unenjoyable), and subjective norms (perceptions of others’ level of endorsement of the behaviour). Attitude is in turn predicted by beliefs about the potential consequences of performing the behaviour (eg ‘it will save time’, ‘it will hurt others’) weighted by evaluations of the desirability or undesirability of those consequences (eg ‘saving time would be a good/bad thing’). Similarly, subjective norms are in turn predicted by normative beliefs about whether particular people would approve of one performing the behaviour in question, weighted by motivation to comply with their views (Fishbein and Ajzen, 1975; Conner and Sparks, 1995).

The TPB incorporates the concept of perceived behavioural control (PBC) as an additional predictor of behaviour (Ajzen, 1988). PBC has been defined and operationalised in varying ways. Some applications of the TPB use a relatively simple measure of control (eg how easy it would be to perform or refrain from a particular behaviour), while others suggest that PBC is determined by two sets of factors, in this case beliefs about the
control one would have over speeding in various circumstances, and the frequency with which one drives in those circumstances. PBC is thought to influence behaviour both directly and through behavioural intentions (see Figure 1).

A number of potential additions to the basic model have been proposed and tested in various studies. It has been suggested that beliefs about the consequences of speeding include not only instrumental benefits and disadvantages (such as arriving quicker or causing an accident), but also emotional benefits and disadvantages; that is, feelings which might be experienced while speeding (Lawton, Parker, Manstead and Stradling, 1997). A positive feeling might be pleasure in the sensation of speed, while a negative feeling might be anxiety that one looks foolish or inconsiderate to other road users. These beliefs have been termed ‘positive affective beliefs’ and ‘negative affective beliefs’ (eg Lawton et al., 1997; Stradling and Parker, 1996) and, like behavioural beliefs, are combined with their corresponding outcome evaluations to produce composite positive and negative affective belief variables.

In the Foolsspeed evaluation, the TPB was operationalised using, where available and appropriate, measures used in other studies, to allow comparisons to be drawn with other research. Additional components, including affective beliefs, were also added, as the study provided an opportunity not only to evaluate the Foolsspeed campaign’s impact on TPB components but also to add to the wider field of research into the model’s utility.

THE FOOLSSPEED ADVERTISING CAMPAIGN

Foolsspeed began in 1998 as a planned five-year campaign by the Scottish Road Safety Campaign designed to reduce the use of inappropriate and excessive speed on Scotland’s roads. The campaign was targeted at the general driving population in Scotland. However, a key sub-group for the campaign was drivers with a known tendency to speed, particularly 25–44-year-old males in social classes ABC1.

The TPB was used to shape a series of television advertisements, each designed to address a key determinant of behavioural intention according to the TPB. The campaign began in November 1998 with the introduction of the Foolsspeed logo in television advertising, publicity materials and unpaid publicity. In spring 1999, a 40-second television advertisement, Mirror, designed to address attitudes towards speeding, was developed and
screened. A second 40-second television advertisement, *Friends and Family*, was screened in spring 2000, designed to address subjective norms regarding speeding. In Summer 2001, a third 40-second advertisement, *Simon Says*, addressed perceived behavioural control over speeding (Table 1).

<table>
<thead>
<tr>
<th>Year</th>
<th>Ad</th>
<th>Designed to address</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>Mirror</td>
<td>Attitudes</td>
</tr>
<tr>
<td>2000</td>
<td><em>Friends and family</em></td>
<td>Subjective norms</td>
</tr>
<tr>
<td>2001</td>
<td><em>Simon says</em></td>
<td>Perceived behavioural control</td>
</tr>
</tbody>
</table>

Concepts for each ad were devised by an advertising agency after briefing by the Scottish Road Safety Campaign (SRSC). These concepts were then taken, in storyboard form with narrative audiotape, into focus group research with a sample of the target audience. Findings from the focus groups were fed back to the agency and to the SRSC, and were used to refine the communication concepts further before the ads were put into production.

**Methodology**

Foolsspeed was evaluated using a three-year longitudinal survey of a quota sample of drivers aged 17–54. The aims of the evaluation were threefold:

1. To assess awareness and recall of elements of the Foolsspeed campaign among the driving population.
2. To examine drivers’ response to the Foolsspeed advertising in terms of comprehension, identification, involvement and perceptions of key messages.
3. To measure and compare drivers’ reported behaviour, intentions, attitudes, subjective norms and perceived behavioural control in relation to urban speeding (ie speeding on a 30mph limit road) at baseline and at subsequent stages to assess whether any changes occurred.

A baseline survey was conducted in October 1998, and follow-up surveys were conducted in spring 1999, spring 2000, and summer 2001, around four–six weeks after the screening of each ad. A structured questionnaire was administered face-to-face in respondents’ homes by experienced market research interviewers. Each survey took measures of respondents’ demographic and driving characteristics, speeding behaviour and TPB components, to enable a comparison to be made with the sample at baseline and to allow for assessment of any changes in attitudes, norms, intentions and behaviour over the period of the campaign. Full TPB component measures were taken in the survey (Figure 2 overleaf). The follow-up surveys also took measures of spontaneous and prompted recall of the Foolsspeed campaign, and examined in detail reactions to the three 40-second television advertisements.

The survey was conducted in Renfrew, in the west of Scotland, an area representative of the overall Scottish population in terms of car/home ownership and range of affluence and deprivation. The baseline sample (n=550) was selected to be broadly representative of the 17–54-year-old driving population, with interlocking quota controls on age and sex. The achieved sample at the second survey was 388, at the third survey 367, and at the fourth survey 287.
Respondents were asked to make judgements about their own views and behaviour in the scenario below:

**You are driving in your car or van down a road in town. There are some shops and parked cars. It is about 2 o’clock on a fine dry afternoon. There are no other cars driving on the road. The speed limit is 30mph (adapted from Parker et al., 1992):**

Behavioural intentions were measured using three statements: ‘I would probably drive faster than 30mph myself in this situation’, ‘I would never drive faster than 30mph in this situation’, and ‘In this situation I would want to drive faster than 30mph’. Reliability analysis showed that these items were highly consistent (alpha=0.81).

Eight behavioural beliefs about the possible consequences (both good and bad) of speeding (at 40mph) in the scenario were used. These were identified from the questionnaire piloting and from other studies (eg Stradling and Parker, 1996; Parker et al., 1996; Lawton et al., 1997). Respondents were asked to indicate how likely or unlikely they judged each of the consequences to be (eg ‘If I drove down this road at 40mph I would find it difficult to stop in an emergency’). Reliability for these items was relatively high (alpha=0.71).

Outcome evaluations were measured using eight statements corresponding to the behavioural beliefs. Respondents were invited to indicate how desirable or undesirable each outcome would be. These two sets of items were summed using the TPB formula to produce a composite attitude towards the behaviour. Reliability for these items was adequate (alpha=0.60).

Normative beliefs were measured with 11 items in which respondents were asked to indicate how much various significant others (or ‘salient referents’) would approve or disapprove of their speeding (ie driving at 40mph) in the scenario described. Again, these salient referents were identified from the piloting exercise and from previous studies (eg Parker et al., 1992).

Motivation to comply was assessed by asking respondents to indicate the extent to which they generally liked to drive in a manner of which each referent would approve. These two sets of items were summed using the TPB formula to produce a composite subjective norm score. Reliabilities for the two sets of items were high (normative beliefs: alpha=0.70; motivation to comply: alpha=0.85).

Perceived behavioural control was measured by asking respondents whether, in eight different circumstances, they would be more or less likely to speed (for example, ‘if you were running late for an appointment?’). A corresponding eight items asked respondents how often they found themselves in such circumstances when driving. These two sets of items, control beliefs and control frequency, were summed to produced a composite perceived behavioural control. Reliability was high for the control beliefs (alpha=0.88) but low for the control frequencies (alpha=0.31).

An alternative simpler measure of perceived behavioural control was also obtained, using two items, ‘I would find it frustrating/I would find it easy to stick to 30mph in this situation’. The different measures were used because there appears to be limited consensus on how control should be operationalised within the TPB. Reliability for the alternative measure of perceived behavioural control was high (alpha=0.80).

Positive affective beliefs (PABs) and negative affective beliefs (NABs) were measured with three items for each (eg positive: ‘Driving down this road at 40mph would give me a feeling of pleasure’; negative: ‘If I drove down this road at 40mph I would feel that I was driving foolishly’). A corresponding outcome evaluation statement was added for each item. Reliability for the PABs was 0.59 (0.70 for the corresponding outcome evaluations). Reliability for the NABs was 0.70 (0.63 for the corresponding outcome evaluations).

Reported behaviour was measured by asking respondents how often, in the past 12 months, they had driven over the speed limit in three different circumstances: on a 30mph road, late at night or early in the morning, and on a motorway.

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**Figure 2: TPB measures used in the survey**

Respondents were asked to make judgements about their own views and behaviour in the scenario below:

**You are driving in your car or van down a road in town. There are some shops and parked cars. It is about 2 o’clock on a fine dry afternoon. There are no other cars driving on the road. The speed limit is 30mph (adapted from Parker et al., 1992):**

Behavioural intentions were measured using three statements: ‘I would probably drive faster than 30mph myself in this situation’, ‘I would never drive faster than 30mph in this situation’, and ‘In this situation I would want to drive faster than 30mph’. Reliability analysis showed that these items were highly consistent (alpha=0.81).

Eight behavioural beliefs about the possible consequences (both good and bad) of speeding (at 40mph) in the scenario were used. These were identified from the questionnaire piloting and from other studies (eg Stradling and Parker, 1996; Parker et al., 1996; Lawton et al., 1997). Respondents were asked to indicate how likely or unlikely they judged each of the consequences to be (eg ‘If I drove down this road at 40mph I would find it difficult to stop in an emergency’). Reliability for these items was relatively high (alpha=0.71).

Outcome evaluations were measured using eight statements corresponding to the behavioural beliefs. Respondents were invited to indicate how desirable or undesirable each outcome would be. These two sets of items were summed using the TPB formula to produce a composite attitude towards the behaviour. Reliability for these items was adequate (alpha=0.60).

Normative beliefs were measured with 11 items in which respondents were asked to indicate how much various significant others (or ‘salient referents’) would approve or disapprove of their speeding (ie driving at 40mph) in the scenario described. Again, these salient referents were identified from the piloting exercise and from previous studies (eg Parker et al., 1992).

Motivation to comply was assessed by asking respondents to indicate the extent to which they generally liked to drive in a manner of which each referent would approve. These two sets of items were summed using the TPB formula to produce a composite subjective norm score. Reliabilities for the two sets of items were high (normative beliefs: alpha=0.70; motivation to comply: alpha=0.85).

Perceived behavioural control was measured by asking respondents whether, in eight different circumstances, they would be more or less likely to speed (for example, ‘if you were running late for an appointment?’). A corresponding eight items asked respondents how often they found themselves in such circumstances when driving. These two sets of items, control beliefs and control frequency, were summed to produced a composite perceived behavioural control. Reliability was high for the control beliefs (alpha=0.88) but low for the control frequencies (alpha=0.31).

An alternative simpler measure of perceived behavioural control was also obtained, using two items, ‘I would find it frustrating/I would find it easy to stick to 30mph in this situation’. The different measures were used because there appears to be limited consensus on how control should be operationalised within the TPB. Reliability for the alternative measure of perceived behavioural control was high (alpha=0.80).

Positive affective beliefs (PABs) and negative affective beliefs (NABs) were measured with three items for each (eg positive: ‘Driving down this road at 40mph would give me a feeling of pleasure’; negative: ‘If I drove down this road at 40mph I would feel that I was driving foolishly’). A corresponding outcome evaluation statement was added for each item. Reliability for the PABs was 0.59 (0.70 for the corresponding outcome evaluations). Reliability for the NABs was 0.70 (0.63 for the corresponding outcome evaluations).

Reported behaviour was measured by asking respondents how often, in the past 12 months, they had driven over the speed limit in three different circumstances: on a 30mph road, late at night or early in the morning, and on a motorway.
Findings

AWARENESS AND RECALL OF ADVERTISING

A range of advertising measures were taken to assess awareness and recall of the campaign elements, and to provide detailed feedback on response to the three advertisements.

Between a fifth and a third of respondents over the three surveys spontaneously mentioned having seen Foolsspeed on television. There were also relatively high levels of spontaneous awareness, at all stages, of Foolsspeed in a range of other media, including vehicle-side advertising, posters and billboards, newspapers and cinema (Figure 3). The level of recall rose when respondents were prompted with the Foolsspeed name (64 per cent at the second survey to 92 per cent at the fourth survey) and with a picture of the Foolsspeed logo (66 per cent at the second survey to 95 per cent at the fourth survey).

Of the three 40-second ads, the Mirror ad received the highest level of prompted recall, 74 per cent in Spring 1999 rising to 86 per cent in both subsequent years. Friends and Family and Simon Says received lower levels of prompted recall in the years they were first screened (55 per cent and 53 per cent respectively), although prompted awareness of Friends and Family rose to 83 per cent by its second year. Because respondents were exposed to visuals of the Foolsspeed advertising and logo at each survey stage, the earliest awareness measure taken for each campaign element is perhaps the most meaningful (Table 2).
A series of closed questions examined respondents' liking, comprehension and identification of and involvement with the advertisements, while open-ended questions probed their spontaneous response at an emotional level. Respondents were asked 'what thoughts and feelings occurred to you on seeing the ad?' and 'what do you think the ad is trying to say?'. They were encouraged to say as much as possible, and verbatim responses were transcribed and coded by theme. Immediate reactions such as these provide indications as to whether advertising is engaging with its target group, engagement with an advertisement being an important precursor to attitude and behaviour change.

The Mirror ad, designed to address the attitudes component of the TPB, appeared to trigger, at a spontaneous level, feelings of identification and of reassessment of one's own driving. For example, 21 per cent made unprompted comments such as 'I could recognize myself/this could have been me', and 17 per cent made comments such as 'it made me think about my own driving'. Encouragingly, drivers in the target age group of 25–44 were more likely to express feelings of involvement than other drivers. At a prompted level, the majority of respondents liked the Mirror ad, found it easy to understand, considered that it did not ‘talk down’ to them, and made them think about their own driving. Frequent speeders were most likely to feel that the ad was targeted at them and to agree that the advertisement made them feel that they ‘drove too fast’ (Figure 4).

The Friends and Family ad, designed to address the subjective norms component of the Theory of Planned Behaviour, appeared to trigger different sorts of thoughts and feelings. Although respondents did feel to some extent that the ad challenged them to consider their own driving, they appeared to feel less identification with it than with Mirror. This may be partly because the driving behaviour depicted in Friends and Family was more obviously ‘bad’ or extreme than that depicted in Mirror. Where the Friends and Family ad did trigger feelings of identification, emotion and empathy, these tended to be more in relation to the passengers than the driver. For example, 23 per cent made unprompted comments such as ‘he [the driver in the ad] didn’t care about his family/child/passengers’.

**SPONTANEOUS AND PROMPTED RESPONSE TO ADVERTISING**

| Table 2: Prompted awareness of Foolsspeed ads: second, third and fourth surveys |
|-----------------------------------------------|-----------------|-----------------|-----------------|
| Base: All respondents                        | 2nd survey      | 3rd survey      | 4th survey      |
|                                               | (388) %         | (367) %         | (287) %         |
| 10-second ads                                 | 37              | 46              | 54              |
| 40-second Mirror ad                           | 74              | 86              | 86              |
| 40-second Friends and Family ad               | -               | 55              | 83              |
| 40-second Simon Says ad                       | -               | -               | 53              |
| Average number of times respondents had seen Mirror in 1999: | 5               |
| Average number of times respondents had seen Friends and Family in 2000: | 6               |
| Average number of times respondents had seen Simon Says in 2001: | 6               |
The Friends and Family ad appeared to communicate messages about speeding and displaying concern for others. As with Mirror, the majority of respondents found the ad easy to understand, liked it, considered that it did not ‘talk down’ to them; the ad also appeared to encourage them to think about how passengers viewed their driving. Again, frequent and infrequent speeders reacted slightly differently, although differences were less pronounced and consistent than with the Mirror ad.

The Simon Says ad was designed to address the perceived behavioural control component of the TPB – ie to increase awareness of, and ability to cope with, internal and external pressures which reduce one’s control over speeding. The theme of external pressure appears to have been communicated reasonably effectively by the ad, with over half of the respondents who had seen the ad spontaneously commenting on this theme. Half of the respondents also spontaneously expressed some degree of recognition of and identification with the scenarios depicted in the ad. At a prompted level, the majority of respondents found the ad easy to understand, felt it did not ‘talk down’ to them, liked it, and felt it made them think about their own driving. Agreement with three of the statements – ‘the ad made me feel I need to have more control over my speed’, ‘the ad made me feel bad about how I drive’ and ‘the ad made me feel that I drive too fast’ – increased with more frequent speeding behaviour; this suggests that, as with Mirror, the ad was more successful in encouraging reflection about own driving among drivers who speed (Figure 5).
PREDICTIVE ABILITY OF THE TPB

Multiple regression analyses found that the basic TPB was able to predict between 47 per cent and 53 per cent of the variance in intentions to speed (when analysed at each survey stage separately), and between 33 per cent and 40 per cent of the variance in reported speeding behaviour (speeding on a 30mph road). The amount of variance explained in intentions was highest at the second survey (53 per cent), although subjective norms did not significantly contribute to the model at this stage. In each case, PBC was the most powerful independent variable associated with intentions. At all but the second survey, subjective norms were also significantly associated, with stronger scores (more encouraging of speeding) being associated with higher intentions to speed. At each stage, higher intentions to speed and a higher PBC score (equivalent to a greater lack of control) were associated with increased speeding behaviour. Replacing the full PBC measure with a shorter alternative measure improved the model's ability to predict intentions (64–70 per cent of variance explained), but reduced its ability to predict reported behaviour (29–37 per cent of variance explained).

The addition of positive affective and negative affective beliefs (PABs and NABs) to the model, using the alternative measure of PBC, made little difference to the amount of variance explained, increasing it very slightly to a range of between 64 per cent and 71 per cent. NABs made a significant contribution to the model at all but the second survey. A higher score (more NABs) was linked to a lower intention to speed. PABs contributed significantly to the model only at the baseline with a higher score (more PABs) linked to a greater intention to speed. The inclusion of PABs and NABs resulted in the attitude measure no longer making a
significant contribution at the third and fourth surveys. This is likely to be caused by an association between attitude, PABs and NABs, and suggests that the model would be better with one or more of these removed.

We also examined the TPB model's ability to predict behavioural intentions and reported behaviour over time. Table 3 shows the ability of baseline measures and campaign awareness to predict speeding intentions and behaviour at the fourth survey

<table>
<thead>
<tr>
<th></th>
<th>Intentions</th>
<th>Behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4th survey</strong></td>
<td>n=269</td>
<td>n=275</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.266</td>
<td>0.217</td>
</tr>
</tbody>
</table>

**Betas:**

- Intentions at baseline: 0.215**
- Attitude at baseline: 0.170**
- Subjective norms at baseline: 0.165*
- PBC: 0.207** 0.199**
- Awareness of Mirror ad at any survey: 0.039 -0.013
- Awareness of Friends and Family ad at any survey: 0.042 0.068
- Awareness of Simon Says ad at 4th survey: -0.034 0.005
- Gender: -0.014 -0.075
- Social class: -0.067 0.003
- Age: -0.231*** -0.220***

Adjusted R² (percentage of variance explained) is shown in the top row. Betas are shown for the TPB components, awareness of Foolsspeed advertising measures, and demographic characteristics

*p<0.05  **p<0.01  ***p<0.001

Where the dependent variable was intentions, the amount of variance explained was low, at 27 per cent. Significant predictors of intentions to speed were attitude, PBC, subjective norms and age. Higher intentions to speed (at fourth survey) were predicted by a higher baseline measure of attitude (equivalent to more pro-speeding attitudes), PBC (equivalent to a greater lack of control) and subjective norms (i.e. ones more encouraging of speeding), and by being younger. Awareness of the campaign elements, gender and social class were not significant predictors of intentions to speed.

Where the dependent variable was reported behaviour, the amount of variance explained was slightly lower at 22 per cent. A tendency to report speeding behaviour at the fourth survey was predicted by a higher baseline measure of PBC (equivalent to a greater lack of control), higher baseline intentions to speed, and being younger. Awareness of the campaign elements, gender and social class were not significant predictors of speeding behaviour.

The analyses confirmed that the basic TPB is a useful model for predicting speeding intentions and behaviour. The proportions of variance explained in this study are comparable to those found in other applications of the TPB to speeding (e.g. Parker et al., 1992; Stradling and Parker 1996). They also suggest that the predictive strength of the TPB remains consistent when measures are taken at four separate survey stages, and the ability
o baseline characteristics to predict a moderate amount of variance in intentions and behaviour three years later suggests that its predictive strength remains reasonably robust. Finally, the analyses lend support to the argument that affective beliefs provide a useful extension to the model (eg Lawton et al., 1997; Stradling and Parker 1996).

**CHANGES IN TPB COMPONENTS**

The survey took measures of all the main TPB components, plus several additional components, at baseline and each subsequent survey. Scores for all components were compared between the baseline and relevant follow-up surveys to assess whether any changes occurred over the period of the research. Results were analysed by two key variables, awareness of Foolsspeed advertising and baseline frequency of reported speeding. The former analysis was conducted to assess whether any of the changes in TPB component scores, where these occurred, could be associated with exposure to Foolsspeed advertising. The latter was conducted to examine and compare any trends in response between those categorised at the baseline as frequent, occasional or infrequent speeders.

**Attitudes**

Table 4 displays attitude to the behaviour at an individual item level, comparing the baseline and second survey scores (those obtained after the first screening of the Mirror ad).

At this combined level, two of the belief items displayed a significant change, in an anti-speeding direction, between the baseline and second survey (‘finding it difficult to stop quickly in an emergency’ and ‘driving at what you feel is a comfortable speed’). Between the baseline and third survey, combined scores for four of the items became significantly more anti-speeding: ‘difficult to stop quickly in an emergency’ (baseline -2.69, third survey -3.41, p<0.05), ‘being able to keep up with the flow of traffic’ (baseline 1.30, third survey 0.89, p<0.05), ‘driving at what you feel is a comfortable speed’ (baseline 0.18, third survey -0.52, p<0.01) and ‘saving time’(baseline 1.08, third survey 0.45, p<0.01).

By the fourth survey, only two of the items displayed a significant change, and one of these changes was in the ‘wrong’ direction (ie more pro-speeding): ‘causing an accident’: baseline -1.84, fourth survey -1.11, p<0.05, pro-speeding direction; ‘driving at what you feel is a comfortable speed’: baseline 0.02, fourth survey -0.65, p<0.05, anti-speeding direction).
Table 4: Attitudes towards the behaviour: comparison of baseline and second survey

<table>
<thead>
<tr>
<th>Attitude</th>
<th>Mean</th>
<th>Std deviation</th>
<th>Paired differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Causing danger to pedestrians</td>
<td>-3.52</td>
<td>5.17</td>
<td>t=-1.106, df=385, ns</td>
</tr>
<tr>
<td>(ii) Finding it difficult to stop quickly in an emergency</td>
<td>-2.68</td>
<td>5.55</td>
<td>t=3.236, df=385, p&lt;0.01</td>
</tr>
<tr>
<td>(iii) Causing an accident</td>
<td>1.31</td>
<td>5.16</td>
<td>t=1.587, df=382, ns</td>
</tr>
<tr>
<td>(iv) Getting caught for speeding</td>
<td>-1.26</td>
<td>5.29</td>
<td>t=1.372, df=384, ns</td>
</tr>
<tr>
<td>(v) Being able to keep up with the flow of traffic</td>
<td>1.15</td>
<td>3.27</td>
<td>t=0.043, df=383, ns</td>
</tr>
<tr>
<td>(vi) Getting to your destination quicker</td>
<td>0.50</td>
<td>3.26</td>
<td>t=-0.560, df=384, ns</td>
</tr>
<tr>
<td>(vii) Driving at what you feel is a comfortable speed</td>
<td>-0.05</td>
<td>4.33</td>
<td>t=2.535, df=384, p&lt;0.05</td>
</tr>
<tr>
<td>(viii) Saving time</td>
<td>0.88</td>
<td>3.14</td>
<td>t=0.306, df=384, ns</td>
</tr>
</tbody>
</table>

This suggests that the favourable changes in beliefs observed between the baseline and third survey were beginning to wear off by the fourth survey. When the composite Attitude to the Behaviour scores over the four surveys are examined (Table 5), this is further confirmed.

Table 5: Attitude to the Behaviour: comparison of baseline with each subsequent survey stage

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Mean</th>
<th>Std deviation</th>
<th>Paired differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>-6.25</td>
<td>18.92</td>
<td>t=2.050, df=373, p&lt;0.05</td>
</tr>
<tr>
<td>2nd survey</td>
<td>-8.21</td>
<td>19.33</td>
<td>t=-2.156, df=353, p&lt;0.05</td>
</tr>
<tr>
<td>Baseline</td>
<td>-5.57</td>
<td>19.62</td>
<td>t=0.071, df=277, ns</td>
</tr>
<tr>
<td>3rd survey</td>
<td>-7.69</td>
<td>18.86</td>
<td>t=0.071, df=277, ns</td>
</tr>
</tbody>
</table>

The changes in individual behavioural beliefs and outcome evaluation scores reported in Tables 1–3 were strong enough to produce a significant change (in an anti-speeding direction) between the baseline and second survey in the overall Attitude to the Behaviour score, and this change was sustained at the third survey. However, by the fourth survey this change in attitudes towards speeding was no longer apparent.
COMPARISON BY AWARENESS OF MIRROR AD

In order to assess whether the observed changes in beliefs and attitudes could be associated with exposure to the Foolsspeed campaign, scores for those who had seen the Mirror ad were compared with scores for those who had not, at each survey stage.

This analysis revealed that the change in the composite Attitude to the Behaviour, observed at the second and third surveys, was not associated with awareness of the Mirror ad at the second survey, but was associated with having seen Mirror at the third survey (seen Mirror: baseline -5.85, third survey -7.96, p<0.05; not seen Mirror: baseline -3.70, 3rd survey -5.91, ns). In addition, the majority of the changes in individual beliefs which make up attitudes were associated with awareness of the Mirror ad. Overall, the analysis provide reasonable evidence for a modest effect by the Mirror ad on beliefs and attitudes. This effect appears to have been slightly stronger at the third survey than the second, but weaker by the fourth survey.

COMPARISON BY SPEEDING BEHAVIOUR

Attitude scores were also analysed to assess whether those categorised as frequent speeders at the baseline survey demonstrated similar or different patterns of response, in relation to attitudes, to those categorised as occasional and infrequent speeders. This analysis indicated that although the sample as a whole became more negative between the baseline and second survey in attitude towards the behaviour, the difference was only significant in those who were categorised as infrequent speeders at the baseline. Occasional and frequent speeders did not demonstrate a significant change in attitude, although scores did tend to become more negative. A similar pattern was observed at the third survey. However, at the fourth survey, none of the three groups displayed a significant change in attitudes.

SUBJECTIVE NORMS

There was no change in composite subjective norms for the sample as a whole between the baseline and third survey (after the first screening of the Friends and Family ad). Several of the normative belief and motivation to comply scores for individual referents changed significantly, in the direction of discouraging speeding, between the baseline and third survey (although some changed in the direction of encouraging speeding). These minor changes were not large enough to produce a change in composite subjective norms, and by the fourth survey most of the changes appeared to have worn off.

COMPARISON BY AWARENESS OF FRIENDS AND FAMILY AD

In order to assess whether there were any changes in subjective norms which could be associated with exposure to the Friends and Family ad, item and composite subjective norms scores for those who had seen the ad were compared with the scores for those who had not. Those who saw the ad displayed significantly more negative scores (i.e. more anti-speeding) at the third survey compared to the baseline for two of the referent items, ‘boss’ and ‘people you work with’. Those who did not see the ad did not display any changes between the baseline and third survey for any of the referents.

At the fourth survey, those who had seen Friends and Family displayed significant changes in normative beliefs scores for five of the referents. However, two of these changes, for ‘father’ and ‘mother’, were in the ‘wrong’ direction; that is, respondents perceived them as less rather than more disapproving of speeding. The three referents who were perceived as more disapproving of speeding were ‘boss’, ‘people you work with’, and ‘a competent driver’. Those who had not seen the Friends and Family ad at the fourth survey displayed no significant
changes in an anti-speeding direction, and had a significantly higher score (ie more pro-speeding) for the referent ‘the police’ at the fourth survey. Overall, the analysis conducted to date suggests that the ad had, at best, only a weak effect on subjective norms.

**COMPARISON BY SPEEDING BEHAVIOUR**

None of the three categories of speeder displayed any significant change between the baseline and third survey in composite subjective norms. Baseline occasional speeders displayed a more negative combined score (ie normative belief x motivation to comply) for the referent ‘people you work with’ (baseline -2.99, third survey -3.90, 𝑝<0.05), and infrequent speeders displayed a more negative combined score for ‘boss’ (baseline -4.73, third survey -6.97, 𝑝<0.05). Frequent speeders displayed no changes for any of the referents at the third survey.

Between the baseline and fourth survey, none of the three groups displayed a change in composite subjective norms, or in combined scores for any of the referents.

**PERCEIVED BEHAVIOURAL CONTROL**

There was no change in composite PBC for the sample as a whole, or for the different categories of speeder, between baseline and fourth survey (after the first screening of the Simon Says ad). Some, minor, changes were observed in scores for the items which make up PBC, although these changes were in both anti- and pro-speeding directions. There was an unclear relationship between these minor changes and awareness of the advertising – that is, some favourable changes were found in those who both had and had not seen the Simon Says ad, as were some unfavourable changes. There were no changes between the baseline and fourth survey in the alternative PBC measure. Overall, there appeared to be no clear evidence that the Simon Says ad had an effect on PBC.

**PABS AND NABS**

Between the baseline and the second survey, the composite NAB increased significantly and the composite PAB decreased significantly; that is, both became more strongly anti-speeding. At the third survey, only the NAB displayed a significant change from the baseline, but at the fourth survey both the composite NAB and the composite PAB again displayed significant changes, in the same anti-speeding direction as at the second survey (NAB: baseline 74.35, fourth survey 80.47, 𝑝<0.01; PAB: baseline 71.04, fourth survey 67.00, 𝑝<0.01).

**COMPARISON BY AWARENESS OF THE MIRROR AD**

None of the three Foolsspeed ads were designed specifically to address affective beliefs. However, affective belief scores were analysed to assess whether any of the changes observed over the survey could be associated with exposure to Foolsspeed advertising. This analysis was conducted for awareness of the Mirror ad, as this ad was judged to be the most likely of the three to have an impact on affective beliefs.

The analysis revealed strong evidence that the changes in affective beliefs were associated with awareness of the Mirror ad. All of the significant changes, apart from the increase in negative affective beliefs between the baseline and second survey, were associated with awareness of the Mirror ad at each survey stage (Table 6). This suggests that, although the Mirror ad was not specifically designed to influence affective beliefs, it did appear to have an impact on them.
Comparison by speeding behaviour

When PAB and NAB scores were analysed by baseline frequency of speeding, frequent speeders had the weakest NABs and the strongest PABs (ie most pro-speeding), while for infrequent speeders the situation was reversed. None of the three speeding frequency sub-groups displayed any change in PAB or NAB scores between baseline and second or between baseline and third surveys. Between baseline and fourth survey, occasional speeders displayed a significant increase in negative affective beliefs.

BEHAVIOURAL INTENTIONS

Behavioural intentions for the sample as a whole, and for the different categories of speeder, displayed no significant changes between baseline and any subsequent survey stage. There was no evidence that awareness of any of the adverts had an effect on intentions.

REPORTED BEHAVIOUR

Reported frequency in the last 12 months of speeding ‘on a 30mph road’ (the specific speeding behaviour targeted by the Foolsspeed campaign) decreased significantly between the baseline and third survey and between the baseline and fourth survey (Table 7).

Table 6: Summary of significant changes in NABs and PABs, by awareness of Mirror ad

<table>
<thead>
<tr>
<th>Base: all matching at each survey stage</th>
<th>Total sample</th>
<th>Seen Mirror ad</th>
<th>Not seen Mirror ad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>Increase in NAB</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2nd survey</td>
<td>Decrease in PAB</td>
<td>Decrease in PAB</td>
<td>-</td>
</tr>
<tr>
<td>Baseline</td>
<td>Increase in NAB</td>
<td>Increase in NAB</td>
<td>-</td>
</tr>
<tr>
<td>3rd survey</td>
<td>Increase in NAB</td>
<td>Increase in NAB</td>
<td>-</td>
</tr>
<tr>
<td>Baseline</td>
<td>Decrease in PAB</td>
<td>Decrease in PAB</td>
<td>-</td>
</tr>
<tr>
<td>4th survey</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7: Reported speeding behaviour: baseline and third survey, baseline and fourth survey

<table>
<thead>
<tr>
<th>Base:</th>
<th>Mean</th>
<th>Std deviation</th>
<th>Paired differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>1=Never, 7=Almost all the time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How often have you driven over the speed limit on a road with a 30mph limit?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>3.82</td>
<td>1.86</td>
<td>t=2.433, df=365, p&lt;0.05</td>
</tr>
<tr>
<td>3rd survey</td>
<td>3.60</td>
<td>1.71</td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>3.61</td>
<td>1.79</td>
<td>t=2.464, df=286, p&lt;0.05</td>
</tr>
<tr>
<td>4th survey</td>
<td>3.35</td>
<td>1.61</td>
<td></td>
</tr>
</tbody>
</table>
Repeated measures ANOVA revealed no significant interaction between awareness of any of the three ads and reported speeding behaviour on a 30mph road. Reported frequency of speeding in two other circumstances did not change.

Frequent speeders reported significantly lower frequency of speeding, comparing baseline and fourth survey scores, in all of the three potential road situations presented to respondents. Infrequent speeders, conversely, reported significantly higher frequency of speeding (although still low levels of speeding overall) in all of the three circumstances. This is possibly a regression effect (Markus, 1979), whereby groups which have more extreme scores on a specific variable at the first stage of a survey tend towards the norm when re-measured on the same variable at a later stage.

Discussion

The TPB provides a useful model not only for understanding and describing the predictors of speeding behaviour (eg Parker et al., 1992; Stradling and Parker 1996; Parker et al.,1995), but also for designing and planning theoretically rigorous road safety interventions.

Foolsspeed was designed for a general adult driving population, with a core target of male drivers and drivers in non-manual jobs, groups known to have a higher incidence of speeding. It was decided that in order to increase drivers’ identification and engagement with the advertising, a shock-horror approach would be eschewed in favour of a low-key realistic style depicting everyday driving scenarios. Fear-arousing messages are successful in gaining audience attention, but there is a risk that advertising which portrays extreme threats is either avoided after initial viewing because it is too distressing, or is discounted by viewers as unrealistic, not personally relevant, and lacking in credibility (Snipes, LaTour and Bliss, 1999; deTurck, Goldhaber, Richetto and Young, 1992; Witte, Berkowitz, Cameron and McKeon,1998; Blumberg 2000; Ruiter, Abraham and Kok, 2001). It was hoped that a more empathetic and credible style of road safety advertising (Slater, 1999) would prove equally, if not more, effective in engaging audiences.

The results reported here provide strong support for the approach adopted in the Foolsspeed campaign. When evaluated against communication measures – awareness, recall, identification, comprehension of message, liking, emotional engagement and so forth – the Foolsspeed campaign demonstrated that it is possible to create memorable and involving advertising without using graphic and fear-inducing images. The campaign generated high levels of spontaneous awareness and prompted recall for a social advertising campaign of moderate media spend (£1.8 million over three to four years). Spontaneous (open-ended) and prompted reactions to the ads suggested that respondents liked the ads, understood their intended messages, identified to varying extents with the scenarios and behaviours depicted, and were engaged by them to reassess their own feelings about driving and driving behaviour. Encouragingly, drivers who reported the most frequent speeding behaviour often displayed the strongest levels of identification and were most strongly challenged by the ads to reassess their own driving behaviour.

When evaluated in terms of impact on TPB measures, however, a more mixed picture emerges. There were desired changes over the campaign period in the three attitudinal components – composite Attitude towards the Behaviour, composite PABs and composite NABs. Most of these changes were significantly associated with awareness of the Mirror ad – ie they did not occur in those who did not see the Mirror ad – providing reasonable support for the preliminary conclusion that the Mirror ad had a favourable effect on attitudes and affective beliefs about speeding.

Less encouragingly, there was no evidence that desired changes occurred in composite subjective norms or composite PBC over the campaign period. Minor changes did occur in the items which make up these two

222
components, but these were either short lived or not always in the desired anti-speeding direction. There
appears, at best, only weak evidence that awareness of the Friends and Family ad had an effect on subjective
norms, and no evidence that awareness of the Simon Says ad had an effect on PBC.

There are a number of possible explanations for these results. It is possible that the Mirror ad was conceptually
stronger (and more persuasive) than the Friends and Family and Simon Says ads, with the result that the ad
generated higher initial recall and had a greater impact on the attitudinal components it was designed to
influence. The Mirror ad was also the earliest of the three ads to be screened, so may have benefited from
prolonged and cumulative exposure effects. In turn, the Friends and Family ad and Simon Says ad may have been
conceptually weaker in how they addressed and challenged their respective components, subjective norms and
PBC. In addition, it may be that subjective norms and PBC are less easy to operationalise in communication
terms, or are less susceptible to change, by communications means alone, than attitudes. Both components
arguably have an external dimension: subjective norms potentially comprise both the respondent's
perceptions of what significant others feel and what these significant others do actually feel, while PBC
comprises both internal control factors (for example, feelings of frustration when sticking to the speed limit)
and external control factors (for example, direct pressure from the traffic environment) (Conner and Sparks,
1995).

Finally, the apparent failure of the campaign, according to the evidence here, to influence components of the
TPB other than attitudes should be considered in the context of what the mass media can realistically achieve
in terms of social change. Advertising can be an effective and cost-effective way of raising awareness of an issue
– putting it on the public agenda – and of stimulating attitude change (Dorn and Murji, 1992; Flay and Burton,
1990; Rice and Atkin, 1994; Backer, Rogers and Sopory, 1992; Bandura, 1994; Hastings and Stead, 1999; Petty
and Priester, 1994; Reid, 1996; Mudde and DeVries, 1999; Secker-Walker, Worden, Holland, Flynn and
Detsky, 1997). Even in this context, effects are likely to be small (Schilling and McAlister, 1990). However,
advertising alone, however theoretically sound and well designed, is unlikely to impact on behaviour unless
used as part of a multi-faceted strategy involving also, for example, legislative or other environmental change
(Pentz and Valente, 1993; Pierce, Macaskill and Hills, 1990; Maibach and Parrott, 1995; Pentz, Mihalic and
Grotpeker, 1997). In this context, the Foolsspeed campaign's ability to place speeding on the agenda of
Scottish drivers and to stimulate attitude change should be considered a worthwhile achievement.

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Changing drivers’ attitudes: is there potential for changing drivers’ behaviour?

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Introduction

Aberrant driving behaviour is a major concern for road safety. Numerous studies have shown that behaviours such as speeding and drink driving are strongly associated with accident involvement (eg Finch, Kompfner, Lockwood and Maycock, 1994; Parker, Reason, Manstead and Stradling, 1995b; Parker, West, Manstead and Stradling, 1995c; Stradling, 2000; Taylor, Lynam and Baruya, 2000). A large volume of research has therefore been carried out into aberrant driving behaviours to provide a better understanding of why they are carried out and how they can be changed to improve safety.

One approach to understanding driver behaviour is provided by social cognition models such as the Theory of Planned Behaviour (TPB; Ajzen, 1985, 1988, 1991). According to such models, it should be possible to achieve changes in drivers’ behaviour by manipulating underlying psychological constructs – eg attitudes. However, this approach has seemingly had limited success. This paper, therefore, outlines a number of potentially important issues with respect to the question: ‘is there potential for influencing drivers’ behaviour by changing their attitudes’?

Three issues with respect to the TPB and the potential for influencing drivers’ behaviour are considered in this paper. These issues, among others, are actively being investigated in an empirical research programme being funded by the Transport Research Laboratory (TRL) in which the TPB is being used to investigate the attitude-behaviour relationship and the target behaviour of compliance with speed limits. The issues addressed in this paper are:

1. the causal ordering of the relationships within the TPB
2. the prediction of objective versus subjective measures of behaviour, and
3. the role of habit.

The Theory of Planned Behaviour

The TPB, probably the most influential theoretical account of the relationship between attitudes and behaviour, postulates that people’s intentions to pursue a course of action are the main determinants of future behaviour. Intentions are determined independently by attitudes towards the behaviour (people’s positive or
negative evaluations about their performing the behaviour), subjective norms (peoples’ perceptions of approval or disapproval from significant others for performing the behaviour) and perceived behavioural control (PBC) (peoples’ perceptions of their ability to perform a behaviour). Attitudes, subjective norms and perceived control are each, in turn, determined by beliefs based on expectancy-value theory (eg Peak, 1955). Attitudes are determined by behavioural beliefs – the product of the perceived likelihood of particular outcomes occurring (outcome beliefs) and the evaluation of those outcomes (outcome evaluations). Normative beliefs are posited as antecedents of subjective norm and are the product of perceived social pressure from individual referents (referent beliefs) and motivation to comply with those referents. Finally, PBC is posited to be determined by control beliefs – the product of the perceived frequency of encountering salient inhibiting or facilitating factors (control belief frequency) and the perceived power of those factors to inhibit or facilitate behaviour (control belief power). The theory is represented pictorially in Figure 1.

Applications of the TPB to driving behaviour

The TPB has been applied to a number of driving behaviours in the past, including speeding (eg Forward, 1997; Manstead and Parker, 1996; Parker, Manstead, Stradling, Reason and Baxter, 1992), drink driving (eg Aberg, 1993; Beck, 1981; Parker et al., 1992); overtaking (eg Forward, 1997; Parker et al., 1992; Parker, Manstead and Stradling, 1995a), close following (eg Parker et al., 1992), lane discipline (eg Parker et al., 1995a), running red lights and flashing headlights (eg Manstead and Parker, 1996), and seatbelt use (eg Budd, North and Spencer, 1984; Stasson and Fishbein, 1990; Trafimow and Fishbein, 1994). This research has demonstrated strong relationships between the various theoretical components of the TPB, and thus has provided some support for the model as an explanation for why different driving behaviours are carried out.

The inherent usefulness of the TPB is that it can be used to inform road safety interventions which aim to change drivers’ behaviour via changes in their beliefs, attitudes and intentions. The notion that behavioural change is possible via changes in drivers’ attitudes is certainly attractive. If attitudes can be changed to make drivers want to drive safely (eg comply with traffic laws and rules) then the resulting behaviour change is likely to be longer lasting than behaviour change brought about by other types of road safety interventions which are based on extrinsic forms of control (ie interventions which place external constraints on the driver). Enforcement for example can be ineffective in bringing about long lasting behaviour change because, due to the limited resources available, aberrant driving behaviours often go unpunished. Similarly, engineering interventions (eg speed cameras and traffic calming) have only temporary effects on behaviour because they
are confined to specific places in the road environment – even then drivers are still required to interact safely with the engineering measures, and influencing drivers’ behaviour via their attitudes could be a way to accomplish this.

Although it is an attractive possibility that drivers’ behaviour can be influenced via their attitudes, research has shown that interventions to change drivers’ attitudes based on social cognition models such as the TPB have produced little systematic change in drivers’ intentions and/or behaviour (e.g., Meadows and Stradling, 1999; Parker, Stradling and Manstead, 1996). This has contributed to current debate in the field of road safety as to whether attitude change can be effectively used to influence drivers’ behaviour (see Grayson, 1991–99, 2001). Although research has not convincingly demonstrated that driving behaviour can be influenced by interventions based on the TPB, it should be noted that long-term attitude change is notoriously difficult to achieve (Cook and Flay, 1978). It might be the case that in previous empirical investigations the techniques used to change drivers’ attitudes have been ineffective, only producing small changes over time which might not be sufficient to change driving behaviour. Thus, the potential for manipulating driver behaviour via attitude change may still exist. To explore this potential, a number of issues with respect to the relationships between drivers’ attitudes and behaviour are potentially important. Three of these issues are described below.

Casual ordering of the relationships within the TPB

In order for interventions based on the TPB to be effective in changing drivers’ behaviour, the relationships within the model need to exert a causal influence (i.e., beliefs – attitudes – intentions – behaviour). If drivers’ behaviour and/or their behavioural intentions are only associated with TPB variables, or the causal relationships are in the opposite direction than postulated by the theory, then interventions based on the model which aim to change drivers’ beliefs, attitudes or intentions may be ineffective at influencing their behaviour.

Whether drivers’ beliefs and attitudes cause them to behave in a certain way or whether their behaviour causes them to hold certain attitudes, however, is not known. As described above, many TPB studies have provided support for the model in so far that a large amount of statistical variance in behavioural intention and/or behaviour can be accounted for by the TPB variables (see Stradling and Parker, 1997). However, a major limitation for the majority of these studies is that cross-sectional research designs have been used. Although this has proved useful for providing information about associations between the TPB variables, an assessment of the causal ordering of the variables cannot be conducted when cross-sectional surveys are carried out. Prospective designs, however, whereby all TPB variables and behaviour are measured at two points in time separated by a time interval, allow the underlying dynamic relationships within the model to be assessed via the application of statistical techniques such as structural modelling or cross lagged panel correlation analysis (see Kenny, 1975). Prospective TPB studies applying such techniques have provided some support for the postulated causal ordering of the TPB variables (e.g., Armitage and Conner, 1999; Bentler and Speckart, 1981). However, to the best of the authors’ knowledge, there have been no such studies carried out when applying the TPB to driving behaviours.

The prediction of objective versus subjective measures of driving behaviour

To provide support for the TPB in its application to a number of driving behaviours, research studies have relied heavily on self-reported behaviour data. In so far as these self-reported measures of driving behaviour are concerned, researchers have convincingly demonstrated the predictive utility of the TPB (e.g., Manstead and Parker, 1996). However, there have been few studies which have attempted to assess the predictive utility of
Changing drivers’ attitudes

the TPB with respect to real measures of driving behaviour. In one example – a study of drivers’ speeding behaviour – Manstead and Parker (1996) did find that the TPB accounted for a statistically significant amount of variance in observed speeding behaviour. However, as seems to be the case across a wide number of behavioural domains (see Armitage and Conner, 2001, for a meta-analysis) the amount of variance accounted for in observed behaviour (vehicle spot speeds) was much less than that accounted for in reported behaviour (only 18 per cent explained variance in observed versus 71 per cent for reported).

On the basis of such results it could be argued that attitude change interventions based on the TPB might be fairly ineffective at changing real driving behaviour. However, there may be other reasons why relatively small amounts of variance in observed driver behaviour have been accounted for by the TPB variables in previous research. One main reason is that the measures of real driving behaviour used in the past might not have mapped perfectly onto the TPB measures. It is known that to achieve strong correlation coefficients between attitudes and behaviour, these constructs need to be measured adhering to psychometric principles of compatibility (see Fishbein and Ajzen, 1974; Ajzen and Fishbein, 1977). Early research which did not adhere to these principles failed to demonstrate strong relationships between attitudes and behaviour (see Deutscher, 1966; Wicker, 1969). Similarly, in previous research applying the TPB to real measures of driving behaviour, it could be argued that perfect psychometrically compatible measures of behaviour and TPB variables have not been used.

Therefore, further research is needed, applying the TPB to alternative measures of real driving behaviour. The use of driving simulators and black box technology to collect more appropriate objective measures of behaviour than self-reports are possibilities. Although it is recognised that obtaining such measures of behaviour can be costly, it would be highly desirable to determine whether the TPB can usefully account for real driving behaviour.

The role of habit

Habits are learned patterns of behaviour that become automated through repetition, so that their performance requires little conscious effort and they are easily and effortlessly carried out (eg Triandis, 1980). Given that repeated behavioural performance is needed for the development of a habit, it is of little surprise that researchers have found strong relationships between habit and behavioural intentions and/or behaviour (see Ouellette and Wood, 1998 for a review). Within the behavioural domain of driving the role of habit is likely to be important, given that many driving behaviours are readily repeatable. With respect to the TPB and driving behaviour specifically, Manstead and Parker (1996) found that habit was a strong predictor of behavioural intentions to speed and reported speeding behaviour.

However, as well as being a direct predictor of behavioural intentions and behaviour, it has been also been suggested that habit could moderate the relationships between TPB variables and intentions/behaviour (Trafimow, 2000). Studies of condom use (eg Trafimow, 2000) and of travel mode choice (eg Verplanken, Aarts, van Knippenberg and Moonen, 1998; Verplanken, Aarts, van Knippenberg and van Knippenberg, 1994) have supported this hypothesis. However, the moderating role of habit within the TPB for driving behaviours (eg speeding) needs empirical investigation.

In considering how habit might moderate the relationships between TPB variables and intentions/behaviour, it is reasonable to argue that the influence of the TPB’s conscious, or ‘planned’, processes on how drivers behave (or how they develop their intentions to behave) are weakened by habit. Thus, drivers with a strong level of habit to perform a particular behaviour may not behave (or form their behavioural intentions) on the basis of their attitudes, subjective norms and perceptions of control, because the behaviour is triggered in a more automatic way (ie by habit). This may have important implications for the potential to influence drivers’ behaviour via their beliefs – attitudes – intentions. Interventions to change these variables, for example, may...
be less likely to have success in changing the behaviour of drivers with strong habits than drivers with weak habits. This would be encouraging if the target behaviour was one which could be termed a ‘safe’ behaviour, for example complying with speed limits. This is because drivers who are in the habit of complying with speed limits already carry out the desirable course of action and, therefore, their behaviour does not require modifying. Drivers not in the habit of complying with speed limits, however, do need their behaviour changing from a road safety point of view. However, assuming that habit does moderate the attitude-behaviour relationship in this way, it might be the case that drivers with a weak level of habit to comply with speed limits have a strong level of habit to exceed speed limits. If so, it could be argued that interventions designed to change these drivers’ attitudes towards complying with the speed limit might not influence their speeding behaviour. However, this would depend on whether attitudes towards keeping within speed limits are merely diametrically opposed to attitudes towards exceeding speed limits, or whether they are actually different. Logically, one would assume that these two types of attitudes would be diametrically opposed. However, previous research into approach and avoidance behaviour (eg Higgins, 1998) has demonstrated that self-regulatory principles underlying approach behaviour (which could be defined in this context as attitudes to speeding) are actually different to the principles underlying avoidance behaviour (eg attitudes to not speeding – or keeping within the speed limit).

Empirical research is required to investigate these issues relating to habit and the underlying attitudinal mechanisms which may govern how drivers approach and avoid driving behaviours.

Summary of conclusions

Research suggests that interventions to change drivers’ attitudes based on the TPB have only limited successes in influencing driver behaviour. This has led to current debate in road safety as to whether attitude change techniques can be effectively used to reduce the commission of aberrant driving behaviours. However, it is not necessarily the case that attitudes are unable to influence driving behaviour. It might be the case that, in previous empirical studies, an effect on behaviour of attitude change interventions has not been observed because the interventions that have been evaluated have not brought about substantial and long-lasting changes in attitudes.

To demonstrate whether or not there is the potential to influence drivers’ behaviour by changing their attitudes, a number of issues with respect to the attitude-behaviour relationship are important. This paper has addressed three of these issues with respect to the TPB, and the following is concluded:

- The relationships between drivers’ attitudes – intentions – behaviour need to be causal. If they are not then interventions to change drivers attitudes (or intentions) may not affect their driving behaviour. Further research is required to demonstrate whether or not these relationships are causal.
- The TPB has been shown to predict self-reported driving behaviour very well. However, evidence for an impact on real driving behaviour is less convincing. Further research is needed to explore whether more objective measures of driving behaviour can be predicted well by TPB variables. The use of driving simulators and on-road studies, perhaps using black box technology, are possible research tools for investigating this issue.
- Given that habit may have a strong influence on the potential to influence drivers’ behaviour via their attitudes, further investigation into the role of habit is required to better understand how it affects the attitude-behaviour relationship. Further research is also required to explore how the attitudinal mechanisms which may govern how drivers approach a behaviour and how they may avoid it need to be investigated.
Empirical research is currently being carried out at TRL to investigate these issues with respect to the TPB, to provide a better understanding of the extent to which behaviour can be influenced by attitude change. The results of this research are expected to be available by 2003.

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Drivers’ illusions of superiority for hazard perception and vehicle control skill

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Introduction

One robust finding in the social cognition literature is that people tend to think they are superior to others and more likely to encounter positive future events than others across a number of domains (Taylor and Brown, 1988). These types of belief have been described as illusory because, while it is possible that any one individual might be better than average, it is not possible that everyone can be better than average. With respect to driving, it has been found that people tend to rate themselves as more skilful than average, safer than average (Groeger and Brown, 1989; Svenson, 1981), slower than average (Walton and Bathurst, 1998), and less likely to have an accident than average (McKenna, 1993). As an indication of how pervasive these beliefs are, McKenna, Stanier, and Lewis (1991) found that drivers rated themselves as better than average on 20 out of 20 different components of driving skill.

What are the consequences of drivers holding these types of belief? While some have suggested that these beliefs are important for self-esteem (Taylor and Brown, 1988), it has also been argued that they leave us with a problem for road safety (McKenna, 1993). In the first place, if drivers believe that they are less vulnerable to accidents than is objectively the case then they have less incentive to protect themselves from accidents. In addition, these beliefs could impede the effectiveness of safety campaigns. For example, drivers may agree with the message of a particular campaign and consider it reasonable that most people should, for example, slow down, but that they themselves do not need to follow this advice, as they are of the conviction that they are already slower than other drivers.

This paper reviews findings in a recent study by Horswill, Waylen and Tofield (under review), which focuses on driving skill. The popular public perception is that drivers’ level of driving skill influences their safety on the road. A recent survey found that members of the public believe that poor driving skill is one of the main factors that makes driving unsafe (LTSA, 1998, cited in Walton and Bathurst, 1998). Also, Horswill (1994) reported a significant correlation ($r=0.56$, $n=1000$, $p<0.001$) between drivers’ ratings of their own skill and their own safety, such that drivers who consider themselves more skilful also tend to believe that they are safer. Is this perception that driving skill maps onto traffic safety justified? The answer to that question depends on the type of driving skill under consideration. We will look at two types of driving skill: vehicle control and hazard perception.

To our knowledge, no empirical links between vehicle control skills and safety have been found, despite a number of attempts. For example, McPherson and McKnight (1976) developed a Motorcycle Operator Skills Test that focussed on measuring motorcycle control skills. This failed to discriminate between accident-
involved and accident-free motorcyclists (Jonah, Dawson and Bragg, 1981). In fact, the group that performed best were young males: a group known to have the highest motorcycle accident risk. Training people in vehicle control skills such as skid management has been found to have little effect on road safety. For example, Katila, Keskinen, Hatakka and Laapotti (1996) found that compulsory skid training in Finland had no overall effect on subsequent accident involvement (controlling for mileage) despite considerable power (n=30,616). In the laboratory, crash rates in simulated vehicle control tasks failed to predict drivers’ accident involvement on the real road (West, Elander and French, 1992, cited in Elander, West and French, 1993). In one study, it was younger drivers who crashed less in the laboratory situation, which is contrary to the pattern in real-life accidents (Taylor, Dorn, Glendon, Davies and Mathews, 1991).

So, for vehicle control skills, it appears that the public perception that driving skill maps onto safety is flawed. However, a different picture emerges for hazard perception skill, which has been found to relate to accident involvement in a number of studies. Pelz and Krupat (1974) showed drivers a film of various traffic situations in which they indicated the level of safety or danger they perceived moment by moment, by manipulating a handle. They found that accident-free drivers reacted earlier to hazardous situations than accident-involved drivers. This result was replicated by Quimby, Maycock, Carter, Dixon and Wall (1986) using the same response mode. Hull and Christie (1992) report a hazard perception test in which drivers viewed a computerised video of traffic situations and touch the screen to indicate when it is safe to commence a manoeuvre. Those drivers who obtained a better hazard perception score were found to have had fewer accidents over the previous five years (n=1944). Finally, McKenna and Horswill (1999) reported a significant relationship between response latency and accident involvement for a hazard perception test in which drivers viewed a video of various road scenes and were required to press a button whenever they detected a potentially dangerous situation. It should be pointed out that while these are all film/video-based simulator studies, the actual nature of the simulator and the type of response required from drivers differs between these studies. This indicates that the findings are unlikely to be just an artefact of having a particular type of response mode.

Given this apparent difference between vehicle control skills and hazard perception skills, is it the case that drivers’ ratings of their own hazard perception skill differs from their ratings of their vehicle control skill and their driving skill overall? For example, given that vehicle control skills are what tends to be applauded when the public consider skilful drivers (for example, on the race track) then maybe vehicle control skills are more important for self-esteem than hazard perception skills. This might lead to drivers’ rating of their own hazard perception skill being less subject to illusions of superiority than their vehicle control skill. In addition, is it the case that the relationship between drivers’ ratings of their own skill and safety is maintained for all the different components of driving skill? That is, do drivers who consider themselves better at hazard perception also consider themselves safer drivers, in the same way that drivers who consider themselves better at vehicle control skill also consider themselves safer drivers?

The study

To answer these questions, we ran an internet questionnaire study between January and February 2002 (Horswill, Waylen and Tofield, under review). Using group discussions, we created a list of 18 components of driving, where some components were related to vehicle control and some were related to hazard perception. Six experienced drivers rated these characteristics on the degree to which they thought they involved either hazard perception or vehicle control. This process yielded six items that were related to hazard perception and seven items relating to vehicle control. There was one ambiguous item and four items that were not rated highly for either vehicle control or hazard perception. These were not included in the two factors.

We used the following method to measure drivers’ illusions of superiority. First, we asked them to rate themselves against the average driver, where average was defined as the population median (50 per cent better, 50 per cent worse). We used an 11-point scale, where the top point was defined as the ‘most skilful 10 per cent’ and the bottom
point was labelled ‘least skilful 10 per cent’. Then, we asked drivers to rate an average member of their own peer
group on the same scale, where we defined peers as ‘drivers who were the same age, sex, driving experience,
education, occupation, etc, as yourself’. Drivers’ bias scores were the difference between their self ratings and their
peer ratings. This was to avoid the criticism that our sample may for some reason be justifiably better than the
average driver and also to avoid criticisms that the term ‘average’ itself might be interpreted as negative. In our
study, people were essentially comparing themselves with someone who was the same as themselves.

The sample were recruited by sending e-mails to contacts in a number of companies and by sending e-mails to
non-professional acquaintances. We also asked 20 undergraduate students taking part in a group project to
send e-mails to everyone they knew. There was no incentive to take part and the recruiting students were not
penalised if they failed to recruit anyone.

There were two versions of the questionnaire. In the first version, we asked drivers to rate their own and their
peers’ overall skill, safety, speed, and accident liability before asking about the 18 components of driving skill.
In the second version, we asked the questions the other way round. This was intended to be a manipulation to
influence illusory beliefs (see Horswill, Waylen and Tofield, under review, for further details) but given that
this manipulation generated no significant effects, we treated it as an (unnecessary) order counterbalance in
the other analyses. Altogether, 181 UK drivers completed the questionnaire. There were 98 males and 83
females, with a mean age of 36 years and a mean annual mileage of 10,388 miles.

Significant biases were found for all of the dimensions we measured (see Horswill, Waylen and Tofield, under
review, for the data). There were significant illusions of superiority for every one of the things we measured.
Drivers considered themselves slower, safer, more skilful, and less accident liable than their peers overall and
also more skilful for every one of the 18 skill components measured, including the aggregated hazard
perception and vehicle control measures.

Contrary to expectation, for the mean hazard perception skill ratings the superiority bias was found to be
significantly greater than the bias for overall skill and the bias for vehicle control skills. One possible
explanation for this is that maybe drivers receive less direct feedback about their hazard perception
performance compared with their vehicle control performance. For example, a driver who does not notice a
dangerous situation will receive no feedback on their failure unless a crash or near miss happens. In contrast, if
someone has difficulty parking in a tight spot, their failure is highly salient. Another potential explanation
could involve exposure to other drivers’ skills. Drivers often experience many highly salient demonstrations of
world-class vehicle control skill in, for example, motor racing on television. Drivers are reminded that there
are at least some people better at controlling a car than themselves. Equivalent demonstrations of hazard
perception skill are arguably less obvious and less frequent.

We also examined the relationships between drivers’ ratings of their own skill and safety. There were highly
significant correlations between safety and skill (overall, hazard perception, and vehicle control), indicating
that participants who considered themselves more skilful drivers also rated themselves as safer. This replicated
previous findings.

We constructed a number of General Linear Models to determine whether either hazard perception or vehicle
control skill ratings could account for variance in self-assessed safety over and above the effect of their overall
driving skill rating. Hazard perception was found to account for significant variance in safety bias beyond
overall skill. Vehicle control only accounted for marginal variance in safety bias above overall skill. Also,
vehicle control skill bias did not relate to safety once hazard perception bias had been accounted for, but
hazard perception bias accounted for variance above the effects of vehicle control bias. This indicated that
participants’ belief in their hazard perception skill related to beliefs about their own safety to an extent that
could not be accounted for by driving skill overall or vehicle control skills, despite the high correlations
between all the skill ratings. One explanation for this is that drivers do appear to appreciate the importance of
hazard perception for safe driving at a personal level, above and beyond the role of driving skill in general.
One final issue we addressed is the relationship between self-perceived skill and risk-taking behaviour. Is it the case that people who consider themselves more skilful are willing to take more risks? The data set in the study under review failed to replicate previous correlations between self-reported speed (as measured by a three item questionnaire – West, French, Kemp and Elander, 1993) and skill. However, given that there was no clear reason why the results of the study under review should differ from the previous work, we decided to resolve the issue by using meta-analysis. If we assume that differences between the various studies were due to sampling errors, one way to determine the true relationship would be to increase the power of the analysis. One route to increasing power is to combine the data from different studies to reduce the sampling error. We identified four studies, including the study under review, in which we examined the relationship between self-perceived skill and self-reported risk taking. The other three studies were Horswill (1994, postal survey/laboratory data, n=995), McKenna and Horswill (under review, Study 1, laboratory data, n=126), and McKenna and Horswill (under review, Study 2, postal survey/laboratory data, n=400). The correlations from the four studies were combined using the sample sizes as weightings (see Horswill, Waylen and Tofield, under review, for full details of this meta-analysis and see Mullen (1989) for a description of meta-analytic theory and techniques). The overall correlation between self-perceived driving skill and self-reported speeding behaviour was found to be 0.25 (p<0.0001). This was slightly less than a medium effect size (r=0.3) as defined by Cohen (1992). So we conclude that there is a modest relationship between the two, such that those who consider themselves more skilful do also report driving faster to some extent.

Conclusions

We have evidence that people do seem to appreciate the benefit of hazard perception skill with respect to safety over and above the value of general driving skill and vehicle control skill. This is good news for road safety in that it suggests that the public do not need much persuading that hazard perception training is an effective route to improving road safety. However, there is a complication. The data also indicated that hazard perception skill is subject to a greater illusion of superiority than overall driving skill and vehicle control skill. In addition, Farrand and McKenna (in press) reported that drivers’ ratings of their own hazard perception ability did not correlate with their actual hazard perception ability as measured in a video simulator. Hence, any safety benefit to be derived from drivers’ appreciation of the benefits of learning better hazard perception may be undermined by drivers’ misplaced beliefs that their own hazard perception skill is already better than the average driver and better than their own peer group. In addition, our meta-analysis indicated that this could also encourage them to drive faster as well.

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These proceedings are the twelfth in a series reporting on an annual seminar on behavioural research in road safety organised by the Road Safety Division of the Department for Transport (DfT). These seminars have the aim of providing a forum for the discussion of current research and the exchange of ideas in this area of behavioural research. The proceedings of seminars one to nine were published by the Transport Research Laboratory, and the tenth and eleventh seminars by DfT’s predecessor departments; these reports are still available.

Behavioural Research in Road Safety: Twelfth Seminar