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# Attitudes towards vehicle driving behaviour: Categorising and contextualising risk

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**Abstract**

In driving motorised vehicles, the amount of risk accepted varies between individuals. Traditional theories of risk have tended to focus on a lack of skill as a function of risk taking and have ignored social motivations and attitudes for engaging in risk. This study aims to categorise and contextualise risk taking behaviour in relation to car driving through studying the motivations and attitudes towards risk. The results were tested on a representative sample ($n = 1655$) of the UK driving population and four groups were identified based on motivations; those that took risk unintentionally formed the largest group. Three smaller groups who took deliberate risks were also found, a reactive risk taking group who took risks when reacting to stress or being in a hurry, a calculated risk taking group who took risks when they felt it was safe to do so, such as late at night or on well-known roads, and a continuous risk taking group who frequently took risks for their own sake.


*Keywords:* Risk; Driving; Attitudes; Motivation

## 1. Introduction

When engaging in a potentially hazardous activity, such as driving a motorised vehicle, people accept a certain degree of risk. The level of risk, however, is not fixed and varies between individuals. Studies have shown that certain groups of driver display different levels of risk, for example, male drivers are particularly more likely than female drivers to drive with increased level of risk, shown by displaying faster speeds (Baxter et al., 1990; Evans and Wasielewski, 1982, 1983; Smeed, 1972; Wasielewski, 1984), driving with a shorter headway (Evans and Wasielewski, 1982; Wasielewski, 1984) and displaying more risky driving manoeuvres (French et al., 1993; Reason et al., 1990; Rolls et al., 1991; Staughton and Storie, 1977 and West et al., 1992). In addition, younger drivers are more likely than older drivers to drive with an increased level of risk, as shown by displaying faster driving speeds (Baxter et al., 1990; Galin, 1981; Fancher et al., 1998; Fildes et al., 1991; Quimby et al., 1999a,b; Smeed, 1972), shorter headways (Baxter et al., 1990; Dingus et al., 1997; Evans and Wasielewski, 1982; Fancher et al., 1998; Wasielewski, 1984), and displaying more risky driving manoeuvres (Baxter et al., 1990; French et al., 1993; Quimby et al., 1999b; Reason et al., 1990; Rolls et al., 1991; West et al., 1992).

The skills approach to risk variance suggests that risk is associated with driving skill or ability. Therefore, insufficient or poor driving skill leads to an increase in risk. Research has shown that inexperienced drivers display less driving skill with regard to hazard detection and prediction (see Brown and Groeger, 1988; Groeger and Brown, 1989; Grayson and Sexton, 2002). Some studies suggest it is not a deficit in skills per se that means inexperienced drivers show more risk while driving, but an underestimation in the importance of risk and a failure to understand the link between risk and accident involvement. That is, individuals who display risky behaviour are unable to judge the importance of the risk, rather than unable to judge the risk itself. Matthews and Moran (1986) found that younger drivers are less likely than older drivers to cite speed as a major cause of road traffic accidents and believe they were less likely to be involved in a road traffic accident. In addition Finn and Bragg (1986), Groeger and Brown (1989), McKenna et al. (1991) and Svensson (1981) have all found that younger drivers tend to overestimate their own skill and underestimate the skill of other drivers and this is more pronounced the younger the driver. Thus, younger and less expe-

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rienced drivers have higher levels of confidence in their driving skill. However, it must be remembered that inexperience is confounded with age and it is not possible to determine whether risk is due to an inexperienced acquisition of skills or due to attitudes associated with being young (Brown and Groeger, 1988; Grayson and Sexton, 2002; Groeger and Brown, 1989; Rolls and Ingham, 1992). Indeed some research suggests attitudes are more important than skills (Rolls and Ingham, 1992).

Reason et al. (1990) developed the driver behaviour questionnaire (DBQ), and which contained a series of questions addressing the frequency of performing certain behaviours while driving. A factor analysis was employed on the responses to the DBQ in a sample of drivers from the United Kingdom (UK). Clusters of behaviour were found that could be labelled violations (i.e. intentional errors such as disregarding speed limits late at night and getting involved in unofficial races), dangerous errors (i.e. unintentional yet hazardous errors such as misjudging the speed of oncoming vehicles when overtaking) and 'silly' errors (i.e. unintentional and non hazardous errors, such as driving in the wrong gear). Drivers who score high on the violation factor tend to be younger in age, male, drive higher number of miles than average and believe themselves to be better than the average driver. Drivers who score high on the dangerous error factor tend to drive less often on motorways, are less likely to describe themselves as safe drivers and describe themselves as being more affected by mood. Drivers who score high on the "silly error" factor are similar in background to those who perform dangerous errors but are more likely to be female. One of the main problems with the DBQ is that 'how often' the driver performs the behaviour is the main focus meaning the motivation is pre-determined and drivers do not get an opportunity to explore their own motivations for risky behaviour.

Risk Homeostasis Theory (RHT) (Wilde, 1982, 1994, 1998) maintains that at all times people accept a certain subjectively evaluated level of risk, known as target risk, to their safety (and other things they value), in exchange for the benefits they hope to receive from a certain activity. So, people assess the amount of risk they are currently experiencing and compare this to the amount they are willing to accept. If it is lower than is acceptable, then individuals will engage in further risk. If it is higher than acceptable, then individuals will seek to reduce the risk. Homeostasis does not mean that target risk stays the same and variations in target risk are found between and within individuals (Wilde, 1994). Target risk can be relatively stable and long-lasting relating to cultural norms and values (such as the state of the economy, peer-group attitudes, level of education, age group, gender etc.), or can be shorter-term and occur within an individual (e.g. due to specific purpose of trip or urgency to arrive on time, mood, fatigue etc.) Wilde (1982, 1994, 1998) relates RHT to car driving behaviour and suggests that individuals drive to a constant level of target risk.

Wilde (1994) highlights examples of how interventions aimed at reducing risk do not reduce target risk. For example, he cites the Munich Taxicab experiment (see Hauer and Garder, 1986) where taxis equipped with Anti-lock Braking Systems (ABS) are involved in as many accidents as those without. In addition, drivers of such vehicles display increased levels of risk, such as shorter following distance and increased heavy braking. He also cites research that shows that traffic-lights being introduced changes the type (for example, from right-angle to rear-end crashes) not the frequency or severity of accidents (see Short et al., 1982). Using government statistics, Wilde (1994) also demonstrates that as alcohol related road traffic accidents are reduced, accidents where alcohol consumption is not a factor have risen. In addition, Wilde (1998) demonstrates using macro-scale statistics that vehicle accidents decrease as vehicle use increases. Thus, interventions aimed at reducing target risk, merely introduce a change in behaviour to re-balance the risk, rather than target risk itself, which is influenced by more global psychosocial factors such as specific intrinsic motivations (such as mood, urgency, fatigue) or extrinsic motivations (such as purpose of trip) (Wilde, 1982, 1994, 1998). However, evidence is needed at a microscopic level addressing individual behaviour to support this claim.

This paper aims to classify different types of car driver based on their reported propensity to take risks while driving. Within each category of driver, background characteristics will be identified. Therefore, the paper aims to categorise and contextualise risk taking amongst car drivers.

## 2. Methodology

### 2.1. Philosophical framework

Much of the previous literature seems to infer what is meant by risk where attitudes surrounding the motivation for risk have been largely prescribed through questionnaires. It was imperative that this research started with a "clean slate" so that attitudes towards risk will be generated from the research, rather than be prescribed by the authors, resulting in categorisation and contextualisation of risk relating to vehicle driving behaviour. It seems appropriate that the research should use the philosophical underpinning of 'grounded theory'. This approach suits the nature of generating and developing knowledge and meaning from a wide variety of opinions and attitudes, without doing an injustice to their diversity and depth. Therefore, a researcher does not begin with a preconceived theory in mind, rather crafting theory from the rich collection of knowledge. The aim of grounded theory is to explain the knowledge from whence it came (Glaser, 2001). The theory does not pretend to describe the data accurately, but to explain the knowledge conceptually and contextually.

In line with grounded theory this study initially gathered in-depth knowledge through open-ended emergent interviews in a qualitative phase. The knowledge was then analysed and contextualised before being further tested in a quantitative phase involving statistical analysis.

### 2.2. Qualitative participants

Participants who had nominated themselves as "interested participants" within 3 universities in the South of the United Kingdom were sent a correspondence about the project. A total of 47 participants (27 male, 20 female), all holding a full UK driving licence, agreed to take part and were interviewed. Their

ages ranged from 17 to 64 years-old and they had held a UK driving licence between 3 months and 47 years.

### 2.3. Qualitative procedure

One hour interviews were carried out with each of the 47 participants. The interviews were semi-structured and explored the meaning of risk, risk in relation to driving, motivation for displaying risk and driving behaviour in general. Very general questions were asked. A constant comparative analysis was employed on the data. For further details on the qualitative methodology see Musselwhite (2004).

### 2.4. Qualitative findings

The interviews were transcribed and analysed. During the interview analysis, clusters of behaviour were found, which suggested the presence of four distinct groups of driver. First, there were drivers who would rarely, if ever, take intentional risks while driving. There also seemed to be a 'reactive' group of drivers who would drive at fast speeds when late, in a hurry, stressed, lost or tired. There was also a calculated group of drivers who would take 'calculated' risks for example when there was less traffic or pedestrians or when it was good weather. Finally, there was a group of intentional risk takers who took more deliberate and wilful risk in their driving.

### 2.5. Quantitative method

A questionnaire was developed in order to test whether the categories deriving from the qualitative findings could be rigorously tested through statistical analysis of a larger and more representative sample. In line with grounded theory, the questions reflected the answers given by the drivers in the interview section.

### 2.6. Quantitative design

A questionnaire was developed consisting of questions in two sections. The first section addressed background details of the respondents including age, gender, length of time held UK driving licence and typical number of miles driven per week. To check that the four categories exist the second section covered a series of questions on driving behaviour (see Table 1). To increase the utilisation of the data, it was decided that the answers should be given on a scale, from 7 indicating 'always performing such behaviour' through to 1 indicating 'never performing such behaviour'. Questions on the interview section had explored a variety of different road types and situations (including rural, urban and restricted and unrestricted speed limits). The areas with most contrasting responses and that created the most interesting debate were developed into the questions on driving behaviour in this section (Table 1). One road type emerged as being most appropriate to focus upon, this being urban 30 mph zones. In the UK these are roads with the greatest variation of road user with an abundance of light or vulnerable road users that have the highest incidence of speeding and injury accident rate compared with any other road type (DTLR, 2002).

### 2.7. Quantitative procedure

Potential participants were approached at motorway service stations and local garages along a holiday route in the South of the United Kingdom during the summer months which enabled collection of data from people all over the country from a variety of backgrounds. Those who agreed to take part in the research were given a questionnaire. To keep anonymity, a box (similar to a ballot box) was provided for returned questionnaires. In 3962 questionnaires were distributed of which 1686 (42.56%) were returned.

Table 1
Questions found in the questionnaire addressing self-reported driving behaviour

| Question |
|---|
| a. How often do you drive on 30 mph roads that you feel should have a speed limit of at least 40 mph? |
| b. How often are in a hurry to get somewhere when you are driving? |
| c. How often, on a 30 mph road, do you look at your speedometer and realise you have been driving faster than you thought you were? |
| d. If you realised, on a 30 mph road, that you were travelling faster than you thought you were would you reduce your speed immediately? |
| e. How often, on a 30 mph road, do you drive at a faster speed than 30 mph because you feel it is safe to do so? |
| f. How often, on a 30 mph road, do you drive at a faster speed than 30 mph even if it feels unsafe to do so? |
| g. If you are in a hurry, on a 30 mph road, would you drive faster than the speed limit? |
| h. If you are feeling angry, annoyed or irritated, on a 30 mph road, would you drive faster than the speed limit? |
| i. If another car was driving very close behind you on a 30 mph road, would you drive faster than the speed limit to try and increase the gap between you and the other vehicle? |
| j. If you encountered a vehicle travelling at 20 mph on a 30 mph road, would you overtake the vehicle even if it meant an oncoming vehicle had to slow or take avoiding action? |
| k. If you were late for an appointment and you encountered a vehicle travelling at 20 mph on a 30 mph road, would you overtake the vehicle even if it meant an oncoming vehicle had to slow or take avoiding action? |
| l. If you were late for an appointment, on a 30 mph road, would you drive very close to the vehicle in front? |
| m. How often do you use a different lane to other vehicles going in the same direction as you, to avoid being held up, when at a roundabout or traffic lights? |
| n. If you were late for an appointment, how often do you use a different lane to other vehicles going in the same direction as you, to avoid being held up, when at a roundabout or traffic lights? |
| o. How often do you use fast acceleration and/or heavy braking as part of your normal driving on 30 mph roads? |
| p. How often do you use fast acceleration and/or heavy braking as part of driving when you are late for an appointment on 30 mph roads? |

### 2.8. Quantitative participants

Overall data was collected for 1686 individuals of which 31 questionnaires were spoiled resulting in 1655 questionnaires which could be analysed further. A total of 885 (53.6%) were male and 765 (46.4%) were female. The average age of the respondents who completed the question was 37.82 years of age (distribution from 17 to 81 years). On average respondents had held their full UK driving license for 18.42 years and stated they drove 114.93 miles per week (distribution from 20 miles to 525 miles per week). The background details compare favourably with the UK driving population at the time of the research (see DTLR, 2002), where age and gender distribution was fairly similar to the sample. The sample tended to drive fewer miles on average than the national population, but it must be remembered that the sample were asked for number of miles in a typical week, whereas the national population were asked for number of miles driven per year, thus unusual high mileage weeks would not be seen in the sample population. Overall, the sample could be said to reflect the driving population of the UK reasonably well.

### 2.9. Statistical technique

In order to establish categories within the data a hierarchical cluster analysis using Ward's method and Squared Euclidean distance was performed on the data to tease out clusters of driving behaviours. The analysis was performed on driver behaviour so only question 7 (see Table 1) was entered into the model. However, the questions that deal with base component information on driving, questions 7a, b and c, were omitted, since these do not directly address attitudes towards driving. Thus, questions 7d to 7p were entered into the hierarchical cluster analysis.

## 3. Results

### 3.1. Quantitative results—descriptive statistics

Table 2 shows the mean frequency that respondents reported they perform the different types of driving behaviour (on a scale with 7 indicating 'always performing such behaviour' through to 1 indicating 'never performing such behaviour'). As can be seen the most frequently reported behaviours include reducing speed when realising driving faster than was thought, using other lanes at roundabouts and junctions in order to get ahead, driving faster than the speed limit as it feels safe to do so and driving faster than the speed limit when in a hurry. The least reported behaviours include dangerous overtaking, driving faster than a 30 mph speed limit when it feels unsafe to do so, dangerous overtaking when late and fast acceleration and heavy braking. Table 2 also shows the percentage of drivers who report they "never" or "always" perform such a behaviour. As can be seen those reporting "never" are relatively low on all factors, meaning at some point most individuals engage in the risky behaviour outlined. For further information on the distribution see Musselwhite (2004).

In all cases where the same behaviour is presented twice on the questionnaire, once in normal situations and once in situations where the driver is late for an appointment, on average drivers tend to report they perform the behaviour more often in the "being late" situation. Drivers are significantly more likely to overtake dangerously if late or in a hurry compared to normal ($t(1641) = -24.85$; $p < 0.01$), are significantly more likely to use other lanes at junctions and roundabouts in order to get ahead when late compared to normal ($t(1638) = -26.36$; $p < 0.01$) and are significantly more likely to use fast acceleration and braking when late compared to normal ($t(1647) = -26.08$; $p < 0.01$).

### 3.2. Quantitative results—statistical analysis

The hierarchical cluster analysis was forced into 4 clusters as consistent with the findings from the qualitative section. Using statistical package for social sciences (SPSS) to calculate, 1579 of the 1655 (95.41%) could be clustered, resulting in 376 (23.81%) in group 1, 611 (38.7%) in group 2, 227 (14.38%) in group 3 and 365 (23.12%) in group 4.

As Table 3 shows the mean results of each cluster to driving behaviour clearly identifies unintentional risk takers, reactive risk takers, calculated risk takers and continuous risk takers.

Table 2
Table highlighting responses to driving behaviour questions

| How often perform the following particular type of driving behaviour | % Reporting never | % Reporting always | Mean | Standard deviation |
|---|---|---|---|---|
| Realised driving faster than thought so reduced speed ($n = 1649$) | 1.3 | 11.2 | 4.75 | 1.38 |
| Use other lanes when late to get ahead ($n = 1649$) | 12.7 | 24.4 | 4.59 | 2.14 |
| Drive faster than a 30mph speed limit as it feels safe to do so ($n = 1647$) | 6.5 | 12.7 | 4.32 | 1.79 |
| Drive faster than the speed limit if in a hurry ($n = 1643$) | 12.1 | 12.4 | 4.26 | 1.94 |
| In a hurry to get somewhere ($n = 1645$) | 4.4 | 5.4 | 4.22 | 1.53 |
| Feel that 30 mph should really be 40 mph ($n = 1648$) | 5.7 | 7.2 | 4.2 | 1.67 |
| Perform fast acceleration and heavy braking when late ($n = 1651$) | 19.8 | 18 | 3.96 | 2.21 |
| Use other lanes to get ahead ($n = 1644$) | 17 | 11.8 | 3.65 | 2.01 |
| Drive faster than a 30 mph speed limit if angry ($n = 1641$) | 26 | 5.4 | 3.52 | 2.04 |
| Drive close to other vehicles when late ($n = 1645$) | 25.9 | 7.3 | 3.51 | 2.08 |
| Realised driving faster than thought ($n = 1642$) | 8.8 | 1.1 | 3.47 | 1.47 |
| Drive faster to increase gap if a car is close behind ($n = 1648$) | 26.9 | 3.6 | 3.31 | 1.93 |
| Perform fast acceleration and heavy braking ($n = 1650$) | 26.8 | 9.1 | 2.95 | 1.91 |
| Dangerous overtaking when late ($n = 1643$) | 49.9 | 2.5 | 2.73 | 2 |
| Drive faster than a 30 mph speed limit even if it feels unsafe to do so ($n = 1650$) | 33.4 | 1.1 | 2.52 | 1.56 |
| Dangerous overtaking ($n = 1651$) | 66.8 | 0.6 | 1.76 | 1.38 |

Table 3
Answers given by respondents to driver behaviour questions based on the categories developed through hierarchical cluster analysis using Ward's Method

| How often perform the following particular type of driving behaviour | Group 1 mean response (standard deviation) ($n = 376$)[a] | Group 2 mean response (standard deviation) ($n = 611$)[b] | Group 3 mean response (standard deviation) ($n = 227$)[c] | Group 4 mean response (standard deviation) ($n = 365$)[d] | Significance ANOVA ($F$-value) and $T$-Tests ($t$-value) |
|---|---|---|---|---|---|
| Feel 30 mph should really be 40 mph | 5.29 (1.16) | 2.84 (1.31) | 5.85 (0.86) | 4.35 (1.12) | $F(3, 1572) = 526.45^{**}$<br>1 v2 $t(863.53) = 30.47^{**}$<br>1 v3 $t(573.69) = -6.85^{**}$<br>1 v4 $t(735) = 11.12^{**}$<br>2 v3 $t(611.63) = -38.63^{**}$<br>2 v4 $t(851.31) = -18.97^{**}$<br>3 v4 $t(561.34) = 18.33^{**}$ |
| In a hurry to get somewhere | 4.3 (1.27) | 3.23 (1.32) | 4.96 (1.22) | 5.31 (1.22) | $F(3, 1571) = 237.22^{**}$<br>1 v2 $t(982) = 12.47^{**}$<br>1 v3 $t(600) = -6.23^{**}$<br>1 v4 $t(736) = -11.08^{**}$<br>2 v3 $t(432.75) = -17.72^{**}$<br>2 v4 $t(807.44) = -24.95^{**}$<br>3 v4 $t(586) = -3.47^{**}$ |
| Realised driving faster than thought | 3.39 (1.5) | 2.96 (1.4) | 4.48 (1.26) | 3.8 (1.27) | $F(3, 1569) = 75.58^{**}$<br>1 v2 $t(753.29) = 4.58^{**}$<br>1 v3 $t(536.23) = -9.49^{**}$<br>1 v4 $t(723.03) = -3.92^{**}$<br>2 v3 $t(832) = -14.3^{**}$<br>2 v4 $t(967) = -9.32^{**}$<br>3 v4 $t(585) = 6.35^{**}$ |
| Realised driving faster than thought so reduced speed | 4.53 (1.08) | 5.71 (0.97) | 3.04 (1.28) | 4.42 (0.92) | $F(3, 1578) = 400.71^{**}$<br>1 v2 $t(985) = -17.81^{**}$<br>1 v3 $t(601) = 15.39^{**}$<br>1 v4 $t(728.42) = 1.42$<br>2 v3 $t(328.55) = 28.67^{**}$<br>2 v4 $t(796.72) = 20.64^{**}$<br>3 v4 $t(373.09) = -14.25^{**}$ |
| Drive faster than a 30 mph speed limit as it feels safe | 5.56 (1.14) | 2.65 (1.23) | 6.22 (0.78) | 4.58 (0.91) | $F(3, 1578) = 914.75^{**}$<br>1 v2 $t(985) = 38.41^{**}$<br>1 v3 $t(592.43) = -7.11^{**}$<br>1 v4 $t(712.9) = 14.23^{**}$<br>2 v3 $t(635.78) = -49.8^{**}$<br>2 v4 $t(928.28) = -28.01^{**}$<br>3 v4 $t(535.31) = 23.27^{**}$ |
| Drive faster than a 30 mph speed limit even if it feels unsafe to do so | 2.2 (1.13) | 1.43 (0.65) | 5.16 (1.15) | 3.09 (1.02) | $F(3, 1578) = 916.42^{**}$<br>1 v2 $t(530.78) = 12.03^{**}$<br>1 v3 $t(601) = -31.02^{**}$<br>1 v4 $t(739) = -11.25^{**}$<br>2 v3 $t(281.52) = -46.2^{**}$<br>2 v4 $t(543.8) = -27.86^{**}$<br>3 v4 $t(590) = 22.9^{**}$ |
| Drive faster than a 30 mph speed limit when in hurry | 4.56 (1.16) | 2.4 (1.31) | 5.79 (0.8) | 6.16 (0.76) | $F(3, 1578) = 1099.49^{**}$<br>1 v2 $t(869.55) = 27.04^{**}$<br>1 v3 $t(589.52) = -15.37^{**}$<br>1 v4 $t(651.48) = -22.35^{**}$<br>2 v3 $t(658.05) = -45.05^{**}$<br>2 v4 $t(973.31) = -56.65^{**}$<br>3 v4 $t(590) = -5.71^{**}$ |

Table 3 (*Continued*)

| How often perform the following particular type of driving behaviour | Group 1 mean response (standard deviation) ($n = 376$)[a] | Group 2 mean response (standard deviation) ($n = 611$)[b] | Group 3 mean response (standard deviation) ($n = 227$)[c] | Group 4 mean response (standard deviation) ($n = 365$)[d] | Significance ANOVA ($F$-value) and $T$-Tests ($t$-value) |
|---|---|---|---|---|---|
| Drive faster than a 30 mph speed limit if angry | 3.36 (1.49) | 1.6 (0.93) | 5.52 (0.9) | 5.62 (0.83) | $F(3, 1578) = 1401.88^{**}$<br>1 v2 $t(557.88) = 20.64^{**}$<br>1 v3 $t(601) = -22.17^{**}$<br>1 v4 $t(592.21) = -25.67^{**}$<br>2 v3 $t(836) = -54.62^{**}$<br>2 v4 $t(974) = -67.99^{**}$<br>3 v4 $t(590) = -1.51$ |
| Drive faster to increase gap if a car is close behind | 2.91 (1.5) | 1.66 (0.94) | 5.19 (1.02) | 5.35 (0.88) | $F(3, 1578) = 1116.41^{**}$<br>1 v2 $t(559.58) = 14.55^{**}$<br>1 v3 $t(592.49) = -22.14^{**}$<br>1 v4 $t(610.9) = -27.09^{**}$<br>2 v3 $t(836) = -47.07^{**}$<br>2 v4 $t(974) = -60.62^{**}$<br>3 v4 $t(590) = -2.09^{*}$ |
| Dangerous overtaking | 1.38 (0.77) | 1.09 (0.32) | 4.59 (1.33) | 1.55 (0.7) | $F(3, 1578) = 1321.1^{**}$<br>1 v2 $t(454.98) = 6.9^{**}$<br>1 v3 $t(318.13) = -33.28^{**}$<br>1 v4 $t(739) = -3.3^{**}$<br>2 v3 $t(235.61) = -39.3^{**}$<br>2 v4 $t(453.54) = -11.93^{**}$<br>3 v4 $t(305.95) = 31.78^{**}$ |
| Dangerous overtaking when late | 1.75 (1.23) | 1.44 (0.43) | 5.15 (0.97) | 4.96 (1.09) | $F(3, 1578) = 1992.94^{**}$<br>1 v2 $t(432.44) = 9.26^{**}$<br>1 v3 $t(558.4) = -37.49^{**}$<br>1 v4 $t(733.11) = -37.61^{**}$<br>2 v3 $t(259.6) = -59.79^{**}$<br>2 v4 $t(432.94) = -63.95^{**}$<br>3 v4 $t(590) = 2.107^{*}$ |
| Drive close to other vehicles when late | 3.12 (1.46) | 1.63 (0.87) | 5.81 (0.82) | 5.63 (0.96) | $F(3, 1578) = 1513.71^{**}$<br>1 v2 $t(540.05) = 17.89^{**}$<br>1 v3 $t(597.88) = -28.84^{**}$<br>1 v4 $t(649.01) = -27.68^{**}$<br>2 v3 $t(836) = -62.69^{**}$<br>2 v4 $t(708.05) = -65.25^{**}$<br>3 v4 $t(534.62) = 2.34^{*}$ |
| Use other lanes to get ahead | 5.29 (1.29) | 2.03 (1.05) | 6.37 (0.77) | 2.98 (1.2) | $F(3, 1578) = 1191.76^{**}$<br>1 v2 $t(674.14) = 41.2^{**}$<br>1 v3 $t(600.85) = -12.87^{**}$<br>1 v4 $t(737.72) = 25.15^{**}$<br>2 v3 $t(552.25) = -65.38^{**}$<br>2 v4 $t(686.73) = -12.52^{**}$<br>3 v4 $t(589.64) = 41.81^{**}$ |
| Use other lanes when late to get ahead | 5.79 (1.02) | 2.23 (1.13) | 6.6 (0.59) | 6.06 (0.88) | $F(3, 1578) = 1948.73^{**}$<br>1 v2 $t(857.12) = 51.27^{**}$<br>1 v3 $t(600.12) = -12.33^{**}$<br>1 v4 $t(729.39) = -3.88^{**}$<br>2 v3 $t(747.89) = -72.68^{**}$<br>2 v4 $t(908.61) = -59.15^{**}$<br>3 v4 $t(586.73) = 8.87^{**}$ |
| Perform fast acceleration and heavy braking | 4.08 (1.33) | 1.73 (0.74) | 6.68 (0.61) | 5.87 (1.07) | $F(3, 1578) = 1520.11^{**}$<br>1 v2 $t(519.31) = 25.42^{**}$<br>1 v3 $t(569.65) = -38.93^{**}$<br>1 v4 $t(715.22) = 11.4^{**}$<br>2 v3 $t(480.69) = -98.92^{**}$<br>2 v4 $t(571.81) = -14.01^{**}$<br>3 v4 $t(586.71) = 59.29^{**}$ |

Table 3 (*Continued*)

| How often perform the following particular type of driving behaviour | Group 1 mean response (standard deviation) ($n = 376$)[a] | Group 2 mean response (standard deviation) ($n = 611$)[b] | Group 3 mean response (standard deviation) ($n = 227$)[c] | Group 4 mean response (standard deviation) ($n = 365$)[d] | Significance ANOVA ($F$-value) and $T$-Tests ($t$-value) |
|---|---|---|---|---|---|
| Perform fast acceleration and heavy braking when late | 4.99 (1.53) | 4.66 (0.88) | 5.41 (0.55) | 5 (0.91) | $F(3, 1578) = 1860.38^{**}$<br>1 v2 $t(529.18) = 27.18^{**}$<br>1 v3 $t(512.37) = -30.09^{**}$<br>1 v4 $t(614.85) = -19.51^{**}$<br>2 v3 $t(646.92) = -97.77^{**}$<br>2 v4 $t(974) = -70.43^{**}$<br>3 v4 $t(589.3) = 13.58^{**}$ |

[a] Calculated risk takers.
[b] Unintentional risk takers.
[c] Continuous risk takers.
[d] Reactive risk takers.
[*] Significant at $p < 0.05$.
[**] Significant at $p < 0.01$.

Drivers assigned to group 1 score particularly high on feeling that 30 mph should really be 40 mph, driving at a faster speed than the 30 mph speed limit because it feels safe to do so and using a different lane to other vehicles going in the same direction, to avoid being held up, when at a roundabout or traffic lights both normally and when late. Group 1 drivers do not score particularly low on any of the questions. Thus, this group could accurately be described as the calculated risk taking group.

Drivers in group 2, the largest group of respondents, score lower than the average response on nearly all responses, apart from being in a hurry to get somewhere, realising driving faster than thought, reducing speed when realising driving faster than thought and dangerous overtaking normally and when late, where they score more of an average score. Thus, this group can be accurately described as the unintentional risk taking group.

Drivers assigned to group 3, the smallest group of respondents, score much higher than average on all questions except 'being in a hurry' where an average score is found and reducing speed when realising driving faster than was thought where a lower than average score is given. Thus, group 3 accurately reflects continuous risk takers.

Drivers assigned to group 4 score highly on being in a hurry, driving faster than the speed limit when in a hurry, driving faster than the speed limit when angry, annoyed or irritated, drive faster to increase gap when a car drives very close behind, dangerous overtaking when late, driving close to other vehicles when late for an appointment, using different lanes at roundabouts or junctions to cars travelling in the same direction to avoid being held up when late and fast acceleration and braking when late. Thus, group 4 accurately describes reactive drivers.

Table 3 highlights, through the use of an ANOVA, that there are significant differences between the answers given by each group to each driving behaviour question studied. *T*-tests were carried out between each group for each question and all groups were found to give significantly different answers for each question (see Table 3) except: calculated and reactive risk takers gave similar answers (i.e. not significantly different) for how often they see themselves reducing speed when they realise they are going faster than they thought ($t(728.42) = 1.42$; $p > 0.05$) and continuous and reactive risk takers give similar answers (i.e. not significantly different) for how often they drive faster than a 30 mph speed limit when they are angry ($t(590) = 1.51$; $p > 0.05$).

As Table 4 shows the average age of each groups varies, with continuous risk takers having the youngest mean age of all the four groups, at just 26.35 years old, and unintentional risk takers having the oldest mean age across the four groups, at 41.93 years of age. Calculated risk takers are slightly older by mean age at 38.61 years of age, than reactive risk takers who have a mean age of 37.38 years of age, whose mean ages are between unintentional and continuous risk takers.

An ANOVA shows that there are significant differences between the mean age of the four groups ($F(3, 1536) = 79.99$; $p < 0.01$). *T*-tests show that unintentional risk takers are significantly older in age than all intentional risk taking groups: calculated ($t(848.96) = 3.82$; $p < 0.01$); continuous ($t(511.845) = 16.85$; $p < 0.01$) and; reactive ($t(808.99) = 5.2$; $p < 0.01$). *T*-tests show that continuous risk takers are significantly younger in age than all other risk groups: calculated risk takers ($t(520.58) = -12.6$; $p < 0.01$); unintentional risk takers ($t(511.85) = -16.85$; $p < 0.01$) and; reactive risk takers ($t(518.58) = -11.25$; $p < 0.01$). There is no significant difference between the ages of calculated risk takers and reactive risk takers ($t(722) = 1.33$; $p > 0.05$).

However, it must be remembered that there is a highly significant positive correlation between age of driver and length of time held licence ($r = 0.969$; $p < 0.01$; $n = 1605$). Thus, it is not possible to identify whether age or length of time held full UK driving licence is more significant in categorising drivers to groups. As Table 4 shows, the mean number of years that individuals have held full UK driving licences tends to follow a very similar pattern to ages, with unintentional risk takers having the highest mean showing the longest amount of years that they have held a full UK driving licence compared to the other groups (22.24 years), continuous risk takers having the lowest mean, showing they have held a full UK driving licence for the shortest amount of time of all the groups (8.08 years). Calculated and reactive risk takers fall in between with calculated risk takers having a slightly higher mean, having held UK driving licences

Table 4
Age, length of time held UK driving licence and miles driven per typical week for each risk taking group

| Background of driver groups | Group 1 ($n = 376$)[a] | Group 2 ($n = 611$)[b] | Group 3 ($n = 227$)[c] | Group 4 ($n = 365$)[d] | Significance ANOVA ($F$-value) and $T$-tests ($t$-value) |
|---|---|---|---|---|---|
| Mean Age (standard deviation) | 38.61 (12.52) | 41.93 (13.97) | 26.35 (10.83) | 37.38 (12.42) | $F(3, 1536) = 79.99^{**}$<br>1 v2 $t(848.96) = -3.82^{**}$<br>1 v3 $t(520.58) = -12.6^{**}$<br>1 v4 $t(722) = 1.33$<br>2 v3 $t(511.85) = 16.85^{**}$<br>2 v4 $t(808.99) = 5.2^{**}$<br>3 v4 $t(518.58) = -11.25^{**}$ |
| Mean Length of Time Held Licence | 19.37 (12.26) | 22.24 (13.95) | 8.08 (9.83) | 17.56 (12.28) | $F(3, 1563) = 69.74^{**}$<br>1 v2 $t(868.45) = -3.38^{**}$<br>1 v3 $t(550.24) = -12.38^{**}$<br>1 v4 $t(735) = 2^{*}$<br>2 v3 $t(567.02) = 16.33^{**}$<br>2 v4 $t(835.68) = 5.44^{**}$<br>3 v4 $t(548.87) = -10.3^{**}$ |
| Mean Miles Driven per Typical Week | 126.15 (63.88) | 100.39 (44.97) | 143.27 (71.04) | 108.94 (47.32) | $F(3, 1569) = 41.26^{**}$<br>1 v2 $t(597.82) = 6.83^{**}$<br>1 v3 $t(597) = -3.05^{**}$<br>1 v4 $t(685.74) = 4.16^{**}$<br>2 v3 $t(294.27) = -8.47^{**}$<br>2 v4 $t(972) = -2.81^{**}$<br>3 v4 $t(349.87) = 6.43^{**}$ |

[a] Calculated risk takers.
[b] Unintentional risk takers.
[c] Continuous risk takers.
[d] Reactive risk takers.
* Significant at $p < 0.05$.
** Significant at $p < 0.01$.

for slightly longer on average (19.37 years) than reactive risk takers (17.56 years).

An ANOVA shows that there are significant differences between the mean number of years that the individual has held a full UK driving licence of the four groups ($F(3, 1563) = 69.74$; $p < 0.01$). $T$-tests show that unintentional risk takers have held their full UK driving licence for significantly longer than all intentional risk taking groups: calculated ($t(868.45) = 3.38$; $p < 0.01$); continuous ($t(567.02) = 16.33$; $p < 0.01$) and; reactive ($t(835.68) = 5.44$; $p < 0.01$). $T$-tests show that continuous risk takers have held their licence for significantly less amount of years than all other risk groups: calculated risk takers ($t(550.24) = -12.38$; $p < 0.01$); unintentional risk takers ($t(567.02) = 16.33$; $p < 0.01$) and; reactive risk takers ($t(548.87) = -10.3$; $p < 0.01$). There is, however, a significant difference between the amount of time a calculated risk taker has held a full UK driving licence and the amount of time a reactive risk taker has held a full UK driving license ($t(735) = 2$; $p < 0.05$), showing calculated risk takers have held a full UK driving licence a significantly longer amount of time than reactive risk takers.

As Table 4 shows continuous risk takers, on average, drive the most number of miles per typical week with a mean of 143.27 miles per week, and unintentional risk takers drive the least amount of miles per typical week with a mean of 100.39 miles. Calculated risk takers drive the second most number of miles per week of the four categories of driver with a mean of 126.15 miles per typical week, followed by reactive risk takers who drive a mean of 108.94 miles.

An ANOVA shows that differences in the mean number of miles driven in a typical week are significant between the groups ($F(3, 1569) = 41.26$; $p < 0.01$). $T$-tests were run to show where the significant differences were to be found. It was found that unintentional risk takers drive significantly less number of miles per typical week than all other intentional risk taking groups: calculated ($t(597.82) = -6.83$; $p < 0.01$), continuous ($t(294.27) = -8.5$; $p < 0.01$) and reactive ($t(972) = -2.81$; $p < 0.01$). Continuous risk takers drive significantly more miles per week than other risk taking groups: calculated ($t(597) = 3.05$; $p < 0.01$), unintentional ($t(294.27) = 8.47$; $p < 0.01$) and reactive ($t(349.87) = 6.43$; $p < 0.01$). There is also a significant difference between calculated and reactive risk takers where calculated risk takers drive significantly higher number of miles per typical week than reactive risk takers ($t(685.74) = 4.16$; $p < 0.01$).

As Table 5 shows reactive risk takers are more likely to be female (73% compared to 26% male). Continuous risk takers are much more likely to be male (90% compared to 9% female). Calculated risk takers are more likely to be male (69% compared to 31% female). Taking into account there are more male drivers (53.6%) than female drivers (46.4%) in the sample, unintentional risk takers are more likely to be female (53% compared to 47% male).

Table 5
Gender of respondent by driver risk taking group

| Gender of respondent by driver category | Group 1 ($n = 376$)[a] | Group 2 ($n = 611$)[b] | Group 3 ($n = 227$)[c] | Group 4 ($n = 365$)[d] |
|---|---|---|---|---|
| Number of female drivers (% of total drivers in group) | 118 (31.4%) | 323 (53%) | 21 (9.3%) | 268 (73.8%) |
| Number of male drivers (% of total drivers in group) | 258 (69.6%) | 286 (47%) | 205 (90.7%) | 95 (26.2%) |

[a] Calculated risk takers.
[b] Unintentional risk takers.
[c] Continuous risk takers.
[d] Reactive risk takers.

## 4. Discussion

It is reassuring that behaviours listed on the questionnaire that appear the most dangerous, such as dangerous overtaking and driving faster than a 30 mph speed limit when it feels unsafe to do so, are those reported most infrequently by individuals. However, 0.6% of drivers say they perform "dangerous overtaking" always and 1.1% of driver report they drive faster than a 30 mph speed limit even when it feels unsafe to do so. Although this may seem a small amount, this could have a devastating effect on road safety, particularly on light or vulnerable road users, given the number of drivers this would represent. In addition, the distribution shows that at some point 33.2% of drivers use dangerous overtaking and 66.6% of drivers drive faster than a 30 mph speed limit even when it is unsafe to do so, which is a large amount.

The behaviour that is reported, on average, to be performed most often is the one behaviour in the questionnaire that is beneficial, that is how often individuals reduce their speed if they realise they are driving faster than the speed limit. However, there is some concern over the increase in the frequency of more dangerous driving behaviour shown by individuals if they are late for an appointment compared to normal. This is even more disturbing when, on average, drivers are reporting they are driving fairly frequently when in a hurry. However, on closer inspection not all the drivers' behaviour changes when they are late for an appointment. A distinct category of drivers emerges that performs more risk in such conditions. The hierarchical cluster analysis highlighted such a group, which perform increased risk in reaction to being late and also to being under stress; this group is named the 'reactive risk taking group'.

One of the most valuable findings to emerge from the data is the establishment of four distinct groups of driver, measured through clustering similar behaviour patterns found on the questionnaire. Using a hierarchical cluster analysis has been highly successful in demonstrating that there are four distinct groups of driver, which can be labelled as calculated risk takers, unintentional risk takers, continuous risk takers and reactive risk takers. The group that display the lowest level of risk through reporting they infrequently perform dangerous behaviours, the unintentional risk taking group, have the largest number of drivers in their category ($n = 611$; 38.7% of all drivers). The group with the highest level of risk through displaying the highest frequency of dangerous driving behaviours, the continuous risk taking group, have the lowest number of drivers in their group ($n = 227$; 14.4% of all drivers). This supports previous work which suggests that there are more drivers who could be rated as safe drivers than there are drivers rated as unsafe (e.g. Parker et al., 1992a,b; Rolls et al., 1991). The establishment of these two categories is also harmonious with categories found in previous research, such as unsafe and safe categories of driver (developed through Rolls et al., 1991 and continued throughout Rolls and Ingham, 1992) and unintentional and intentional categories of driver found by Reason et al. (1990). The continuous risk taking group consists mainly of male drivers who are younger in age and drive more miles per week compared to the unintentional risk taking group. These findings are congruent with categories of driver found in previous studies, for example the unsafe group (Rolls et al., 1991 and Rolls and Ingham, 1992) and drivers displaying deliberate risk or violations (Parker et al., 1992a,b).

In addition to the unintentional and continuous risk taking groups, this research found a calculated and reactive risk taking group. Previous research (e.g. Parker et al., 1992a,b; Quimby et al., 1999a,b; Rolls et al., 1991; Rolls and Ingham, 1992) has hinted at the possibilities of such groups based on motivation and intention to speed and commit risk, but have not identified such drivers. Further analysis of unintentional risk takers could attempt to find if there are any scenarios or situation in which they may consider taking more risks. Furthermore, it could be examined whether they do take risks but do not notice or do not report risk taking accurately. In addition, such a group may include drivers who feel they are safe but unintentionally take a number of dangerous risks, through lapses or slips in concentration, as previously found in studies on human error and driving (Parker et al., 1992a,b). Alternatively, with the continuous risk taking group, it can be identified if there are any situations where such drivers do not take such continuous risks. It may be found that drivers in this category do not take such risks when they have passengers of certain types or ages, for example.

The results of the research offer a contextual framework to Risk Homeostasis Theory (Wilde, 1982, 1994, 1998). The theory has been tested previously on a macro-scale, where individuals have been treated as a homogeneous group. Although Wilde (1994) has noted that target risk is related to intrinsic and extrinsic motivations, empirical data has not supported this. The research presented in this paper shows that motivations for risk vary depending upon intrinsic and extrinsic motivations. It appears from the research that continuous risk takers may relate their need for a high level of risk to reach their target risk through increasing the risk in their car driving behaviour. It could be that unintentional risk takers either have a lower level of target risk or may use other means other than car driving to achieve their target risk. Further research is suggested as important to study this.

Calculated risk takers' target risk is based on their appraisal of a risky situation, an appraisal of an extrinsic factor, which varies depending upon the context. Reactive risk takers' target risk is linked very much to their intrinsic motivation, particularly stress, anger and annoyance. Unintentional risk takers need to take only a low level of risk to reach their target risk. Further research could help investigate these differences in target risk, concentrating on the mechanisms, including biology, culture and attitudes, that create and support such differences.

It is important to note that the pattern of behaviours found through the cluster analysis show that a number of driver behaviours are clearly linked together. For example, driving over the speed limit which is found as being very common for continuous risk takers in all situations is coupled with other aberrant driving behaviours. Calculated risk takers who mention frequent speeding also mention fast acceleration and heavy braking and using other lanes in order to get ahead. Reactive risk takers, who speed when late, also mention performing other risky behaviours when late. Thus, the claims that speed of vehicles is linked with accidents (Fildes et al., 1991; Finch et al., 1994; Garber and Gadirau, 1988; Sabey, 1983; Staughton and Storie, 1977; Treat, 1980) may not explain the entire situation, since other behaviours are compounded with speeding, such as acceleration and braking (as also noted by Quimby et al., 1999a,b), switching lanes in order to get ahead and even dangerous overtaking. Thus, speed alone is not the only variable associated with road traffic accidents and as such campaigns and technology aimed at reducing speed alone may not have the desired effect on road safety particularly if other dangerous driving behaviours are not additionally addressed.

Overall, the research has shown that target risk and therefore clusters of risky behaviour vary between individuals. In order to reduce the level of risk shown by drivers on our roads further understanding for the motivations of risk are needed so that appropriate education, enforcement and engineering can be used to mediate aberrant driving behaviour.

## References


Baxter, J.S., Manstead, A.S.R., Stradling, S.G., Campbell, K.A., Reason, J.T., Parker, D., 1990. Social facilitation and driver behaviour. Br. J. Psychol. 81, 351–360.

Brown, I.D., Groeger, J.A., 1988. Risk perception and decision taking during the transition between novice and experienced driver status. Ergonomics 31 (4), 585–597.

Dingus, T.A., McGhee, D.V., Monakkal, N., Jahns, S.K., Carney, C., Hankey, J.M., 1997. Human factors field evaluation of automotive headway maintenance/collision warning devices. Hum. Factors 39 (2), 216–229.

DTLR, 2001. Road Accidents Great Britain. The Casualty Report. The Stationary Office, London.

Evans, L., Wasielewski, P., 1982. Do accident involved drivers exhibit riskier everyday driving behaviour? Accid. Anal. Prev. 14, 57–64.

Evans, L., Wasielewski, P., 1983. Risky driving related to driver and vehicle characteristics. Accid. Anal. Prev. 15 (2), 121–136.

Fancher, P., Ervin, R., Sayer, J., Hagan, M., Bogard, S., Bareket Z., Mofford, M., Haugen, J., 1998. Intelligent Cruise Control Field Operational Test, UMTRI, NHTSA.

Fildes, B.N., Rumbold, G. Leening, A., 1991. Speed behaviour and drivers' attitude to speeding, Montash University Accident Research Centre report number 16. Montash: Montash University Accident Research Centre.

Finch, B.N., Kompfner, P., Lockwood, C.R. Maycock, G., 1994. Speed, speed limits and accidents. Transport Research Laboratory report number PR58. Crowthorne: Transport Research Laboratory.

Finn, P., Bragg, B.W.E., 1986. Perception of the risk of an accident by young and older drivers. Accid. Anal. Prev. 18, 289–298.

French, D.J., West, R.J., Elander, J., Wilding, J.M., 1993. Decision making style, driving style and self-reported involvement in road traffic accidents. Ergonomics 36, 627–644.

Galin, D., 1981. Speeds on two-lane rural roads: a multiple regression analysis. Traffic Eng. Control 22, 433–460.

Garber, S., Gadirau, J.D., 1988. Speed Variance and its Influence on Accidents. AAA Foundation for Traffic Safety, Washington, DC.

Glaser, B.G., 2001. The Grounded Theory Perspective: Conceptualization Contrasted with Description. Sociology Press, Mill Valley, CA.

Grayson, G.B., Sexton, B.F., 2002. The Development of Hazard Perception Testing. TRL Report TRL 558. Crowthorne: TRL Limited.

Groeger, J.A., Brown, I.D., 1989. Assessing one's own and others' driving ability: influences of sex, age and experience. Accid. Anal. Prev. 21 (2), 155–168.

Hauer, E., Garder, P., 1986. Research into the validity of the traffic conflicts technique. Accid. Anal. Prev. 18, 471–481.

Matthews, M.L., Moran, A.R., 1986. Age differences in male drivers' perception of accident risk: The role of perceived driving ability. Accid. Anal. Prev. 18, 299–313.

McKenna, F.P., Stanier, R.A., Lewis, C., 1991. Factors underlying illusory self-assessment of driving skill in males and females. Accid. Anal. Prev. 23 (1), 45–52.

Musselwhite, C.B.A., 2004. Driver Attitudes, Behaviour and Engineering Speed Management Strategies. Ph.D. Thesis. Transportation Research Group, University of Southampton.

Parker, D., Manstead, A.S.R., Stradling, S.G., Reason, J.T., 1992a. Determinants of intention to commit driving violations. Accid. Anal. Prev. 24 (2), 117–131.

Parker, D., Manstead, A.S.R., Stradling, S.G., Reason, J.T., Baxter, J.S., 1992b. Intention to commit driving violations: an application of the theory of planned behaviour. J. Appl. Psychol. 77 (1), 94–101.

Quimby, A., Maycock, G., Palmer, C. and Buttress, S., 1999. The factors influencing a driver's choice of speed—a questionnaire study, Transport Research Laboratory report number 325, Crowthorne: Transport Research Laboratory.

Quimby, A., Maycock, G., Palmer, C. Grayson, G.B., 1999. Drivers' speed choice: an in-depth study, Transport Research Laboratory report number 326, Crowthorne: Transport Research Laboratory.

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

Rolls, G.W.P., Hall, R., Ingham, R., McDonald, M., 1991. Accident Risk and Behavioural Patterns of Younger Drivers. AA Foundation for Road Research, Basingstoke.

Rolls, G.W.P., Ingham, R., 1992. Safe and Unsafe: A comparative study of younger male drivers. AA Foundation for Road Research, Basingstoke.

Sabey, B.E., 1983. Road Safety in the 80s. Symposium on Recent Development and Research in Road Safety Remedial Measures. Salford, UK.

Short, M.S., Woelfl, G.A., Chang, C.J., 1982. Effects of traffic signal installation on accidents. Accid. Anal. Prev. 14, 135–145.

Smeed, R.J., 1972. The statistics of road accidents. Proceedings of the Third International Symposium on Urban Traffic Safety. Budapest.

Staughton, G.C., Storie, V.J., 1977. Methodology of an in-depth accident investigation survey, Report LR 762, Transport Road Research Laboratory, Crowthorne, Berks.

Svensson, O., 1981. Are we all less risky and more skilful than our fellow drivers. Acta Psychol. 47, 143–148.

Treat, J.R., 1980. A Study of Precrash factors involved in traffic accidents. Highway Safety Res. Inst. Res. Rev. 106/11 (1), 1–35.

Wasielewski, P., 1984. Speed as a measure of driver risk: observed speeds versus driver and vehicle characteristics. Accid. Anal. Prev. 16, 89–103.

West, R., Elander, J., French, D., 1992. Decision making, personality and driving style as correlates of individual accident risk, Transport Research Laboratory report number CR 390, Crowthorne: Transport Research Laboratory.

Wilde, G.J.S., 1982. The theory of risk homeostasis: Implications for safety and health. Risk Anal. 2, 249–258.

Wilde, G.J.S., 1994. Target risk; Dealing with the Danger of Death, Disease and Damage in everyday Decisions. PDE Publications, Toronto, Canada.

Wilde, G.J.S., 1998. Can traffic calming devices be expected to reduce the accident rate per head of population or per unit distance driven? Paper presented at Traffic safety Summit, Kananaskis, Alberta, Canada, 4–7 October.