



# **The contribution of individual factors to driving behaviour: Implications for managing work-related road safety**

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## **RESEARCH REPORT 020**

# **The contribution of individual factors to driving behaviour: Implications for managing work-related road safety**

**Rebecca Lancaster and Rachel Ward**

Entec UK Limited  
Doherty Innovation Centre  
Pentlands Science Park  
Bush Loan  
Penicuik  
Midlothian  
EH26 0PZ

The following report details the findings of a literature review aimed at identifying the individual differences that are associated with driving behaviour and road traffic accidents. Age, gender, ethnicity, education, personality, risk perception, social deviance, previous accident involvement, experience, stress, life events, fatigue and physiology are presented. It is thought that a greater understanding of these issues will aid in the development of more appropriate and effective road safety policies and procedures and in doing so reduce the number of work-related road traffic incidents. Consequently the findings are discussed in relation to policy development and safety culture, recruitment, training, pre and post employment medical screening and management of stress.

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# **CONTENTS**

<b>EXECUTIVE SUMMARY</b>	<b>VII</b>
<b>1. INTRODUCTION</b>	<b>1</b>
1.1 Background	1
1.2 Aims	1
1.3 Methods	2
<b>2. SUMMARY OF REVIEW FINDINGS</b>	<b>3</b>
2.1 Age	3
2.2 Gender	3
2.3 Education	4
2.4 Personality	4
2.5 Aggression	5
2.6 Thoroughness in Decision-Making	5
2.7 Driving Confidence	5
2.8 Attitudes	5
2.9 Risk Perception	5
2.10 Social Deviance	6
2.11 Experience and Previous Motor Vehicle Accidents	6
2.12 Stress	6
2.13 Life Events / Factors	6
2.14 Fatigue	6
2.15 Physiology	7
2.16 Ethnicity	7
<b>3. IMPLICATIONS OF THE FINDINGS FOR OCCUPATIONAL ROAD SAFETY POLICIES AND PROCEDURES</b>	<b>8</b>
3.1 Policy development and Safety Culture	8
3.2 Recruitment	8
3.3 Training	9
3.4 Pre and post employment medical screening	10
3.5 Managing stress	10

<b>4.</b>	<b>AGE</b>	<b>11</b>
4.1	Age and Crash Involvement	11
4.2	Age, Social Deviance, and Driving Violations	12
4.3	Age and Speeding	14
4.4	Age and Alcohol and Drug Usage	15
4.5	Age and Seat-Belt Use	16
4.6	Age and Gender	17
4.7	Age and Ethnicity	17
4.8	Age and Risk Perception	17
4.9	Age and Personality Factors	18
4.10	Age and Aggression / Anger	19
4.11	Age and Experience	20
4.12	Age and Physiology	23
4.13	Age and Driving Skill	23
4.14	Age and Fatigue	24
<b>5.</b>	<b>GENDER</b>	<b>25</b>
5.1	Gender and Crash Involvement	25
5.2	Gender and Driving Violations	26
5.3	Gender and Speeding	26
5.4	Gender and Alcohol and Drug Usage	27
5.5	Gender and Seat-Belt Use	27
5.6	Gender and Risk Perception	28
5.7	Gender and Experience	28
5.8	Gender and Driving Confidence	28
5.9	Gender and Aggression / Anger	29
5.10	Gender and Physiology	29
<b>6.</b>	<b>EDUCATION</b>	<b>30</b>
6.1	Education and Crash Involvement	30
6.2	Education and Speeding	30
6.3	Education and Seat-Belt Use	30
6.4	Education and Alcohol Usage	30

<b>7. PERSONALITY</b>	<b>32</b>
7.1 Personality and Risky Driving	32
7.2 Personality and Crash Involvement	33
7.3 Personality and Driving Violations	35
7.4 Personality and Alcohol and Drug Usage	36
7.5 Personality and Seat-Belt Use	38
7.6 Personality and Social Deviance	39
7.7 Personality and Gender	39
7.8 Personality and Risk Perception	40
7.9 Personality and Driving Confidence	41
7.10 Personality and Fatigue	41
7.11 Personality and Experience	42
7.12 Personality and Education	42
7.13 Personality and Physiology	42
<b>8. AGGRESSION</b>	<b>43</b>
8.1 Aggression / Anger and Crash Involvement	43
8.2 Aggression / Anger and Alcohol Usage	44
8.3 Aggression and Education	44
<b>9. THOROUGHNESS IN DECISION-MAKING, CRASH INVOLVEMENT, AND SPEEDING</b>	<b>45</b>
<b>10. LOW SELF-CONTROL AND SOCIAL DEVIANCE</b>	<b>46</b>
<b>11. DRIVING CONFIDENCE, DRIVING VIOLATIONS, AND CRASH INVOLVEMENT</b>	<b>47</b>
<b>12. ATTITUDES</b>	<b>48</b>
12.1 Attitudes, Crash Involvement, and Driving Violations	48
12.2 Attitudes towards Drink Driving	48
12.3 Attitudes and Fatigue	50
<b>13. RISK PERCEPTION</b>	<b>51</b>
13.1 Risk Perception and Alcohol Usage	51
13.2 Risk Perception and Experience	51
13.3 Risk Perception and Education	51
13.4 Risk Perception and Previous Experience of Accidents	51

13.5 Risk Perception and Cultural Differences	51
14. SOCIAL DEVIANCE	53
14.1 Social Deviance and Driving Violations	53
14.2 Social Deviance and Crash Involvement	54
14.3 Driving Violations and Crash Involvement	54
14.4 Social Deviance, Crash Involvement, and Driving Violations	55
14.5 Social Deviance and Alcohol and Drug Usage	56
14.6 Social Deviance and Aggression	56
15. EXPERIENCE AND PREVIOUS MOTOR VEHICLE ACCIDENTS	57
16. STRESS	58
16.1 Stress and Crash Involvement	58
16.2 Stress and Driving Behaviour	58
16.3 Stress and Personality	58
16.4 Stress and Aggression / Anger	59
16.5 Stress and Fatigue	59
17. LIFE EVENTS / FACTORS AND DRIVING BEHAVIOUR	60
18. FATIGUE	61
18.1 Fatigue and Crash Involvement	61
18.2 Fatigue and Prolonged Driving	61
18.3 Fatigue and Experience	61
18.4 Fatigue and Alcohol Usage	61
18.5 Fatigue and Physiology	61
19. PHYSIOLOGY	63
19.1 Physiology and Crash Involvement	63
19.2 Physiology and Experience	63
20. ETHNICITY	64
20.1 Ethnicity and Crash Involvement	64
20.2 Ethnicity and Driving Violations	64
20.3 Ethnicity and Alcohol Usage	64
21. REFERENCES	67

## EXECUTIVE SUMMARY

An inter-agency Work-related Road Safety Task Group was established in May 2000, serviced by the Department for Transport, Local Government and the Regions (DTLR, formerly the Department of the Environment, Transport and the Regions, i.e. DETR) and the Health and Safety Executive. This group was established to consider the issue of work-related road safety and make practical proposals that, when implemented, would reduce the number of work-related road traffic incidents. At the same time, the Scottish Executive wished to establish the extent of work-related road safety practices and policies in organisations in Scotland, to inform the Scottish Road Safety Campaign and highlight examples of good practice. The HSE and the Scottish Executive therefore jointly commissioned this research to achieve these objectives.

The Task Group subsequently developed terms of reference (TOR), two of which were to *'establish (or signal what further work is required to establish) the main causes and related methods of preventing incidents within the specified scope'*; and to *'propose minimum health and safety management standards'*.

It is commonly understood that individual differences play a role in safe driving performance. Therefore, regardless of efforts by organisations to manage work-related road safety, some individuals are more likely to exhibit safe driving behaviour than others. It is argued that a better understanding of these individual differences will allow more appropriate and effective work-related road safety policies and procedures to be developed, possibly leading to a greater effectiveness in reducing work-related road traffic incidents.

This review forms the first of a three-part study commissioned by the HSE and the Scottish Executive as detailed below:

- Part One:       The contribution of individual factors to driving behaviour: implications for managing work-related road safety.
- Part Two:       Best practice case studies of occupational road safety policy and procedures.
- Part Three:     The extent to which road safety is considered a health and safety issue in Scottish workplaces.

The aims of this review are to:

- Investigate, by reviewing existing literature, the contribution of individual factors as causes of road traffic incidents.
- Discuss the implications of the findings for work-related road safety policies and procedures.

The scope of the review was to draw together existing literature rather than conduct a critical review. Due to the extent of the literature, the review concentrates on those studies conducted in the last two decades. However, personality tended to be investigated earlier than other issues such as fatigue, drugs, and alcohol and therefore earlier studies are reported.

The review was limited to those individual differences that could be applied in occupational road safety policies / procedures. Therefore papers on gender after retiring age were excluded, as were papers on income, residency, and peer pressure. Those studies including an investigation of occupation were also omitted, as these studies investigated ranging levels of accident involvement across different types of organisation, rather than individual differences in terms of different roles within an organisation.



As the literature review was international there are findings associated with cultural / ethnic differences, these findings should be treated with caution as they cannot necessarily be translated to aid our understanding of cultural differences within Great Britain and any implication these may have for occupational road safety.

The general conclusions were as follows:

- Men were more likely to have an accident than women were.
- The nature of the accidents experienced by men and women were different.
- Younger drivers were at greater risk than were older drivers.
- There was generally a greater risk associated with increased levels of education.
- Certain personality characteristics were associated with increased risk; the most reported characteristics being 'Sensation Seeking' and risk-taking.
- There was a relationship between social deviance and violations and accidents.
- There was a decreased risk of accident involvement with experience, although this tended to even out after eight years of experience.
- Stress was associated with increased accidents as were major life events.
- There was increased risk associated with certain medical conditions.
- There were differences across different ethnic groups.

These findings have significant implications for road safety policies and procedures, as it is evident that it is possible to recruit safer drivers, if driving is their main task. Recruitment procedures may include: personality profiling, pre-employment medical screening, and licence checks. The following issues are also discussed in the light of the findings: benefits of tailored training programmes, the role of stress management, employee awareness and involvement in procedure development, and shaping employee attitudes and safety culture.

# 1. INTRODUCTION

## 1.1 BACKGROUND

HSC/E's policy has generally been not to apply health and safety legislation to work-related road journeys because these incidents are covered by road traffic law and its enforcement. However HSC/E's policy on work-related road traffic accidents was recently reviewed and a gap was identified in relation to employers' duties to manage road safety implications of work-related road journeys. HSC/E concluded that it wanted to do more to reduce associated risks by engaging with other stakeholders, particularly the DTLR.

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The Task Group subsequently developed terms of reference (TOR), two of which were to *'establish (or signal what further work is required to establish) the main causes and related methods of preventing incidents within the specified scope'*; and to *'propose minimum health and safety management standards'*.

It is commonly understood that individual differences play a role in safe driving performance. For example age, gender, personality, risk perception and some medical conditions have been shown to be associated with varying risk of road accidents. Therefore, regardless of efforts by organisations to manage work-related road safety, perhaps through training, risk assessment, or provision of guidance for safe driving, some individuals are more likely to exhibit safe driving behaviour than others. It is argued that a better understanding of these individual differences would allow organisations to take account of them in their organisational work-related road safety policies and procedures, possibly leading to a greater effectiveness in reducing work-related road traffic incidents.

This review forms the first of a three-part study commissioned by the HSE and the Scottish Executive as detailed below:

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- Part Two: Best practice case studies of occupational road safety policy and procedures.
- Part Three: The extent to which road safety is considered a health and safety issue in Scottish workplaces.

## 1.2 AIMS

The aims of this review are to:

- Investigate, by reviewing existing literature, the contribution of individual factors as causes of road traffic incidents.

- Discuss the implications of the findings for work-related road safety policies and procedures.

### **1.3 METHODS**

An initial trawl of the literature was conducted to establish the nature of individual factors that had been reported. At that stage key words such as driver, driving, individual differences, road accidents, and road safety were used. Subsequently, a more comprehensive search was conducted using specific key words relating to the individual differences identified in the initial trawl (personality, age, gender, risk perception, alcohol etc.).

The scope of the review was to draw together existing literature rather than conduct a critical review. Due to the extent of the literature, the review concentrates on those studies conducted in the last two decades. However, personality tended to be investigated earlier than other issues such as fatigue, drugs, and alcohol and therefore earlier studies are reported.

The review was limited to those individual differences that could be applied in occupational road safety policies / procedures. Therefore papers on gender after retiring age were excluded, as were papers on income, residency, and peer pressure. Those studies including an investigation of occupation were also omitted, as these studies investigated ranging levels of accident involvement across different types of organisation, rather than individual differences in terms of different roles within an organisation.

As the literature review was international there are findings associated with cultural / ethnic differences, these findings should be treated with caution as they cannot necessarily be translated to aid our understanding of cultural differences within Great Britain and any implications these may have for occupational road safety.

## **2. SUMMARY OF REVIEW FINDINGS**

The main findings from the review are summarised below:

### **2.1 AGE**

Younger drivers:

- Were at a greater risk of crash involvement, with a marked difference between 18/19 year-olds and 25 year-olds.
- Showed an increased level of social deviance.
- Displayed the highest driving violation rates.
- Aged 20 and under showed the highest observed speeds and highest reported 'normal' speeds.
- Were most likely to be involved in alcohol and / or drug-related accidents.
- Were less likely to wear seat-belts
- Tended to overestimate driving ability and underestimate personal risk.
- Generally associated a lower level of risk perception with a variety of driving situations.
- Were more likely to exhibit the risk-taking factors of personality.
- Suffered from a lack of driving skill.
- And inexperienced drivers were shown to be a high-risk group of drivers. Findings suggested a decrease in crash risk, in relation to experience, that stabilises after 8 or 9 years of driving experience.

Older drivers:

- Tended to be more likely to suffer from certain visual impairments and so research has found a relationship between basic visual functions and crash rates among older drivers.
- Showed a greater frequency of drowsy driving - yet were less likely to have crashes involving driver fatigue. Conversely, the frequency of drowsy driving decreased with increasing experience.

### **2.2 GENDER**

Men:

- Were involved in a greater number and more severe traffic accidents. Among the 16-20 and 21-24 age groups, the male population-based fatality rates were observed to be more than twice as high as those rates for females.
- Were more likely to have a traffic accident caused by violations. The odds of an at-fault crash decreased almost twice as fast for women as for men, per year of licensure.

- Incurred violations sooner and had about twice the risk of committing an offence, in any given year.
- Were 3 times more likely to report driving after drinking.
- Were less likely to use seat-belts.
- Made up the majority of aggressive drivers.

Women:

- Were more likely to be involved in crashes as a result of perceptual or judgemental errors (due to specific problems they appear to have in the area of spatial perception and orientation).
- Driving confidence is generally lower in women.

### **2.3 EDUCATION**

- Those with a higher level of education were more likely to report speeding.
- Those participants with tertiary education, in the 45-50 age range, displayed a significantly higher accident risk, but education did not have an effect on the younger drivers.
- Reported use of seat-belts increased with increasing education.

### **2.4 PERSONALITY**

- Risky Driving behaviour was associated with Sensation Seeking scales, thrill-seeking, impulsiveness, hostility / aggression, emotional instability, depression, and locus of control (LOC).
- Those drivers committing more traffic violations tended to have higher scores on Psychoticism and lower scores on Neuroticism. They also tended to have higher scores on Sensation Seeking (SS), Thrill and Adventure Seeking (TAS), and Boredom Susceptibility (BS).
- Research identified other personality characteristics that were associated with crash involvement: e.g. Sensation Seeking, low tension tolerance, immaturity, personality disorder, paranoid conditions, less conformity, 'impulsivity', more difficulty with authority figures.
- Higher scores on Sensation Seeking scales and "risk-taking were associated with drinking and driving. In addition, higher scores on 'venturesomeness' and 'impulsivity' were associated with higher levels of dangerous driving and substance abuse.
- Higher scores on the Sensation Seeking Scale (SSS) were significantly related to never, or inconsistently, using a seat-belt.
- Participants with an internal locus of control (LOC) reported a lower perceived risk than those with an external LOC.
- Drivers scoring high on an "Extraversion-Boredom" personality cluster were more likely to depart from the road due to falling asleep, while those scoring high on a "Disinhibition-Honesty" cluster were more likely to cross solid lane markings but did not seem to fall asleep. Sensation Seekers also said they had less need for sleep.
- People with an external locus of control (LOC) had more road departures, suggesting that LOC has predictive value for vigilance performance.

- Poor academic performance was associated with higher scores on the Thrill and Adventure Seeking (TAS), Disinhibition (Dis), and Boredom Susceptibility (BS) subscales of the Sensation Seeking measure.
- Drivers with compromised vision displayed reduced risk-taking scores.

## **2.5 AGGRESSION**

- Aggressive drivers, or those with a reduced capacity to manage or control hostility, tended to be involved in more traffic accidents.
- Those drivers with the greatest number of crashes and violations had elevated scores on all 5 of the Buss-Durkee scales, as well as on a scale of driving-related aggression.
- Minor accident involvement was associated with more aggression and tension.
- Higher anger / hostility scores were associated with drink driving.
- The majority of aggressive drivers were poorly educated.

## **2.6 THOROUGHNESS IN DECISION-MAKING**

- Hasty decision-making tended to be associated with an increased risk of crash involvement, faster driving, a tendency to commit traffic violations, and social deviance.

## **2.7 DRIVING CONFIDENCE**

- A higher level of driving confidence was associated with a tendency to commit driving violations.
- A lower degree of self-confidence, when driving, was associated with an increased crash risk.
- Driving confidence was associated with a low score on Neuroticism and a high score on Extraversion.

## **2.8 ATTITUDES**

- Those drivers who regularly commit traffic violations tended to endorse the associated driving behaviour.
- Above a certain minimum level of competence at vehicle handling and road reading, it was drivers with inappropriate attitude, rather than poor skill, who were more likely to crash.
- There were differences in attitudes and knowledge between drink driving offenders and non-offenders.
- Drivers who had a stable and optimistic attitude did not feel very sleepy, yet drivers' self-reported attitude, regarding their susceptibility to sleepiness when driving, was not related to their actual driving performance.

## **2.9 RISK PERCEPTION**

- Driving after drinking was associated with a lower level of risk perception.
- An increased level of driving experience was associated with an increased level of risk perception.

- Those drivers with personal experience of accidents, with different risky activities, reported a lower risk perception than those with no or little experience of accidents.
- There were cross-national differences in risk perceptions.

## **2.10 SOCIAL DEVIANCE**

- There was a strong relationship between social deviance and traffic violations, accident involvement, accident repeaters, drink driving and aggression. Violations are suggested to be one manifestation of social deviance.

## **2.11 EXPERIENCE AND PREVIOUS MOTOR VEHICLE ACCIDENTS**

- Duration of licence, rather than prior motor vehicle accidents (MVAs), was related to the likelihood of a crash being at-fault.
- Increased experience was related to a decrease in the likelihood of an accident being at-fault.

## **2.12 STRESS**

- High job stress predicted future motor vehicle accidents (MVAs).
- Financial stress increased the likelihood of more serious accidents.
- Drivers experiencing minor accident involvement reported the highest levels of general stress, whereas participants who had major or no accident involvement scored relatively low levels of stress.
- Levels of general stress were lower in those reporting a speeding conviction than in those reporting minor accident involvement.
- Increased stress was associated with risky driving behaviour, higher lapse scores and speed scores.

## **2.13 LIFE EVENTS / FACTORS**

- Lower life satisfaction scores were associated with poorer driving behaviour scores.
- Higher life event scores were associated with higher scores for violations.
- More negative life events were associated with drink driving.
- Increased life satisfaction was related to a lower risk of accidents in a mid-age range (aged 45-50 years).

## **2.14 FATIGUE**

- Increased experience was related to a reduction in frequency of drowsy driving.
- Alcohol consumption was suggested to be the single greatest cause of driver fatigue.
- Lower self-perceived health was associated with an increase in sleepiness-related difficulties when driving.
- The frequency of reported 'difficulties in remaining alert' increased by 4.44 times, if the driver's self-perceived health was no more than satisfactory health, when compared to excellent health.

- A sleep deficit in combination with lower self-perceived health increased driver sleepiness-related problems further.
- Specific illnesses have also been related to fatigue.
- The use of medication can also increase the likelihood of drowsy driving.
- Driver fatigue has an effect on psychomotor skills and induces perceptual decrements.

## **2.15 PHYSIOLOGY**

- Certain visual impairments predicted accident involvement.
- Specific medical conditions increased accident risk.
- Habitual alcohol consumption increased accident risk.
- Lack of driving experience, at detecting objects in the traffic environment, may be related to poorer perceptual processing.

## **2.16 ETHNICITY**

- Young white American drivers (<45 years old) experienced higher rates of accident involvement, whilst non-white Americans experienced higher accident rates for ages 45 and above.
- Black Americans were no more likely than White Americans to have accidents but, when they occurred, they tended to be more severe. Native Americans had a high crash fatality rate.
- Non-Caucasians tended to run red-lights more frequently than Caucasians in a U.S. study.
- American Hispanics (as one group) and Whites both showed high rates of 'driving while intoxicated' (DWI). Alcohol-related deaths were more prevalent among Mexican Americans than they were among Caucasians, but this was not the case for the Cuban and Puerto Rican Americans.
- Mexican Americans reported heavier and more frequent drinking than Caucasians.
- Black Americans were found to have the least percentage of 'driving while intoxicated' (DWI) accidents.



### **3. IMPLICATIONS OF THE FINDINGS FOR OCCUPATIONAL ROAD SAFETY POLICIES AND PROCEDURES**

The findings of this review may have significant implications for those organisations with existing road safety policies and procedures and may encourage those without procedures to develop more appropriate systems. These implications are discussed below. Ethnicity, whilst showing variations in driver behaviour across different countries and their cultures, is not considered relevant as these variations cannot be generalised to Great Britain.

#### **3.1 POLICY DEVELOPMENT AND SAFETY CULTURE**

It is apparent from the findings of this study that attitudes and risk perception have a significant impact on the causes of road traffic accidents and on driving behaviour generally. Safety culture has been defined as ‘The characteristic shared attitudes, values, beliefs and practices concerning the importance of health and safety and the necessity for effective controls (IOSH, 1994)’. To establish a positive safety culture requires senior management commitment to health and safety and involvement of employees, at all levels, in decision-making.

In many organisations road safety may not be identified as a health and safety issue, and as a consequence managers and peers may be reluctant to question, comment, or point out the dangers and risks of unsafe driving behaviour. In order to establish a positive culture, in respect of occupational road safety, there is a need to raise awareness of the risks and then encourage all employees to question unsafe behaviour. There are significant variations in peoples’ attitudes and their perception of the risk, and the challenge for organisations is to shape the behaviour of those with extreme attitudes by increased awareness and encouraging feedback from colleagues and managers. Involvement of employees in the development of procedures will increase confidence in the efficacy of control measures.

#### **3.2 RECRUITMENT**

The following section highlights how the individual differences identified may be taken into consideration when recruiting new employees. These apply mostly when employees are recruited for jobs where driving is the most significant task. Whilst profiles of safer drivers can be established, it is also necessary to consider the other responsibilities of employees. The characteristics that are associated with safer driving may not be compatible with the characteristics that are typical of effective performance on other tasks. For example, the characteristics required to be an effective sales representative may be very different from those associated with safe driving.

##### **3.2.1 Personality profiles**

It is evident from the review that certain personality characteristics are associated with unsafe driving behaviour and / or accident involvement. Some of these characteristics include: risk-taking, thrill seeking (including Thrill and Adventure Seeking, Boredom Susceptibility, Disinhibition), impulsiveness, hostility / aggression, hasty decision-making, emotional instability, depression, external locus of control, low tension tolerance, immaturity, personality disorder, paranoid conditions, less conformity and more difficulty with authority figures. In addition, high scores on Neuroticism are a strong predictor of stress, which in turn is associated with risky driving behaviour and accident involvement. Various standard personality scales incorporate some of the factors. For example Cattell’s 16PF (16 Personality Factor Scale) includes Emotionality, Venturesome, Tension and Conservatism. The D.I.S.C. personality

profile covers Compliance and Dominance that are relevant to the associated factors. Some individual organisations have profiled their own drivers to identify the characteristics of safer drivers, using this information to develop profiles of safer drivers for recruitment purposes.

### **3.2.2 Age restrictions**

Clearly younger drivers are of significant greater risk of accident involvement, particularly males. The age group at particular high risk are those aged between 18 and 19, with a marked reduction in crash involvement compared with 25 to 54 year-olds. Whilst experience has some affect it only partially explains this relationship. It may be argued that a minimum age limit for driving may improve fleet safety performance.

### **3.2.3 Experience**

There is a reduced risk of at-fault accidents with increased experience. This effect evens out after approximately 8 years. Therefore there may be advantages to recruiting drivers with some years experience.

### **3.2.4 Social deviance**

There is a strong relationship between social deviance and traffic violations and this is associated with crash involvement. Investigating violation records (licence checks) as well as general criminal records may assist in recruiting safer drivers.

### **3.2.5 Risk perception**

Lower risk perception is associated with increased accident involvement and, therefore, exploring peoples' perception of risks and their attitudes towards driving may assist in identifying and recruiting safer drivers.

## **3.3 TRAINING**

There are two aspects to training to improve driving performance, i.e. awareness of the risks and development of skills.

### **3.3.1 Awareness of risk**

There is evidence to suggest that perception of risk has a significant impact on accidents. Therefore, improving peoples' perception of the risk, through training and awareness, could potentially improve driving performance. As well as formal driving courses this training and awareness may take the form of:

- Guidance on safer driving.
- Campaigns on particular risks (winter driving tips, reverse parking policy, safer reversing etc.).
- Incident reports.
- Near miss reports.
- Involvement of drivers in risk assessment.
- Fatigue-awareness programmes: e.g. adjusting car environments to keep drivers awake and alert; emphasising taking breaks, and that different people may become drowsy at different times; measuring for driver sleep deficits.

### **3.3.2 Skill development**

There are significant variations in the types of violations and nature of accidents based on individual differences (e.g. gender, personality). Therefore it is reasonable to assume that the skills of individuals will vary significantly. For example, women are more likely to have a crash as a result of perceptual or judgemental errors, whereas men are more likely to have a crash as a consequence of a violation. People from different cultures may need specific skills training, for example, training for differences in risk perceptions which may be apparent, cross-nationally. In addition, certain ethnic groups may benefit from being targeted by different types of training. Training that involves assessment of individual skills and one-on-one skill development is likely to be much more effective than training presented to a broad audience with mixed and varied skills.

### **3.4 PRE AND POST EMPLOYMENT MEDICAL SCREENING**

A number of medical conditions were found to be associated with increased crash involvement including visual impairment, habitual alcohol consumption, as well as musculoskeletal abnormalities, memory conditions, and chronic illness. A formal medical screening programme would allow assessment of a driver's fitness for work. Additionally certain medications can increase drowsiness and therefore it is important to ensure drivers are aware, when purchasing medication, or that they report taking prescribed medication. Specific illnesses have also been related to fatigue, which increases the risk of accidents.

### **3.5 MANAGING STRESS**

Stress has been shown to increase risky driving behaviour and is associated with increased involvement in minor accidents. Increased stress has also been associated with fatigue states when driving, which in turn has been associated with increased accident involvement. There are two implications of these findings. Firstly the organisation can and should monitor any stress caused by work. There are a number of means of achieving this, including: questionnaires and audits, discussions with staff, as part of the annual review / performance management procedure, and through supportive management. Sickness absence figures may reflect the levels of stress in an organisation and analysis of the reasons for sickness absence can assist in identifying whether or not stress is a cause of sickness. Secondly, stress may be caused by factors outside work, but supportive management style and culture within an organisation can assist in reducing the impact on performance at work.

In addition, major life events have been associated with violations and driving while intoxicated. Therefore, support may be required to reduce the impact of life events, including flexible work arrangements and a well planned and managed return to work.

## 4. AGE

### 4.1 AGE AND CRASH INVOLVEMENT

The literature reviewed consistently, and robustly, showed that younger drivers are at a greater risk of crash involvement than the various older age groups investigated (Norris *et al*, 2000; Abdel-Aty *et al*, 1999; Dobson *et al*, 1999; Attewell, 1998; Lawton *et al*, 1997; NHTSA, 1995; Szlyk *et al*, 1995; Brorsson *et al*, 1993; Elander *et al*, 1993; Furnham & Saipe, 1993; Baker *et al*, 1992 (in the NHSTA, 1995); Maxim & Keane, 1992; Maycock *et al*, 1991; Mayhew *et al*, 1981; Stewart & Sanderson, 1984; Pelz & Schuman, 1971). The NHTSA's (1995) literature review stated that, "the fatality and injury rates for youth remain markedly above other age groups" (p.54), with teenagers and youths in their early 20s, especially young males, having the highest crash involvement rate of any age group. Crash rates for newly-licensed females, of various ages, also showed that the risk of a crash decreased with increasing age. Brorsson *et al* (1993) found that those drivers aged 18 and 19 had six times greater than the average risk for a single vehicle crash, whilst, compared to 25-54 year-olds, they had ten times a greater risk of running off the road. Furthermore, on weekend nights, 18 and 19 year-olds had 49 times a greater than average risk for single-vehicle crashes. Furthermore, there is an age effect in the number of crashes occurring in daylight and darkness; the NHTSA (1993a; in NHTSA, 1995) observed that the younger age groups had a higher percentage of their crashes after dark than the older age groups did. Drivers aged over 75 only had 8 per cent of their crashes at night, whereas for 65 to 74 year-olds this percentage was 12; for 25 to 64 year-olds this figure was 25%, and for the youngest age group (15 to 24), 33% of their crashes were after dark. Results therefore showed that, the younger the driver, the more likely they are to have a crash which takes place after dark.

Norris *et al* (2000) noted that younger age is one of the predictors of future motor vehicle accidents (MVAs), with younger adults (ages 19 to 39) being twice as likely to have an accident than older adults (ages 56 to 88). The middle-age range (40 to 55 years) had a crash rate which was between these two extremes. Norris *et al*'s study involved a multivariate model which also examined situational factors and risky behaviours, however, although the age effect somewhat dropped in strength when additional factors were added into the analysis, the greater risk of younger adults was not completely explained by either their situations or their riskier behaviours. Elander, West and French (1993) noted that the observation of younger drivers having an increased crash involvement is indeed a robust finding, with studies consistently underlining the younger driver's greater risk at being involved in a traffic accident (Maycock *et al*, 1991; Stewart & Sanderson, 1984; Mayhew *et al*, 1981). Maycock *et al* (1991; in Elander *et al*, 1993) found that 17 year-old drivers have 50% more crashes per year than 25 year-olds, who have 35% more crashes per year than 50 year-olds. Attewell (1998; in Dobson *et al*, 1999) revealed that, for women aged 45-54 years, the car driver death rate in 1995 was 0.27 per 100 million km and the hospital admissions rate, due to road accidents was 5.32 per 100 million km. For the women aged 15-24 years the corresponding rates were 1.50 and 31.10 respectively. Likewise, Dobson *et al* (1999) observed that the average number of accidents in the last 3 years was three times greater in the young (18-23) than the mid-age (45-50) group, within their all-female sample.

Additionally, Pelz and Schuman (1971; in NHTSA, 1995) reported that 18 and 19 year-old drivers had the highest violation and crash rates in comparison to older drivers, while controlling for exposure and experience. Furthermore, Toomath and White (1982), and Goldstein (1972; both in Trankle *et al*, 1990) found evidence that the global accident risk of

young drivers does not decrease when annual mileage is taken into account. These studies therefore demonstrate that young drivers are still at a high risk of being involved in an accident, when experience and miles driven are controlled for.

Comparisons between the youngest and oldest drivers have shown that these groups are more likely to be considered at-fault (McGwin & Brown, 1999; in 'Causes of Road Traffic Accidents Update', 2000). Abdel-Aty *et al* (1999; in Abdel-Aty & As-Saidi, 2000) found that, although both teenagers and elderly drivers had high crash rates, teenagers are riskier and experience the highest rates of traffic accidents and injuries, mainly due to speeding, drunk driving and not wearing seat-belts. Szlyk *et al* (1995) found that, although older groups had poorer driving-related skills, they did not have significantly higher on-road accidents than the younger groups did. Studies showed that older and younger age groups tend to be involved in different types of traffic accidents, yet it is still the younger driver groups who are more at risk in terms of crash involvement.

In attempting to explain the high crash frequency apparent among the young, Elander *et al* (1993) identified that research has focused on various factors such as alcohol use (Mayhew *et al*, 1986), risk-taking behaviour (Jonah, 1986) perceptions of risk and hazard (Bragg & Finn, 1982; Quimby & Watts, 1981; Ganton & Wilde, 1971; all in Elander *et al*, 1993) and perception of driving skill and likelihood of crash involvement (Finn & Bragg, 1986; Matthews & Moran, 1986; also in Elander *et al*, 1993). All these various factors are duly considered in the relevant sections within this literature review.

## **4.2 AGE, SOCIAL DEVIANCE, AND DRIVING VIOLATIONS**

This section will consider the associations of age with social deviance and driving violations. The effects of social deviance and violations are often inter-linked, with Lawton *et al* (1997) further suggesting that, "violating behaviour on the roads may be one way in which social deviance manifests itself" (p.258), although they also noted that this does not imply that all driving violators are socially deviant.

Research consistently shows that younger drivers are more likely to commit driving violations than their older counterparts (Dobson *et al*, 1999; McCartt *et al*, 1999; Meadows *et al*, 1998; Lawton *et al*, 1997; NHTSA, 1995; Parker *et al*, 1995a, b; Meadows, 1994; Furnham & Saipe, 1993; Braver *et al*, 1992; Reason *et al*, 1990; Pelz & Schuman, 1971). Dobson *et al* (1999) found that scores for errors and violations for their young (18-23) group were higher than for the mid-age group (45-50 years), in their all-female participant study. Reason *et al* (1990; in Furnham & Saipe, 1993) investigated errors and violations, finding that, although the tendency to commit violations decreased with increasing age, errors did not. The authors also noted that, in particular, women drivers in their mid-30s were noticeably lower on both dangerous violations and errors, and that this was corrected for miles driven (see also the 'Gender and Driving Violations' section). Additionally, Pelz and Schuman (1971; in NHTSA, 1995) reported that 18 and 19 year-old drivers had the highest violation and crash rates in comparison to older drivers, while controlling for exposure and experience.

Lawton *et al* (1997) corroborated these overall age effects, finding that young drivers reported committing more violations than older drivers. Furthermore, Lawton *et al* (1997) observed that age and violations were independently significant predictors of accident rate, with younger drivers and those with higher violations showing a tendency to be involved in more accidents. The study observed that age is a significant predictor of violation score, even though this relationship is partially mediated by social deviance. Additionally, Lawton *et al* (1997) found that being young was associated with a higher accident rate, both independently *and* via the tendency to commit violations. They therefore suggested that there is something about being

young in itself that increases the likelihood of an accident, independent of the younger drivers' tendency to commit violations (see 'Age and Experience' section).

Parker *et al* (1995b) used a Driver Behaviour Questionnaire (DBQ) to measure the respondent's tendency to commit violations. Findings showed that the relationship between DBQ (violations) scores and accident risk became less acute with increasing age and experience. Younger and less experienced drivers therefore reported a tendency to commit more violations, although the study did not separate out the effects of age and experience to see which was the critical variable.

Consideration of the driving violation score used in Lawton *et al's* (1997) study showed that younger respondents and males were more likely to report higher violations. This was also the case for respondents with high annual mileage. Moreover, respondents with higher social deviance scores in the study were particularly likely to score highly on violations. Findings showed that these variables (younger, males, higher annual mileage and higher social deviance scores) together accounted for 38% of the variance in the violation scores.

It appears that social deviance can be manifested in various forms of driving behaviour such as committing driving violations, driving whilst intoxicated (DWI), speeding, tailgating, running red-lights and generally displaying risky behaviour. Both French *et al* (1992) and Parker *et al* (1992; both in Elander *et al*, 1993) found that faster and more deviant driving styles are associated with being young and male. The NHTSA (1995) noted that Bergeron (1991), Jonah (1986), and Evans and Wasielewski (1983) further observed that younger drivers are more likely, than older drivers, to follow the car in front too closely. Furnham and Saipie (1993) found that their "law-breaking" factor was negatively associated with age, indicating that younger drivers were more likely to break the law (the factor was associated with speed limits, the police, and law in general). A survey conducted by the Los Angeles Times in 1989 (noted in Shinar *et al*, 2001), revealed that speeding, DWI, and running red-lights were more characteristic of young males. All these studies corroborate that measures reflecting social deviance, as related to driving behaviour, demonstrate that higher social deviance is more apparent in the younger age group of drivers.

Lawton *et al* (1997) considered the effects of age, social deviance and driving violations and their associations with accident rates. Findings showed that social deviance and violations together affect accident rates *and* that social deviance and age together affect accident rates. However, social deviance was not independently associated with accident rates, once the effects of violations and age were taken out of the equation. The authors therefore suggested that there might be another factor, which was not investigated in their study, which may be associated with age, affecting the relationship between social deviance and accidents. Evans (1991), Meadows (1994), and Meadows & Stradling (1996b; all in Lawton *et al*, 1997) all found youth to be associated with risk-taking and thrill-seeking, and Lawton *et al* (1997) therefore suggest that these factors associated with age may be mediating the relationship between social deviance and accidents. Meadows *et al* (1998) replicated and extended Lawton *et al's* (1997) study and subsequently supported the above suggestion regarding risk-taking and thrill-seeking as possible mediating factors associated with age.

Although Meadow *et al's* (1998) study was a methodological replication and extension of Lawton *et al's* (1997) discussed study, Meadows *et al* used a sample of young offenders, whereas Lawton *et al's* study considered a sample from the wider driving population. Consequently, age was not independently considered in Meadows *et al's* study, as all participants were of the same young age group and so the mitigating effects of age could not be considered. Meadows *et al* (1998) noted that, although their study has limited external validity, due to their sample group not being a cross-section of the wider population, findings were similar to those of the replicated study. One difference, however, was that extreme, rather than

mild, social deviance was found to predict accident involvement in Meadows *et al*'s study. This, however, would be expected considering that the sample was entirely young offenders, who were therefore generally social deviant. Additionally, research has consistently shown that younger drivers have a greater tendency to be involved in traffic accidents, and all these participants were from a younger age group and so were also more likely to be socially deviant. Such factors associated with age and risk-taking (e.g. Meadows & Stradling, 1996b; Meadows, 1994; Evans, 1991; all in Lawton *et al*, 1997) may therefore also account for the relationship between social deviance and accident involvement in this study, as young drivers are more prone to risky behaviour (Dobson *et al*, 1999).

This section of the review has detailed age and its associations with social deviance and driving violations. Driving whilst intoxicated, with either alcohol or drugs, and speeding also reflect forms of driving violations and social deviance, yet the current review discusses them in the following separate sections. This is indicative of the amount of research which considers these factors, and their associations, independently to any related and overall violating / deviant behaviour measures.

### **4.3 AGE AND SPEEDING**

The literature consistently shows that younger drivers are more likely to drive at faster speeds than older drivers are (Ingram, Lancaster, & Hope, 2001; Shinar *et al*, 2001; Stradling, 2000; Abdel-Aty *et al*, 1999; Dobson *et al*, 1999; NHTSA, 1995; Szlyk *et al*, 1995; Elander *et al*, 1993; Chipman *et al*, 1992; French *et al*, 1992; Parker *et al*, 1992; and, the following were all in Trankle *et al*, 1990: Schlag, 1987; Statistisches Bundesamt, 1987; Jonah, 1986; Ellinghaus & Schlag, 1984; Wasielewski, 1984; Galin, 1981; Knoflacher, 1979).

Stradling (2000) observed that, for both genders, 17-20 year-olds reported the highest 'normal' speeds, but for age 20 and above the age effects were split according to gender - until age 50 when male and female nominated 'normal' speeds tended to converge. Females appear to sharply reduce their driving speed, in their 20s, and then maintain this reduced speed with increasing age. Males, however, do not appear to reduce their 'normal' driving speed until their 30s, but still nominate higher speeds than their age-equivalent females (see 'Gender and Speeding' section). Stradling also noted that older drivers were less likely to have been penalised for speeding; the highest speeding offenders were aged between 21 and 40, whereas the lowest were for those drivers aged 60 and above. Furthermore, Stradling controlled for annual mileage, and these age effects still remained significant regardless of the number of miles driven. Additionally, Ingram, Lancaster, and Hope (2001) reported that the likelihood of having broken the speed limit was highest in the 20 to 24 year-old age group, and that this steadily declined with increasing age thereafter.

Wasielewski (1984; in NHTSA, 1995) found that drivers aged 20 years and under had the highest observed speeds. Shinar *et al* (2001) noted that the number of people who reported that they observe the speed limit all the time increased with age, also finding that the tendency to speed decreases with increasing age. Finn *et al* (1985; in NHTSA, 1995) further found that younger drivers perceived speeding to be less dangerous than experienced drivers, indicating the younger driver's greater likelihood to speed. Additionally, French *et al* (1992) and Parker *et al* (1992; both in Elander *et al*, 1993) both observed that faster and more deviant driving styles were associated with being male and young. Such findings therefore all corroborate the association that younger drivers are more likely to display a faster average driving speed. Parker *et al*'s (1992; in the NHTSA, 1995) study also showed that younger drivers endorsed speeding and dangerous overtaking more strongly than did older drivers.

Some of the literature considers the likelihood of accidents resulting from inappropriate speed: Trankle *et al* (1990) reported that Schlag (1987), Statistisches Bundesamt (1987), Jonah (1986),

Ellinghaus and Schlag (1984) and Knoflacher (1979) all observed that young drivers are over-represented in accidents resulting from inappropriate speed. Abdel-Aty *et al* (1999; in Abdel-Aty & As-Saidi, 2000) also noted that teenage drivers experience the highest rate of traffic crashes and injuries, and that this is primarily due to speeding, drink driving, and not wearing seat-belts. Furthermore, McGwin and Brown (1999; in 'Causes of Road Traffic Accidents Update', 2000) observed that older drivers were less likely to have crashes while travelling at high speeds.

#### **4.4 AGE AND ALCOHOL AND DRUG USAGE**

The literature investigating alcohol and drug usage, when driving, consistently demonstrates that younger drivers are more likely to be involved in alcohol and / or drug-related traffic accidents (Abdel-Aty & Abdelwahab, 2000; Abdel-Aty *et al*, 1999; McGwin & Brown, 1999; Burgess & Lindsey, 1997; Chen, 1997; Mason *et al*, 1992; NHTSA, 1992; Evans, 1991; Jonah, 1986; Mayhew *et al*, 1986; Pendleton *et al*, 1986).

In a study on drinking and driving, Anderson and Ingram (2001) found that younger males emerged as the key risk group, being more likely to: a) have driven after drinking alcohol, b) have driven when they thought they might be over the limit, c) have done these things on multiple occasions, and, also d) being more likely to have consumed greater amounts of alcohol before doing so. In addition, Ingram, Lancaster, and Hope (2001) reported that drug-driving appeared to be most prevalent among the 20 to 24 year-old age group, with much lower levels in the older age groups.

McGwin and Brown (1999; in 'Causes of Road Traffic Accidents Update' 2000) found that alcohol is less likely to be a factor in traffic crashes that involve older adults. Mason *et al* (1992; in Abdel-Aty & Abdelwahab, 2000) supported this by observing that alcohol involvement in accidents decreases with increasing age.

In 2000, Abdel-Aty and Abdelwahab conducted a study exploring the relationship between alcohol and the driver characteristics in motor vehicle accidents. They revealed that the middle (25-64) and young (20-24) age groups had higher proportions of traffic accidents while driving under the influence of alcohol. Middle-age drivers also tended to have higher accident proportions while driving under the influence of drugs and both alcohol and drugs. Elderly drivers however, did not show high accident proportions while driving under the influence. Such findings confirm the results of Chen (1997) and Evans (1991). Evans (1991; in Abdel-Aty & Abdelwahab, 2000) found that elderly drivers (those aged 60 years and above) were less likely to be involved in accidents involving alcohol. Chen (1997; in Abdel-Aty & Abdelwahab, 2000) observed that those drivers between the ages of 25 and 44 were found to have a higher percentage of accidents while driving under the influence.

Much of the literature (e.g. Burgess & Lindsey, 1997; in Abdel-Aty & Abdelwahab, 2000) observes that the 21-24 age group experiences the highest proportion of accidents involving alcohol. Pendleton *et al* (1986; in Abdel-Aty & Abdelwahab, 2000) noted that the 21-25 year-old age group had the highest proportion of fatalities involving legally intoxicated drivers, followed by the 26-30 year-old drivers. The 65 and above age group had the smallest proportion of such fatalities. Similarly, the NHTSA (1992; in Abdel-Aty & Abdelwahab, 2000) found that the 21-24 age group showed the highest percentage of alcohol involvement for fatal and injury traffic accidents, followed by the 25-34 age group. Burgess and Lindsey (1997; in Abdel-Aty & Abdelwahab, 2000) further corroborated the high alcohol-related accident rates for this age group, observing that those drivers in the 21-24 age group exhibited the highest rates of intoxication (27.8%), followed by drivers aged 25-29 (27%). Drivers in the age group 16-20, however, were intoxicated in 12.7% of the accidents. This may be expected, considering that very young drivers cannot legally purchase and consume alcohol (Abdel-Aty & Abdelwahab,



2000). Such research suggests that the rate of involvement in alcohol-related accidents decreases with increasing age after the ages of 21-24 years.

However, although Abdel-Aty and Abdelwahab (2000) alternatively found that the middle-age drivers (ages 25-64) experienced higher proportions of accidents involving alcohol than the younger drivers (ages 20-24); the results showed that the 25-34 age group consistently experienced the highest rate of alcohol / drug involvement in accidents. The 35-44 age group was the second highest group. The accident rates therefore also declined with increasing driver age.

The NHTSA's (1995) review noted that younger drivers appear to see less degradation in their performance due to alcohol consumption. Mayhew *et al* (1986; in NHTSA, 1995), however found that youth are at a greater relative risk of traffic accident than older drivers are, at all levels of blood alcohol concentration (BAC). They also found that young drivers, especially those in the age range of 16-19 years, are at a higher risk of fatal crash with relatively low BACs. Abdel-Aty *et al* (1999; in Abdel-Aty & As-Saidi, 2000) also noted that teenage drivers experience the highest rates of traffic crashes and injuries, primarily due to speeding, drink driving, and not wearing seat-belts. Elander *et al* (1993) therefore suggested that, "the effects of the youth and alcohol may interact because alcohol impairs overlearned or automatized skills to a lesser extent than more recently acquired ones, or because of the disinhibiting effects of alcohol on the young, which affect decision-making and risk-taking rather than skills." (p.281). However, they also suggested that the high crash involvement among the young, as related to alcohol, may be a consequence of a subset of the younger drivers who drive dangerously and also consume alcohol.

Shinar *et al* (2001) found that most drivers reported complete avoidance of drinking and driving, and that this hardly varied across the different age, education, and income groups investigated. The only individual difference that significantly interacted with 'refraining from drink driving' in their study was that of gender (see 'Gender and Alcohol and Drug Usage' section).

#### **4.5 AGE AND SEAT-BELT USE**

Research generally shows that seat-belt use is less likely among younger drivers than among older drivers (Shinar *et al*, 2001; Abdel-Aty *et al*, 1999; Beirness & Simpson, 1997; NHTSA, 1995; Waxweiler *et al*, 1993; Preusser, *et al*, 1991; Jonah, 1990). Shinar *et al* (2001) found that more old drivers than young reported that they use seat-belts all the time, and reported use of seat-belts was therefore observed to increase with age. The findings from the NHTSA (1995) review showed that, overall, safety-belt usage tends to increase with age, although a study by Jonah (1990; in NHTSA, 1995) found that the usage rate for 20-24 year-olds was even lower than that for the 16-19 year-old age group. The NHTSA (1995) identified the predictors of seat-belt usage in younger drivers to be: comfort, free choice, risk of crashing, social norms, and perceived effectiveness of belts.

Abdel-Aty (1999; in Abdel-Aty & As-Saidi, 2000) found that teenage drivers experience the highest rates of traffic crashes and injuries, and that these are primarily due to speeding, drink driving, and not wearing a seat-belt. This finding is also therefore indicative of the greater tendency for younger drivers to be less likely to wear a seat-belt.

Although Wasielewski (1984; in NHTSA, 1995) unexpectedly found that drivers in the '20 and under' category had higher belt-usage rates than drivers in the 50-55 and over 70 years age groups, the NHTSA's (1995) report recommended that one should interpret such older studies with caution - as seat-belt laws were not as widespread at the time, so this may account for the lower belt-usage in the older drivers.

## 4.6 AGE AND GENDER

The majority of the papers reviewed together demonstrate that it is the young male driver who displays a more risky driving behaviour (e.g. Lajunen & Parker, 2001; Abdel-Aty & Abdelwahab, 2000; Alm & Lindberg, 2000; Lawton *et al*, 1997; Meadows & Stradling, 1996b; NHTSA, 1995; Parker *et al*, 1995a, b; Meadows, 1994; Elander *et al*, 1993; West, 1993; French *et al*, 1992; Parker *et al*, 1992; Evans, 1991; Reason *et al*, 1990; Summala, 1987; Zuckerman, 1979). Findings showed that younger male drivers report committing more violations, are more likely to behave in a risk-taking manner, displayed through faster and more deviant driving styles, and have also been observed to be more likely to be involved in a traffic accident. Alm & Lindberg (2000) found that those men aged between 13 and 29 years tended to rate perceived risks to be lower and feelings of safety to be higher than did women of the same age. These results were, in most cases, reversed for those participants who were aged 65 years and older. To be young and male is therefore more indicative of a lower risk perception and greater feelings of safety, such factors therefore adding to the observation that this group has been consistently observed to exhibit riskier driving behaviours.

## 4.7 AGE AND ETHNICITY

Of the literature reviewed, there were few considerations of the effects of age and ethnicity together, other studies considered ethnicity, but usually investigating ethnicity with gender and alcohol usage. Abdel-Aty and Abdelwahab (2000) investigated differences in alcohol-related accident involvement among different driver groups, considering ethnic races categorised as 'White', 'Black', 'Hispanic' and 'Other'. The investigation of age with ethnicity showed that those white drivers, in the 25-34 year age group, displayed the highest alcohol-related accident involvement rates. Young white drivers (< 45 years old) experienced higher rates of accident involvement, whilst the non-white drivers experienced higher accident rates for ages 45 and above. The trends for white and non-white drivers is therefore reversed between the two age groups considered in this study. The NHTSA (1995) also reported a study by Baker, O'Neil, Ginsburg, and Li (1992), which also considered age and ethnicity in relation to crash / fatality rates. In this study, Baker *et al* (1992; in the NHTSA, 1995) found that fatality rates peaked between the ages of 15 and 24 for Whites, and between the ages of 20 and 24 for Native Americans and Blacks.

## 4.8 AGE AND RISK PERCEPTION

The literature review consistently found that the younger age groups tended to perceive a lower level of risk associated with driving (Glendon *et al*, 1996; NHTSA, 1995; Drottz-Sjoberg & Sjoberg, 1990a; Trankle, *et al*, 1990; Sivak *et al*, 1989; Brown & Groeger, 1988; Matthews & Moran, 1986; Bragg & Finn, 1982). Younger drivers appear to perceive less risk associated with traffic situations where reflexes or vehicle-handling skill are of importance, such as, speeding, tailgating, curves and passing. Furthermore, not only do younger drivers show a tendency to underestimate personal risk, but they tend to overestimate their driving ability (Glendon *et al*, 1996; Dekker *et al*, 1994; DeJoy, 1992; Groeger & Brown, 1989; Lerner *et al*, 1988; Finn & Bragg, 1986; Jonah, 1986; McCormick *et al*, 1986; Svensson, 1981). These effects are more pronounced for measures of judged ability than crash likelihood. Matthew & Moran's (1986; in Glendon *et al*, 1996) study observed that young drivers (aged 18-30 years) gave a higher estimate of future accident involvement, but gave lower risk perception ratings of accident risk for driving situations where reflexes or vehicle-handling skills are of importance. Additionally, Matthew & Moran's (1986; in Glendon *et al*, 1996) study was the only study to observe that younger males appraise driving as more risky than other groups do. Glendon *et al*'s (1996) study was a replication and extension of Matthew & Moran's study, yet they found no evidence

to support this, rather they found data to confirm that younger males tend to underestimate their own risk and overestimate their driving competence.

McKenna and Crick (1990; in Lawton *et al*, 1997) observed that the ability to assess hazards on the road is known to increase with age. This relationship may be related to the findings that younger drivers have a higher crash involvement rate (e.g. NHTSA, 1995; see 'Age and Crash involvement' section).

A closer consideration of the various age groups investigated in the studies reviewed, shows that there are different effects, for the mid-age group, depending on the traffic situation. Sivak *et al* (1989; in Elander *et al*, 1993) examined situations involving high speed, where although the younger drivers (aged 18-21) perceived less risk than the older drivers (aged 65-75), the younger drivers did not differ from the middle-aged drivers (aged 35-45 years). Risk ratings, measured by Trankle *et al* (1990), revealed that older male and female drivers (65-75) are often close to the middle-age group (35-45), except for those situations characterised by darkness and reduced visibility, where there is a high risk for older drivers, as eye adaptation (to the reduced visibility and darkness) reduces with increasing age. These variations appear to be attributable to physiological aspects changing with increasing age (see 'Age and Physiology' section).

Furthermore, Alm & Lindberg (2000) observed that, for men, perceived accident risk increased with age, whereas this was not the case for women. Matthews & Moran (1986; in Glendon *et al*, 1996) found data which suggested that age differences in risk perception are confined to males, as younger and older females underestimated their personal accident risk to a similar degree (see 'Gender and Risk Perception' section).

#### **4.9 AGE AND PERSONALITY FACTORS**

Of the papers reviewed, results consistently show that the younger drivers are more likely to exhibit the risk-taking factors of personality (Dobson *et al*, 1999; Jonah, 1997; Meadows & Stradling, 1996b; Szlyk *et al*, 1995; Meadows, 1994; Furnham & Saipe, 1993; Evans, 1991; Johnson & Raskin White, 1989; Farrow, 1988, 1987a; Tsuang *et al*, 1985; Zuckerman, 1979). That is, younger drivers tend to have riskier personality tendencies than older drivers. Only one paper (Zuckerman & Neeb, 1980; in the NHTSA, 1995) showed the absence of an age effect, whereby faster drivers obtained higher scores on Sensation Seeking (see below), and this effect was not altered when age was entered as an additional factor into the analyses.

The majority of the papers considering the effects of personality use Zuckerman's Sensation Seeking Scale (SSS). According to Zuckerman (1994; in Jonah, 1997), Sensation Seeking (SS) "is a trait defined by the seeking of varied, novel, complex, and intense sensations and experiences and the willingness to take physical, social, legal, and financial risks for the sake of such experiences" (p. 27). Analyses have shown that SS is made up of four dimensions, which are: (1) Thrill and Adventure Seeking (TAS), (2) Experience Seeking (ES), (3) Boredom Susceptibility (BS); and (4) Disinhibition (Dis). Although these four dimensions of SS are modestly correlated, they have been found to relate differently to various risky behaviours (Zuckerman, 1994; in Jonah, 1997), SS is therefore often not only considered as a whole, but also as a sum of its parts.

According to Furnham & Saipe (1993), those drivers scoring high on the risk-taking factor tended to be young, male, have fewer years driving, more driving convictions, and have higher scores on Psychoticism, Thrill and Adventure Seeking and Boredom Susceptibility. Eysenck's (1983; in Jonah, 1997) Psychoticism dimension of personality is closely related to the broader trait, "impulsive sensation seeking", of which Zuckerman (1994) views SS a part. Furnham & Saipe (1993) also observed that younger people tended to score higher on Extraversion,

Psychoticism and Thrill and Adventure Seeking (TAS), but lower on the Lie scale. (Sensation Seeking correlates weakly with Extraversion - Zuckerman, 1994; in Jonah, 1997).

Zuckerman (1979; in NHTSA, 1995) found that young males who are likely to engage in risky driving (including drink driving) are often characterised by high scores on the TAS, Dis and BS subscales of the Sensation Seeking Scale. These results were corroborated by Szlyk *et al*'s (1995) findings which revealed that older drivers (aged 50 and above) had reduced risk-taking scores. Jonah's (1997) literature review found supporting evidence in that SS was shown to increase with age until about age 16, and then it declines with age. Jonah's (1997) literature review also revealed data, relating to high Sensation Seekers and driving under the influence of alcohol and drugs, which suggested that the predictive value of SS may decline with age. Johnson and Raskin White (1989; in Jonah, 1997) found support for these findings through noting that the relationship between SS and drink-driving may decline with age (see 'Personality and Alcohol and Drug Usage' section).

Meadows and Stradling (1996b), Meadows (1994) and Evans (1991; all in Meadows *et al*, 1998), all found corroborating results suggesting that young and male drivers are more likely to behave in a risk-taking and thrill-seeking manner than other types of drivers. Dobson *et al* (1999) also observed that their younger age group was more prone to riskier behaviour (the study solely consisted of female participants, so this observation was an independent age effect).

A literature review by Tsuang, Boor, and Fleming (1985; in the NHTSA, 1995) considered aspects of personality other than SS, and found that those drivers who were involved in crashes were "generally described as displaying less control of hostility and anger, less tolerance of tension, less maturity, and less conformity; more difficulty with authority figures, more hyperactivity, and more belligerence; and a tendency toward risk-taking" (p. 544). In terms of their relationship with age, Tsuang *et al* (1985; in NHTSA, 1995) speculated that, as many of these factors are highly correlated with age, this might go some way to explaining the high crash rate of youths. Farrow (1988; in the NHTSA, 1995) also investigated effects of anger, hostility, powerlessness, and life events to impaired driving, arguing that these personality variables are important in the prediction of impaired driving in the youngest drivers, as the research has shown them to be with adults. The young DWI (driving while intoxicated) offenders and delinquents displayed high anger and hostility scores, experienced more negative life events than the high school students without DWI convictions, and reported being more aggressive while under the influence of alcohol.

#### **4.10 AGE AND AGGRESSION / ANGER**

Novaco (1989) reviewed research relating to aggression on roadways, finding that younger drivers reported and displayed higher aggression scores (Hauber, 1980; Parry, 1968; Schuman *et al*, 1967; all in Novaco, 1989). Parry (1968; in Novaco, 1989) observed that aggression scores were highest for males between the ages of 17 and 35 years of age, and that higher aggression was associated with higher accident liability. Schuman *et al* (1967; in Novaco, 1989) found that anger reactions, in driving situations, were related to both accident frequency and moving violations, among young male drivers (although this study did not control for the number of miles driven). Furthermore, Hauber (1980; in Novaco, 1989) found support for these age-related effects, observing that the younger drivers were more aggressive than the older drivers were. There were no significant gender-differences, i.e. although, as expected, younger men were more aggressive than older women; younger women were also more aggressive than older men.

Lajunen and Parker (2001) considered driver aggression in relation to age and gender, and found that, among men, age was negatively related to both driver anger and aggression. However, among women, annual mileage was negatively related to driver aggression. This demonstrates that, although younger males are more likely to display driver anger and

aggression (and this likelihood has a tendency to decrease with increasing age), age is not a significant factor amongst women, in terms of driver aggression. Women drivers with high annual mileage seem to get less angered the more driving exposure they experience. This study's results add support to the findings that greater accident risk and a more deviant driving style (in this case, aggression) are associated with being male and young.

All the studies in the present review, that are pertinent to age and aggression, therefore found that it is the younger driver who is more likely to be aggressive when driving.

#### **4.11 AGE AND EXPERIENCE**

Stradling (2000) identified in his analysis that young, inexperienced drivers are a high-risk group of drivers. Abdel-Aty *et al* (1999; in Abdel-Aty & As-Saidi, 2000) also noted that teenage drivers have less training and experience, which leads to more traffic violations. The literature reviewed demonstrates associations of the effects of age and experience with traffic accidents and violations, yet, as the Traffic Injury Research Foundation of Canada (1991; in NHTSA, 1995) and Brown & Groeger (1988; in NHTSA, 1995) observed, our understanding of each factor's independent contribution is limited because of the difficulty of separating the effects of both. However, there have been attempts to separate the effects of age from experience, and so undertaking to understand the independent contributions of these two factors is what concerns this section of the review.

The Traffic Injury Research Foundation of Canada (1991; in NHTSA, 1995) reported findings of attempts to separate the effects of age and experience-related factors in traffic crashes. Crash rates were observed to decrease with increasing driving experience, among drivers of the same age. Alternatively, the crash rates for males of various ages, but with the same level of driving experience (i.e. 4 years), showed that the risk of a crash decreased with increasing age. Additionally, the crash rates for newly-licensed females, of various ages, showed that the risk of a crash decreased with increasing age. The authors also reported that increases in experience had a greater impact on 30 year-old drivers than on 20 year-old drivers (i.e. where the crash risk for 30 year-olds with experience was approximately 38% less than for novice 30 year-old drivers, this difference was only approximately 8% for the 20 year-old drivers). These reported findings therefore suggest that younger drivers, as well as drivers with less experience, are at an increased risk of experiencing a traffic accident. Furthermore, the authors suggested that driving experience is not only important at any age, but that age-related factors contribute greatly to driving behaviour (Traffic Injury Research Foundation of Canada, 1991; in the NHTSA interim report, 1995).

McCartt *et al* (1999) considered the independent effects of age and experience on driving violations (in this study 'violations' refers to a driver's failure to comply with current U.S. hours-of-service regulations) and the frequency of drowsy driving. Findings revealed that age and experience had opposite effects on these two variables measured. When controlling for age, driving violations increased with increasing driving experience, and the frequency of drowsy driving decreased with increasing experience. Conversely, when the authors controlled for driving experience, driving violations decreased as age increased, and drowsy driving increased as age increased. These findings therefore suggest that younger drivers are less likely to adhere to the hours-of-service regulations and are less likely to experience drowsy driving than their older counterparts. The findings also indicate that less experienced drivers are less likely to violate the hours-of-service regulations and more likely to experience drowsy driving. McCartt *et al* (1999) suggested that, although these results may seem counterintuitive, even though age and experience are correlated, they are different constructs. The authors further postulated that the different constructs could be accounted for if, for example, drivers of different ages have

different tendencies towards risk-taking behaviours (see ‘Age and Personality’ section for such associations), while experience may be associated with skill.

The literature shows it is well established that beginning drivers of any age display higher violation and crash rates in the early stages of licensure than they do after more experience has been acquired (Waller *et al*, 2001; Maycock *et al*, 1991; Mayhew & Simpson, 1990). Maycock *et al* (1991; in Waller *et al*, 2001) found evidence that age and experience were both important factors affecting crash risk. The authors observed that delaying licensure from age 17 to 18 was associated with a 6% decrease in crash risk; and a delay from 18 to 19 resulted in an additional 6% decrease. Further subsequent yearly delays were also associated with decreases in crash risk, although these were increasingly smaller. Maycock *et al* (1991; in Waller *et al*, 2001) went on to reveal that experience was an even more important factor, at whatever age it occurred, observing a 30% decrease in crash risk after the first year of licensure, followed by an additional 17% decrease after the second year of driving. Again, further subsequent years of driving resulted in additional decreases in crash risk, although these became increasingly smaller. Gregersen (2000; in Waller *et al*, 2001) conducted a study in Sweden where licensure may not be obtained until the age of 18, however, a novice driver can obtain a permit to begin driving with supervision at age 16 (prior to 1993, the age for this permit was 17.5). Findings showed that those drivers who obtained a permit at 16 acquired more supervised practice, did not experience any pre-licensure increase in crash risk, and had a 35% decrease in crash risk upon full licensure at age 18. This study therefore lends support to the importance of extended supervised experience in reducing crash risk.

Mayhew and Simpson (1990), however, having conducted an exhaustive review of the available studies, concluded that, “age-related factors are more strongly associated with collision risk than are those that are experientially related” (in Waller *et al*, 2001, p.118), which is in contrast to Maycock *et al*’s (1991) above findings. In 2001, Waller *et al* conducted a study that also independently considered the effects of experience and age-related factors. In terms of age at time of licensure, Waller *et al* (2001) found a 5% reduction in total crash odds for each additional year of age at time of licensing, which is consistent with Maycock *et al* (1991; in Waller *et al*, 2001), who reported a 6% risk reduction. However, the older initial licensees actually experienced an increase in the likelihood of an at-fault crash, as well as the proportion of their total crashes that were at fault. Furthermore, consideration of risk of offence, rather than crash experience, revealed that risk of offence increases with increasing age at time of licensure, yet the probability that the offence will be serious decreases. The odds of having an offence of any kind increase by about 9% for each year older the subject is at the time of initial licensure. These results appear to be counterintuitive, as the risk for total crashes decreases whilst the risk for offences increases. However, Waller *et al* proposed that this may be accounted for if novice 18 year-old drivers drive more miles than novice 16 year-old drivers, meaning that there is a greater exposure to risk. However, the authors acknowledged that this only accounts for the increase in offences, unless the crash risk decreases very rapidly with the miles driven.

Waller *et al* (2001) also considered the effects of experience, finding that length of licensure was related to decreased crash risk, and especially a decrease in at-fault crashes. The odds of having one or more crashes in a year declined about 17% per year of licensing, controlling for age at time of licensure, gender, and pre-license offences. Like Maycock *et al*’s (1991; in Waller *et al*, 2001) findings, the initial decrease in crash risk was greater in the first year and the second year (22% and 19% respectively) than in the subsequent years of licensure. However, this is somewhat lower than the 30% reported by Maycock *et al*, for the first year of licensure. Furthermore, Waller *et al* (2001) found that previous crash experience was not predictive of whether a future crash would be at-fault. Rather, the authors observed that it was the duration of licence that was associated with the likelihood of the crash being at-fault, therefore suggesting

that overall driving experience is more important, for avoiding at-fault crashes, than the total number of crashes experienced.

In terms of the findings relating to associations between risk of offence and experience, Waller *et al* (2001) observed that, there was an initial rise in risk of offence, with the second and third year of licensure showing an approximately 30% increase in odds over the initial year, after which the risk then began to steadily decline. This is comparably different to the crash risk findings, where odds of a crash decreased at an average of 9% per year over a 9-year period. These results therefore suggest that although crash risk decreases, after the first year of licensure, risk of offence, on the other hand, appears to increase. Ferdun *et al*'s (1967; in Waller *et al*, 2001) study found a similar trend for offences, for the first four years of licensure in a sample of drivers aged 16-19 years. Dobson *et al* (1999) also found evidence that appears to corroborate these findings, having observed that years of driving were positively associated with higher scores for violations and speeding.

Overall, Waller *et al* (2001) suggested that, "those incidents that appear to be more related to volitional control, i.e. serious offences and at-fault crashes, are more strongly related to experience, as measured by length of licensure" (p.126). Experience in this study therefore appears to have a greater impact on more hazardous offences and at-fault crashes than less serious incidents. The 17% decrease in crash risk for each succeeding year of licensure (with a higher rate in the early years) suggests that, although both age and experience are important, among the young drivers experience contributes more to decreasing crash risk. This appears to be supported by results for the younger drivers (aged 18-23) in Dobson *et al*'s (1999) study, which also showed that the relative risk of accidents was inversely related to years driving, but this was not the case for the older drivers (aged 45-50) in the sample. Cerrelli (1995) and Williams and Carsten (1989; both in Waller *et al*, 2001) conducted studies suggesting that, after around the age 24 or 25, crash risk generally remains low until after approximately 55 years of age. These studies therefore support the literature's indication suggested by Waller *et al* (2001), that the decrease in crash risk relative to inexperience may stabilize after 8 or 9 years of driving experience. As in Cerrelli (1995) and Williams and Carsten (1989), the ages of 24 or 25 would coincide with this proposed stabilisation for the majority of drivers.

Glendon *et al* (1996) conducted a study, which was a replication of Matthews and Moran (1986), investigating age and gender differences in risk perception. Taking into consideration the different experience levels between the younger drivers in their own sample and that used by Matthews and Moran (1986), Glendon *et al* (1996) proposed that, for the variables in their study, experience was a more important variable than age. Another study which also investigated risk perception, observed that younger drivers perceived speeding to be less dangerous than experienced drivers (Finn *et al*, 1985; in NHTSA, 1995). However, it is not clear whether this study controlled for age and experience as separate factors, so this finding may be confounded.

Earlier, in the 'Age and Social Deviance and Driving Violations' section of this literature review, Lawton *et al*'s (1997) findings were discussed. Lawton *et al* (1997) suggested that there is something about being young in itself that increases the likelihood of an accident, independent of the younger drivers' tendency to commit violations. This arose from an observation that being young was associated with an increased accident rate both directly and indirectly, via the increased tendency to commit violations. Additionally, the authors also observed a significant positive correlation between age and mileage, which indicated that the older drivers, within their sample of 17-40 year-old drivers, had fewer accidents, despite higher average mileage. The authors thus argued that accidents were therefore not simply the result of greater exposure to danger. Lawton *et al* subsequently proposed that it is possible that the direct relationship between age and accident involvement reflects the greater inexperience of young

drivers. Such a proposal is certainly a possibility in light of the literature reviewed, yet it again serves to highlight the difficulty of separating the effects of age from experience when considering their independent contributions to crash risk.

#### **4.12 AGE AND PHYSIOLOGY**

The literature investigating age and physiology considers compromised vision and reflex factors in relation to traffic accidents. Research has generally found a relationship between basic visual functions and crash rates among older drivers (Owsley *et al*, 1991; Trankle *et al*, 1990; Hills & Burg, 1977; Shinar, 1977; Hofstetter, 1976; Henderson & Burg, 1974). Owsley *et al* (1991; in Elander *et al*, 1993) conducted a study looking at the crash rates of drivers between the ages of 57 and 83 years, in relation to a battery of visual tests. Findings showed that a measure of visual attention gave the highest correlation with crash rate (0.36), with overall results indicating that, in older drivers, basic perceptual functions may be relevant to crash risk. Elander, West, and French (1993) further suggested that such perceptual deficits might help to explain why older drivers are at an increased risk of side-impact collisions. Trankle *et al* (1990) also observed that the accident risk ratings for older drivers (aged 65-75) were often close to those ratings observed for the middle-age group, except for those situations which were characterised by darkness and greatly reduced visibility. It therefore appears that older drivers are at an increased risk of a traffic accident in situations or circumstances of compromised visibility.

In terms of drivers' reflexes in response to potential hazards, the literature shows that older drivers have slower reflexes, yet it has also been observed that there is no relationship between simple reaction time and crash frequency (e.g. Cox *et al*, 1987; Quimby *et al*, 1986; Quimby & Watts, 1981; Goldstein, 1961; all in Elander *et al*, 1993). Quimby and Watts (1981; in Elander *et al*, 1993) found that potential hazards, in a driving simulator, were responded to less quickly by drivers older than 55 years and younger than 25 years than by those of intermediate age. Since the younger drivers displayed faster reaction times than both the older and middle-age groups, Quimby and Watts suggested that the younger drivers responded less quickly due to a failure to recognise the situations as hazardous. Such an effect is supported by the 'Age and Risk Perception' findings (see section above). Matthews and Moran (1986; in NHTSA, 1995) reported that younger drivers reported less risk for themselves in those scenarios where quick reflexes or good vehicle handling skills were important. It therefore appears that the older driver's strength lies in their aversion to risk, but that this is counterbalanced by perceptual problems and difficulty judging and responding to traffic flow (McGwin & Brown, 1999; in 'Causes of Road Traffic Accidents Update', 2000).

Szlyk (1995) observed that older subjects (aged 50 years and above) *and* those with compromised vision had reduced risk-taking scores. Furthermore, Szlyk (1995) went on to postulate that the older drivers make a behavioural compensation for their visuocognitive / motor deficits, in that they display reduced risk-taking, decreased speed, and increased eye-movements. However, the author also found that those subjects with visual field loss could not as easily compensate for the age-related losses of driving skills, given that compromised vision predicts accident involvement.

#### **4.13 AGE AND DRIVING SKILL**

McGwin and Brown (1999; in 'Causes of Road Traffic Accidents Update', 2000), Lawton *et al* (1997), and Lester (1991; in Lawton *et al*, 1997) indicated that the younger driver suffers from a lack of driving skill. Lawton *et al* (1997) reported that the skill component of driving is known to increase with age, whilst McGwin and Brown (1999; in 'Causes of Road Traffic Accidents Update', 2000) noted that the younger driver's primary problem is risk-taking and lack of skill.



Conversely, Szlyk (1995) found that their older subjects, whether visually compromised or not, performed more poorly on the driving simulator than did the younger subjects. However, although the older group displayed these poorer driving-related skills, they did not have significantly higher on-road accident rates than the younger drivers. Such findings were accounted for by the behavioural compensation described above (in the ‘Age and Physiology’ section).

In considering driving-related skills, Matthews (1986; in NHTSA, 1995) interestingly observed that, although the tendency to rate oneself as a more skilful, or less vulnerable driver than one’s own peers is not unique to younger drivers; the tendency is, however, more pronounced for younger drivers.

#### **4.14 AGE AND FATIGUE**

The literature is sparse in terms of specific references to any possible association between age and fatigue and its effect on driving. Furthermore, the two relevant studies, within this literature review, were contradictory in their findings. McCartt *et al* (1999) reported that drowsy driving increased with increasing driver age, meaning that the older driver showed a greater tendency to demonstrate drowsy driving. McGwin and Brown (1999; in ‘Causes of Road Traffic Accidents Update’, 2000), however, observed that older drivers were less likely to have crashes involving driver fatigue. Although these results appear to be contradictory, it may be noted that, whilst McGwin and Brown were considering age and fatigue in relation to crash involvement, McCartt *et al* were investigating the *frequency* of drowsy driving. Furthermore, McCartt *et al*’s study controlled for the effects of experience (incidentally, finding the opposite effect for experience, i.e. that, as experience increases, drowsy driving decreases). This may account for the difference in findings, between the two studies, as McGwin and Brown’s (1999; in ‘Causes of Road Traffic Accidents Update’, 2000) study does not appear to have included experience as one of the investigated factors, suggesting that experience may have confounded the effects of age in this particular study.

## 5. GENDER

### 5.1 GENDER AND CRASH INVOLVEMENT

The literature consistently shows that men are more likely than women to have been involved in a traffic accident (Waller *et al*, 2001; Abdel-Aty & As-Saidi, 2000; Norris *et al*, 2000; Lawton *et al*, 1997; NHTSA, 1995; Parker *et al*, 1995; West, 1993; Chipman *et al*, 1992; Maxim & Keane, 1992; Maycock *et al*, 1991; Alexander *et al*, 1990; Evans & Wasielewski, 1983). Chipman *et al* (1992) reported that the crash rate per 1,000 drivers is more than double for men what it is for women. Waller *et al* (2001) evidenced not only that men had an overall higher risk of crashing, but that they incurred their first crash sooner, and their crashes were more likely to be at-fault. The proportion of crashes at-fault also decreased more than twice as fast for women, as for men, with increasing length of licensure. However, Storie (1977; in Elander *et al*, 1993) found no gender difference in blameworthiness; rather findings showed that whereas men were more likely to be involved in crashes caused by violations (such as speeding, drinking, or unwarranted risk-taking), women were more likely to be involved in crashes as a result of perceptual and judgemental errors (see 'Gender and Physiology' section). Norris *et al* (2000) corroborated this finding by suggesting that the males' greater accident risk may be at least partially accounted for by their greater tendency to disregard speed limits and traffic rules (see 'Gender and Speeding' section).

The Journal of the Institute of Automotive Engineer Assessors (1998; in 'Causes of Road Traffic Accidents Update', 1997-2000) investigated which gender makes the better driver, finding gender differences in terms of accident severity and types of accident. Findings showed that, although women seemed more likely to be involved in accidents with another vehicle, where they were at-fault, these accidents seemed to be slightly less severe than for men. Furthermore, men were observed to be almost twice as likely to be in accidents *not* involving third parties, and the costs of such accidents were somewhat higher (the authors suggested that this, again, might be as a result of using inappropriate speeds). Women were also found to be more involved in parking and manoeuvring incidents, but men caused slightly more damage in such accidents. These results therefore appear to support Storie's (1977) aforementioned findings, as men seem to be more at risk of accidents resulting from speed; whereas women appear to be involved in more accidents as a result of perceptual and judgemental errors.

Maycock *et al* (1991; in Elander *et al*, 1993) found that females were at a lower risk of crashing than males at all ages, but that the difference was greatest for young and inexperienced drivers. The study was also reported to observe a crash liability for females, which was 30% less than the male crash liability. Furthermore, the NHTSA (1995) documented that males have higher crash fatality rates than females for every age group, per 100,000 population. In addition, among the 16 to 20 age groups and the 21 to 24 age groups, the male population-based fatality rates were observed to be more than twice as high as those rates for females. However, there was less disparity observed between genders for injury rates, with females of ages 16 to 20 actually showing a slightly higher injury rate than their male counterparts.

In other research, Lawton *et al* (1997) failed to find gender to be independently predictive of accidents, once the effects of violation score were removed from the equation. The authors therefore suggested that gender only has an indirect effect on accident rate, with the relationship between gender and accident rate being mediated by the tendency to commit violations (see 'Gender and Driving Violations' section for further details).

## 5.2 GENDER AND DRIVING VIOLATIONS

The literature consistently reports that males are more likely than females to commit driving violations (Waller *et al*, 2001; Lawton *et al*, 1997; Parker *et al*, 1995a, b; Meadows, 1994; Furnham & Saipe, 1993; Reason *et al*, 1990; Michiels & Schneider, 1984; Storie, 1977). Waller *et al* (2001) found that men had about twice the risk of committing an offence, in any given year, when compared to women. In addition, the authors observed that men also tend to incur their first offence sooner than women do. Reason *et al* (1990; in Furnham and Saipe, 1993) reported that women, of all ages, were more prominent among those *low* on dangerous errors and violations, and that this finding was corrected for miles driven (which has been traditionally lower amongst women drivers). Results showed that men outnumbered women on violations, although the genders were fairly equal below the age of 20. Interestingly, however, women were found to outnumber men on harmful lapses up until the age of 30 years.

Lawton *et al* (1997) considered the effects of gender on driving violations, as well as the tendency to be involved in traffic accidents. Findings demonstrated that males tend to commit more violations than females and therefore have more accidents as a result. Tendency to commit violations was independently associated with both gender and with accident involvement. However, results also showed that, once the effects of violation score were removed from the equation, gender was no longer found to be independently predictive of accidents. Such a pattern of relationships led the authors to suggest that the effect of gender on accident involvement was mediated by the tendency to commit violations.

## 5.3 GENDER AND SPEEDING

The majority of the literature has found that speeding is associated with being male (Shinar *et al*, 2001; Norris *et al*, 2000; Stradling, 2000; Furnham & Saipe, 1993; French *et al*, 1992; Parker *et al*, 1992; Statistisches Bundesamt, 1987; Michiels & Schneider, 1984; Storie, 1977). The Statistisches Bundesamt (1987; in Trankle *et al*, 1990) reported that young female drivers were less often involved in accidents caused by speeding and veering off the lane than young males were. Women also reported higher rates of observing the speed limits than did men (Shinar *et al*, 2001). Elander *et al* (1993) further reported a general finding in the literature that faster and more deviant styles are associated with being male and young (French *et al*, 1992; Parker *et al*, 1992). Similarly, Michiels and Schneider (1984; in Trankle *et al*, 1990) found that young male drivers were more likely to commit violations related to inappropriate speed. This was corroborated by Storie (1977; in Elander *et al*, 1993) who found that men were more likely to be involved in crashes caused by violations such as speeding; and was also supported by Stradling (2000) who noted that males drive faster than females. Norris *et al* (2000) also added to these findings by suggesting that the males' greater accident risk may be at least partially accounted for by their tendency to disregard speed limits and traffic rules.

Stradling also evidenced that more male drivers than female drivers reported being penalised for speeding (9%:6%), but that this difference did not reach statistical significance. Furthermore, Stradling (2000) found a gender difference in the general onset of speed reduction when driving. Female drivers were observed to slow down sharply in their 20s, and then to maintain this velocity across the rest of this age range (21-29). Males drivers, however, do not reduce their velocity until during their 30s, yet still nominate higher speeds than their age-equivalent females. The male and female nominated speeds were not observed to converge until around age 50 (and this was corrected for mileage differences). Stradling (2000) therefore noted that females appear to 'grow out' of speeding much more quickly than males do.

Only Wasielewski (1984; in the NHTSA's 1995 interim report) reported a failure to find a significant effect of driver gender, on vehicle speed, within this literature review.

## 5.4 GENDER AND ALCOHOL AND DRUG USAGE

Research investigating gender and alcohol-usage consistently shows that males are more likely than females to report drinking and driving, and are also more likely to be involved in alcohol-related traffic accidents (Anderson & Ingram, 2001; Shinar *et al*, 2001; Abdel-Aty & Abdelwahab, 2000; Caetano & Clark, 2000; Burgess & Lindsey, 1997; The Florida Department of Highway Safety and Motor Vehicles / DHSMV'S accident database, 1994 & 1995; NHTSA, 1993c; NHTSA, 1991, Pendleton *et al*, 1986; Storie, 1977). A national survey on drinking and driving in Canada (in Abdel-Aty & Abdelwahab, 2000) showed that men were three times more likely than women to report driving after drinking (26% compared to 8%). The DHSMV 1994 and 1995 accident databases (in Abdel-Aty & Abdelwahab, 2000) illustrated that male drivers experience higher alcohol / drug-related accident rates than females, for all age groups. In fact, the male accident rates were reported to be approximately, and consistently, four times that of females. Abdel-Aty and Abdelwahab (2000) found that the alcohol involvement in accidents of male drivers was more than double that of females, noting that this finding confirmed the results of previous studies (i.e. Burgess & Lindsey, 1997; NHTSA, 1991; Pendleton *et al*, 1986). Pendleton *et al* (1986) reported that males had 55% of their driving fatalities in traffic accidents while intoxicated, compared to 32% of all female driver fatalities (in Abdel-Aty & Abdelwahab, 2000).

Anderson and Ingram (2001) supported the above findings by observing that males (and, in particular, young males) were among the highest risk groups for drink driving. Furthermore, Ingram, Lancaster, and Hope (2001) investigated the prevalence of drug driving and reported that men were significantly more likely than women to have driven under the influence of drugs.

Shinar *et al* (2001) conducted a study investigating the self-reports of safe driving behaviours, and found that women reported higher observance rates of abstaining from drinking and driving. The NHTSA (1993c; in the NHTSA, 1995) similarly found that males were more likely to report drinking and driving, regardless of age. Males were also reported to compose a disproportionately large share of driver alcohol fatalities. These findings were again corroborated by Storie's (1977) finding that men were more likely to be involved in crashes that were caused by violations such as drinking. Caetano and Clark (2000) also demonstrated supporting evidence through their findings that drinkers, who drive under the influence of alcohol, are more likely to be men (regardless of ethnicity). The authors further noted that almost all alcohol-impaired driving events are more common among men than women, independent of ethnicity.

Interestingly, Campbell *et al* (1995; in Abdel-Aty & Abdelwahab, 2000) noted that, between 1977 and 1993, the number of male drivers involved in alcohol-related fatal traffic accidents, in the United States, decreased by 22%; whereas, for females, there was an 18% increase. The NHTSA (1991; in Abdel-Aty & Abdelwahab, 2000) also reported that female drivers are becoming more involved in alcohol-related accidents, but that the alcohol-accident problem is still an overwhelmingly male problem.

## 5.5 GENDER AND SEAT-BELT USE

Research generally shows that failure to use a seat-belt is most common among young adults, and particularly males (Beirness & Simpson, 1997; Waxweiler *et al*, 1993; Preusser *et al*, 1991; Jonah, 1990; in Begg & Langley, 2000). Shinar *et al*'s (2001) study investigating safe driving behaviours also observed that it was women who reported higher observance rates for seat-belt use. The authors additionally noted that, while for women reported seat-belt use increased with income, it did not increase with income for male drivers. Begg and Langley (2000) also researched seat-belt use and related behaviours, overall finding that females reported higher use than males. Among the males, the authors noted that, front seat-belt users were significantly less

likely than non-users to drive after drinking, drive after using marijuana, take deliberate risks when driving to make driving more fun, or to have been disqualified from driving. There were no statistically significant differences, on these variables, between female front seat-belt users and non-users, although the authors argued it was important to note the small number of non-users among the females.

## **5.6 GENDER AND RISK PERCEPTION**

The research into gender and risk perception consistently demonstrates a male driver tendency to rate traffic situations as less risky than do female drivers (Alm & Lindberg, 2000; Glendon *et al*, 1996; Drottz-Sjoberg & Sjoberg, 1990a, b; Trankle *et al*, 1990; Trankle *et al*, 1988). Female drivers tended to see traffic accidents as more likely than males did (Glendon *et al*, 1996). Trankle *et al* (1988; in Trankle *et al*, 1990) revealed that young females gave higher risk ratings than their male counterparts, and that their ratings were not significantly lower than those females in other age groups. The young male drivers, however, rated the traffic situations as less risky than did older male drivers, with no comparable age effect for females occurring (Trankle *et al*, 1990). Matthews and Moran (1986; in Glendon *et al*, 1996) also reported data suggesting that age differences in risk perception are confined to males (i.e. younger and older females underestimate their personal risk to the same degree).

Furthermore, Alm and Lindberg (2000) found that men (aged between 13 and 29 years) tended to rate perceived risks to be lower, and feelings of safety to be higher, than did women of the same age. The authors noted that their findings were in accordance with Drottz-Sjoberg and Sjoberg, 1990a, and 1990b. In addition, Alm and Lindberg (2000) also observed that perceived accident risk increased with age for men, but this was not the case for women; further noting Drottz-Sjoberg and Sjoberg's (1990a) finding that men (aged between 18 and 20) seemed to be less risk averse than older men and women. Risk Perception therefore appears to be more stable among female drivers, whereas it is more affected by age amongst male drivers.

The NHTSA's (1995) interim report also noted that a number of studies (i.e. DeJoy, 1992, 1989; Trankle *et al*, 1990; Groeger & Brown, 1989; Sivak *et al*, 1989; Finn & Bragg, 1986; Matthews & Moran, 1986) found that younger drivers tended to underestimate personal risk and overestimate driving ability - and that this bias was more consistent and pronounced for male rather than female drivers.

## **5.7 GENDER AND EXPERIENCE**

Waller *et al* (2001) conducted a study that investigated the changes in young adult offence and crash patterns over time. A consideration of gender differences in relation to experience (as measured by length of licensure) revealed that the odds of a crash being at-fault decreased overall about 6% per year of licensure, but that the decline was more than twice as fast for women as for men. However, the relative decline in risk of serious offence, with increasing length of licensure, was observed to be about the same for both men and women. Findings also showed that men tended to incur their first offences and crashes sooner than women did.

## **5.8 GENDER AND DRIVING CONFIDENCE**

Parker, McDonald, Sutcliffe, and Rabbitt (2001) investigated driving confidence among older drivers, as measured through self-reported levels of nervousness when driving. Amongst the factors analysed, results, for the factor of gender, showed that level of driving confidence was higher among males. For further details of associations of the other factors in this study, with driving confidence, refer to the 'Personality and Driving Confidence' section and the 'Attitudes, Crash Involvement, and Driving Violations' section of this review.

## 5.9 GENDER AND AGGRESSION / ANGER

Lajunen and Parker (2001) considered driver aggression in relation to age and gender, and found that, among men, age was negatively related to both driver anger and aggression. However, among women, annual mileage was negatively related to driver aggression. This demonstrates that, although younger males are more likely to display driver anger and aggression (and this likelihood has a tendency to decrease with increasing age), age is not a significant factor amongst women, in terms of driver aggression. Women drivers with high annual mileage seem to get less angered the more driving exposure they experience. The lack of a relationship between annual mileage and aggression among men, however, indicates that increased exposure to traffic does not tend to alter the male driver's view. Lajunen and Parker (2001) further suggested that this may indicate that males have more 'fixed views' about themselves, as drivers, than females.

Lajunen and Parker (2001) also investigated the manifestation of verbal aggression, which seemed to have a more important role among female drivers than male drivers. Surprisingly, however, the authors observed no differences in physical anger, between men and women. Lawton *et al* (1997; in Lajunen & Parker, 2001), however, divided violations into highway code and interpersonally aggressive violations and found that men reported more aggressive violations than women did. In addition, Macmillan (1975; in Novaco, 1989) reported overall results indicating that it is young males who are fast drivers, competitive, aggressive, and willing to take risks (and that these characteristics were associated with accidents and convictions for motoring offences).

Doob and Gross (1968; in Novaco, 1989) conducted a study on horn-honking and reported that male drivers honked more quickly. However, Chase and Mills (1973; also in Novaco, 1989) did not find a gender effect in the latency of horn-honking. Furthermore, Novaco (1989) surmised that horn-honking is more of an anger measure than an aggression measure, as it is only infrequently related to acts of road aggression and may be used merely in annoyance or as a signal without aggressive qualities.

Mizell (1997, in Norris *et al*, 2000) reported that the majority of aggressive drivers were male, whilst Parry (1968; in Novaco, 1989) also found that aggression scores were highest for males between the ages of 17 and 35; however, Hauber (1980; in Novaco, 1989) failed to find a significant gender difference in aggression / violence studies. Additionally, Novaco (1989) concluded that previous research on roadway aggression indicates, "that antagonistic behaviour in driving is relatively prevalent and that provocative and self-endangering actions are perpetrated by both male and female drivers" (p.54).

## 5.10 GENDER AND PHYSIOLOGY

Halpern (1986; in Trankle *et al*, 1990) reported finding gender-related differences in visual perception, noting a female disadvantage. Trankle *et al* (1990) investigated accident risk in a variety of traffic situations, and found comparatively high accident involvement and relatively low risk rating, of young female drivers, for traffic situations at intersections. Trankle *et al* (1988; in Trankle *et al*, 1990) also evidenced that young female drivers performed remarkably badly in gap-acceptance tasks at intersections. Trankle *et al* (1990) subsequently suggested that the problems females seem to have, in these particular traffic situations, might be as a result of the specific problems they appear to have in the area of spatial perception and orientation. Such findings are supported by Storie's (1977; in Elander *et al*, 1993) study which reported that women were more likely to be involved in crashes as a result of perceptual and judgemental errors. Halpern's (1986; in Trankle *et al*, 1990) study, however, also gave reason to suggest that the training applied, in an attempt to improve these required skills, has been quite optimistic.

## **6. EDUCATION**

### **6.1 EDUCATION AND CRASH INVOLVEMENT**

Norris *et al* (2000) investigated a number of factors and their associations with motor vehicle accidents (MVAs). Results originally showed that those participants with post-secondary education had more accidents than others. However, the effect of education on MVAs was not found to be significant once age was controlled for. Macmillan (1975; in Novaco, 1989) also reported a failure to observe a relationship between education and accidents.

Conversely, Dobson *et al* (1999) observed that those women with tertiary education, in the mid-age group (aged 45-50 years), displayed a significantly higher accident risk, but that education did not have an effect in the younger drivers group (aged 18-23 years).

### **6.2 EDUCATION AND SPEEDING**

Shinar *et al* (2001) also investigated 'observing speed limits' as another example of a safe driving behaviour and found that the number of people who reported that they observed the speed limit decreased with increasing education. This finding was corroborated by Hemenway and Solnick (1993; in Shinar *et al*, 2001) who reported that drivers with higher education were more likely to report that they speed than were drivers with lower levels of education. Dobson *et al* (1999) further supported these studies in their observations that women with higher scores for violations, speeding, lapses and errors were women with tertiary education.

Shinar *et al* (2001) subsequently suggested that, as the level of education increases, people become more familiar with the conflicting arguments and data, regarding the relationship between speeding and crashes, and so believe that they can judge for themselves the merits and risks of speeding.

### **6.3 EDUCATION AND SEAT-BELT USE**

The other example of a safe driving behaviour, as measured by Shinar *et al* (2001), was self-reported seat-belt use. Findings showed that reported use of seat-belts increased with increasing education, for both genders. This was consistent with those studies conducted by Preusser *et al*, (1991) and Jonah (1990; both in Begg & Langley, 2000) who evidenced that those who did not use seat-belts tended to have lower academic qualifications. Begg and Langley (2000) further supported these findings by observing that front seat-belt users, both male and female, had significantly higher school academic qualifications than did non-users. In terms of rear seat-belt usage, male users also displayed higher academic qualifications than did non-users, but there were no significant differences between rear seat-belt users and non-users for the females in the study. Furthermore, once the authors had controlled for the other factors in the study, results showed that the factors most strongly associated with not using a front seat-belt were having no academic qualifications compared with having a higher than school certificate (and also having been disqualified from driving).

### **6.4 EDUCATION AND ALCOHOL USAGE**

The NHTSA (1995) reported research by Zuckerman (1979), which found that poor academic performance was one of the factors associated with engaging in risky driving, including drunk driving, among young males. Further to this, the Insurance Institute for Highway Safety Status

Report (2000) observed fewer years of education amongst Mexican Americans, who were the group reported by the Institute to be most prevalent in terms of alcohol-related deaths, when driving.

In contrast, Shinar *et al* (2001) investigated self-reports of safe driving behaviours, in relation to a number of factors including education. Findings showed that ‘complete avoidance of drinking and driving’ was reported by most drivers in all groups, and that these rates hardly varied across the different education groups (neither did they vary across the different age or income groups).



## 7. PERSONALITY

### 7.1 PERSONALITY AND RISKY DRIVING

The majority of the personality literature reviewed demonstrates relationships between certain personality factors and various aspects of risky driving. Again, Zuckerman's Sensation Seeking (SS) factor, and the SS subscales, appear frequently in the research, with higher Sensation Seekers (SSs) being associated with a more risky driving behaviour (e.g. Arnett *et al*, 1997; Lajunen & Summala, 1996; Rimmo & Aberg, 1996; Beirness, 1995; Burns & Wilde, 1995; Horvath & Zuckerman, 1993; Yu & Williford, 1993; Heino *et al*, 1992; McMillen *et al*, 1992a, b; Arnett, 1990; Donovan *et al*, 1990; Moe & Jenssen, 1990; Wilson, 1990; McMillen *et al*, 1989; Wilson & Jonah, 1988; Donovan *et al*, 1985; Clement & Jonah, 1984; Donovan & Marlatt, 1982; Zuckerman & Neeb, 1980; all in Jonah, 1997; also NHTSA, 1995; Furnham & Saipie, 1993; & Beirness & Simpson, 1988, in Beirness, 1993).

'Risky driving' may be represented by a variety of indices, such as traffic violations, drinking and driving, crash involvement, speeding, risky driving practices / behaviour, or even seat-belt usage. Jonah's (1997) extensive review found that, of the 40 studies investigated, only 4 did not find significant positive relationships between Sensation Seeking (SS) and some aspect of risky driving. Jonah observed stronger relationships with either observed or reported driving behaviour, rather than with traffic violations or collision involvement. All 15 studies investigating SS and 'other risky driving behaviours' (other than drink driving) evidenced an association of high SS with higher risky driving tendencies. Of the 12 studies considering SS and collision involvement, 7 studies observed significant differences between high and low SS on collision involvement, and another study reported a greater number of collisions with high SS. Furthermore, of the 11 studies examining SS and traffic violations, 6 studies reported more violations with increasing SS scores, and 3 studies identified clusters including drivers with high SS scores and violations. Overall, Jonah evidenced that high Sensation Seekers were more likely to experience collisions and violations than low Sensation Seekers, and high Sensation Seekers were also more likely to perceive less danger in risky driving. Consideration of drink driving as an index of risky driving showed that, of the 18 studies within Jonah's review, all but 5 either found that, as SS score increased, reported 'driving while impaired' (DWI) also increased, or, reported / convicted DWIs had higher SS scores. (The associations between various personality factors and drink driving, crash involvement, and driving violations, will be discussed in greater detail in following sections of this report).

Although the subscales of the Sensation Seeking Scale (SSS) have not been examined very often, Jonah's (1997) review noted that, of the positive associations, Thrill and Adventure Seeking (TAS) appears to have the strongest relationship with risky driving, followed by Disinhibition (Dis) and then Experience Seeking (ES). The author also observed that TAS appeared to be most strongly related to driver records. Furnham & Saipie (1993) used a Driver Behaviour Questionnaire to measure 'risk-taking on the road', and found that those scoring high on the "risk-taking" factor tended to have higher TAS, Boredom Susceptibility (BS), and Psychoticism scores.

Beirness (1993) also conducted an extensive review of the literature concerned with the role of personality factors in road crashes. Beirness found that the six personality factors of: thrill-seeking, impulsiveness, hostility / aggression, emotional instability, depression, and locus of control, accounted for up to 35% of the variance in measures of risky driving behaviour.

Research also demonstrated that those drivers who scored high on measures of SS were more likely to engage in risky driving practices such as speeding, impaired driving, accidents, and traffic violations (Johnson & White, 1989; Jamison & McGlothlin, 1973; both in Beirness, 1993). Similarly, faster drivers obtained higher scores on SS (Clement & Jonah, 1984; Zuckerman & Neeb, 1980; both in NHTSA, 1995) and the SS trait was observed to be related to 'driving risk', which was defined as the sum of responsible accidents, traffic convictions, and license suspensions, within the previous 3 years (Wilson & Jonah, 1988; in Beirness, 1993).

Another factor of personality that 3 studies investigated was that of depression, whereby Wilson and Jonah (1988; in Beirness, 1993) found a relatively weak relationship between depression and risky driving. Donovan *et al* (1986; in Beirness, 1993), however, observed that the depressed group displayed a reduction in the level of 'driving risk', with improvements in their affective state. Beirness (1993) therefore suggested that, "the type of depression associated with problem driving may be a more transient, state-like form of depression rather than associated with a more enduring trait" (p.134).

## **7.2 PERSONALITY AND CRASH INVOLVEMENT**

Associations, in the literature, between personality factors and crash involvement appear to be mixed and vary according to the different personality factors. Wilde (1994; in Jonah, 1997) contended that personality has little role to play in collision involvement, and that where these relationships are found, they are generally weak and inconsistent. The research pertaining to the Extraversion and Neuroticism scales of Eysenck's Personality Questionnaire (EPQ) has generally been mixed, yet some studies did observe a relationship between higher Extraversion and / or Neuroticism and traffic accidents (Loo, 1978; Shaw & Sichel, 1971, 1970; Craske, 1968; Fine, 1963; all in Elander *et al*, 1993; & Eysenck, 1961, in Furnham & Saipe, 1993).

Eysenck (1961; in Furnham & Saipe, 1993) argued that Extraverts would tend to be less socialised than Introverts (i.e. having formed weaker conditioned responses), and therefore more prone to accidents and errors. Shaw and Sichel (1971; in Furnham & Saipe, 1993) investigated a sample of bus drivers, with good and bad safety records, finding that the latter group tended to be more extraverted, and also scored higher on Neuroticism. The authors noted that, whereas most accident-prone drivers were neurotic Extraverts, most of the safe drivers tended to be stable Introverts. Craske (1968; in Elander *et al*, 1993) reported an association between Extraversion and crash rates in a sample of clinic patients with minor trauma, yet this relationship was only apparent for males and not females. Another study investigating Extraversion and traffic accidents (Fine, 1963; in Elander *et al*, 1993) also observed a significant relationship between the two factors, showing higher Extraversion with those that tended to be involved in crashes, in a study involving male students.

However, another body of research contradicts the observed associations between Extraversion, Neuroticism, and crash involvement. Wilson and Greensmith (1983; in Elander *et al*, 1993) found no differences in the Extraversion or Neuroticism scores of the crash involved and crash-free drivers, whilst Craske (1968; in Elander *et al*, 1993) found no correlation between Neuroticism and crash rate. Furthermore, Singh (1978; in Elander *et al*, 1993) reported an association between Introversion and crash involvement. On the other hand, Furnham and Saipe (1993) and Matthews *et al* (1991; in Furnham & Saipe, 1993) conversely found that accident rates were not significantly correlated with any of the EPQ scales. Elander *et al* (1993) noted the suggestion that more reliable correlations between driver behaviours and personality dimensions could be obtained by using subscales rather than overall scores. Loo (1979; in Elander *et al*, 1993) investigated this possibility, by reanalysing data which showed a relationship between Extraversion and detection of embedded traffic signs, crashes, and traffic convictions (Loo, 1978; in Elander *et al*, 1993). Loo (1979; in Elander *et al*, 1993) broke down Extraversion into

its 'Impulsivity' and 'Sociability' scales and subsequently found that Impulsivity carried the relationships with all 3 of the driving-related measures (when Impulsivity was broken down further into Sensation Seeking / SS and decision-time, SS carried the relationship between Impulsivity and traffic convictions). Overall, Elander *et al* (1993) argued that the evidence on Extraversion and Neuroticism, with respect to crash involvement, is inconclusive, suggesting that this may be a result of the lack of control in the majority of the aforementioned studies. Powell *et al* (1971; in Furnham & Saipe, 1993) also suggested that Extraverts might simply report more accidents than Introverts, yet this has to be established (Shaw & Sichel, 1971; in Furnham & Saipe, 1993).

Research has also investigated the associations between the Sensation Seeking Scale (SSS) factors and accident involvement. In a sample of high school students, Beirness and Simpson (1988; in NHTSA, 1995) found that drivers who had been involved in a motor vehicle crash scored higher on the Thrill and Adventure Seeking (TAS) subscale of the SSS than those participants who were either involved in a crash as a passenger, or those who were not involved in a crash at all. Beirness (1990; in Beirness, 1993) also evidenced that differences in SSS scores are evident even prior to licensing, suggesting the predictive value of this personality trait for subsequent crash involvement. In addition, Donovan *et al* (1990, 1985; in Beirness, 1993) measured high levels of the SS trait among high-risk drivers (which included drivers who had experienced 3 accidents within 1 year, or 4 within 2 years). Personality traits such as SS (thrill-seeking), hostility, aggression, and emotional lability have all been shown to be frequently and consistently related to risky driving and crash involvement (Beirness *et al*, 1993; Beirness & Simpson, 1991; Wilson, 1991, Donovan *et al*, 1988; all in Beirness, 1993). Beirness' (1993) literature review argued that the six personality factors of: thrill-seeking, impulsiveness, hostility / aggression, emotional instability, depression, and locus of control account for as much as 10 to 20% of the variance in driver crash involvement. Furthermore, Pelz and Schuman (1968) and Schuman *et al* (1967; both in Beirness, 1993) found that higher scores on 'impulse expression' were associated with more accidents in a sample of young, unmarried, male drivers. Schmidt *et al* (1972; in Beirness, 1993) corroborated this with evidence of a generally elevated level of impulsive behaviour among drivers killed in single-vehicle collisions. Norris *et al* (2000), however, evidenced that neither depression nor self-reported concentration difficulties were related to motor vehicle accidents (MVAs).

In contrast, both Furnham and Saipe (1993) and Clement and Jonah (1984; in NHTSA, 1995) failed to find a relationship between SS and number of crashes. Jonah (1997) observed that collision involvement has been less strongly associated with SS, suggesting that this may be due to a lack of variance in the collision measure (in that collisions are relatively rare events), and also because being involved in a collision does not necessarily mean that the driver behaved incorrectly.

In terms of an individual's propensity towards risk-taking, research has shown that those drivers involved in crashes tend to display more risky aspects of behaviour. Suchman (1970; in Beirness, 1993) found that those participants who were "favourably disposed to taking chances" were four times more likely than others to have been involved in more than one collision in the past year. These findings were supported by Pelz and Schuman (1968) and Schuman *et al* (1967; both in Beirness, 1993) who discovered that, amongst those drivers who had been involved in crashes, more than half had engaged in risky driving practices such as racing or taking dares. Mayer and Treat (1977; in Beirness, 1993) also found large differences in propensity towards risk-taking between students who had been involved in 3 or more crashes in the previous 3 years, and those who had not been in any crashes during the same period.

The research in the literature also utilised various other measures of personality in the investigation of associations with crash involvement. Both West *et al* (1992b) and Evans *et al*

(1987; both in Elander *et al*, 1993) examined Type A behaviour, using the Bortner Rating Scale (BRS). West *et al* (1992b; in Elander *et al*, 1993) found that higher scores on Type A behaviour were associated with self-reported fast driving, but not with crash rates. Evans *et al* (1987; also in Elander *et al*, 1993), however, conversely found that those drivers characterised as Type A had higher crash rates than Type Bs, in both India and the U.S. Evans *et al* (1987; in Elander *et al*, 1993) also noted that Type A was associated with more frequent braking, passing, and horn use. It was noted earlier that Beirness (1993) listed locus of control (LOC) as one of the personality factors accounting for the variance in driver crash involvement. However, this has been contradicted by Clement and Jonah (1984; in Elander *et al*, 1993), who, although initially observed a relationship between an external LOC and the number of crashes reported over 3 years, later found that this relationship did not hold once age, annual mileage, and number of years driving were taken into account. Additionally, Guastello and Guastello (1986; in Elander *et al*, 1993) found that the number of crashes reported during the previous 3 years correlated negatively with a “transitional” scale of beliefs about the internal control of crashes (i.e. a higher score on internal control was associated with a fewer number of accidents). There was, however, no such association with the original Rotter Locus of Control (LOC) scale.

Further investigations into other aspects of personality show crash involvement associated with “interests of a less intellectual nature”, expression of hostile feelings, increased aggression, “seeking of prestige and social roles oriented toward authority and competition”, and “disruption and conflict in past and previous family relationships” (McGuire, 1972; in Elander *et al*, 1993). In an extensive review of the literature, McGuire (1976; in Elander *et al*, 1993) also concluded that highway crashes are just another correlate of being emotionally unstable, unhappy, asocial, antisocial, impulsive, under stress, or similarly labelled conditions. Harano *et al* (1975; in Elander *et al*, 1993) found that measures of maturity, risk-taking, driving attitudes, and emotional stability were predictive of multiple crash involvement. In addition, Tsuang *et al* (1985; in Elander *et al*, 1993) identified certain personality characteristics as being risk factors for traffic crashes, and these were termed: low tension tolerance, immaturity, personality disorder, and paranoid conditions.

West *et al* (1992a; in Elander *et al*, 1993) took a slightly different approach by considering that a driver may have a stable trait of “crash liability”. The authors reported that the odds of having a crash in a 2-year period were doubled in drivers who had had one or more crashes in the preceding year. Thus, it was suggested that the proportion of crash risk attributable to a stable trait of “crash liability” was 50%. Furthermore, when crashes for which the driver was partly responsible were added, there was a fourfold increase in the odds, meaning that the crash risk attributable to a stable trait increased to 75%. The authors argued that this emphasises the importance of understanding the individual differences in crash rates; it also demonstrates the importance of noting a driver’s previous accident history (at-fault and not at-fault).

The research has also identified aggression / hostility and anger as factors of personality affecting crash involvement, yet these will be discussed in the later ‘Aggression / Anger and Crash Involvement’ section of this review.

### **7.3 PERSONALITY AND DRIVING VIOLATIONS**

The majority of the literature investigating personality and driving violations / convictions has investigated Zuckerman’s Sensation Seeking (SS) factor and / or Eysenck’s Personality Questionnaire (i.e. the EPQ, which consists of the Extraversion, Psychoticism, Neuroticism, and Lie subscales). Generally speaking, the literature demonstrates that those drivers committing more traffic violations tend to have higher scores on Psychoticism, and SS, and lower Neuroticism scores (e.g [Johnson & White, 1989; Wilson & Jonah, 1988; Zuckerman & Neeb, 1980; Jamison & McGlothlin, 1973; all in Beirness, 1993]; [Loo, 1979; Fine, 1963; both in

Elander *et al*, 1993]; [Matthews *et al*, 1991; Mayer & Treat, 1977; both in Furnham & Saipe, 1993]; also Jonah, 1997; Beirness, 1993; Furnham & Saipe, 1993;).

Furnham and Saipe (1993) found that convicted drivers attained high Psychoticism and low Neuroticism scores, as well as high Thrill and Adventure Seeking (TAS) and Boredom Susceptibility (BS) scores. The Extraversion and Lie scales did not correlate with convictions in this study. The number of convictions, however, were seen to increase with increasing scores on the 'risk factor', i.e. a driver with a high risk factor score tended to have committed more driving convictions. Furthermore, the authors also noted that 'law breaking', 'self confidence', and BS discriminated most between those with and without convictions - convicted drivers tended to show confidence and nonchalance about breaking traffic laws. As stated, convictions correlated negatively with both TAS and BS, although more strongly with BS, leading Furnham and Saipe (1993) to suggest that convicted drivers seek higher levels of thrill and arousal, in order for them to reach their optimal level of stimulation. The authors further proposed that the convicted drivers' propensity to take risk on the road can be accounted for by their "dislike for dull and predictable routine and a preference for excitement and thrill" (p.333). In terms of their findings of both high Psychoticism and low Neuroticism scores, the authors suggested that such drivers are more indifferent towards certain traffic laws, making it more likely for them to drive in an illegal or risk-taking manner. Mayer and Treat (1977; in Furnham & Saipe, 1993) corroborated Furnham and Saipe's (1993) study, by demonstrating that high Psychoticism scores were associated with impulsiveness and 'law-breaking', specifically with respect to driving.

Although Furnham and Saipe (1993) did not find an significant association between Extraversion and traffic violations, a study by Fine (1963; in Elander *et al*, 1993) demonstrated that Extraverts committed more violations than Introverts, subsequently suggesting that Extraverts may be less bound by society's rules. A further contradiction of Furnham and Saipe (1993) is apparent in Matthews *et al*'s (1991; in Furnham & Saipe, 1993) study, which surprisingly found no significant relationship between any of the EPQ scales and speeding convictions.

With respect to personality factors other than those in the EPQ, Zuckerman and Neeb (1980; in Beirness, 1993) observed that high Sensation Seekers tended to choose higher driving speeds. Donovan *et al* (1985, 1990; both in Beirness, 1993) also observed high levels of the SS trait in various types of high-risk drivers, including those committing 3 violations within 1 year, or 4 violations in 2 years. Additionally, Pelz and Schuman (1968) and Schuman *et al* (1967; both in Beirness, 1993) demonstrated that risky driving behaviour was three times more common among those with high violation records, when compared to those drivers with no violations. Pelz and Schuman (1968) and Schuman *et al* (1967; both in Beirness, 1993) again also found a positive relationship between 'impulse expression' and traffic violations, in a sample of young, unmarried, male drivers.

#### **7.4 PERSONALITY AND ALCOHOL AND DRUG USAGE**

The research in the literature also investigates associations of personality factors with the tendency to drink alcohol and drive. Studies again examine the Sensation Seeking (SS) trait of personality, with the majority of the research producing consistent findings - that those drivers scoring higher on SS (or related risk-taking factors), show a greater tendency to drive under the influence of alcohol and / or drugs (e.g. Ingram *et al*, 2001; Jonah, 1997; NHTSA, 1995; Beirness, 1993; [Arnett, 1990b; Clark *et al*, 1990; McMillen *et al*, 1989; all in NHTSA, 1995]; [Donovan & Marlatt, 1990; Klepp & Perry, 1990; Jessor, 1987; Donovan & Marlatt, 1985, 1982; Zuckerman, 1979; all in Beirness, 1993]).

Ingram, Lancaster, and Hope (2001) investigated recreational drugs and driving, noting that research appears to suggest that drug driving is one manifestation, 'of a more general risk-taking personality type' (p.4). The study considered four types of risk-taking behaviour, i.e. speeding, drink driving, drug use, and drug driving. Results showed that those who engaged in one of the aforementioned four types of risk-taking behaviour were more likely than average to have engaged in the other three. Furthermore, those respondents who had endorsements on their licence, and those who had drunk heavily in the past seven days, were also more likely to have engaged in one of the four key risk-taking behaviours.

Jonah (1997) conducted a literature review of SS and risky driving and found that, out of 18 studies, all but 5 evidenced higher SS scores with reported drinking and driving behaviour. As SS increased, reported 'driving while impaired' (DWI) also increased. Johnson and Raskin White (1989; in Jonah, 1997) found that high Sensation Seekers were more likely to report driving while under the influence of alcohol and marijuana, among a group of 18 year-old males. Donovan and Marlatt (1982; in Beirness, 1993), also reported that high scores on the SSS were characteristic of the most deviant group of offenders (in a sample of DWI offenders).

The literature has also considered the subscales of the Sensation Seeking Scale (SSS), with Zuckerman (1979; in NHTSA, 1995) observing that young males who are likely to engage in risky driving (including drink driving) are often characterised by high scores on Thrill and Adventure Seeking (TAS), Disinhibition (Dis), and Boredom Susceptibility (BS). Arnett (1990b; in NHTSA, 1995), in a sample of 17-19 year-old males, reported that having driven a car drunk in the past year was related to the total score on the SSS (Zuckerman *et al*, 1978; in NHTSA, 1995) and to several subscales (i.e. TAS, Dis, & BS). Those having driven impaired in the past year received higher mean scores than those who reported not driving impaired. Impaired driving was not related to the Experience Seeking subscale (Arnett, 1990b; in NHTSA, 1995). Arnett (1990b; in NHTSA, 1995) also found that drunk driving is associated with high scores on the BS subscale. Farrow (1987a; in NHTSA, 1995) corroborated these findings by evidencing that young 'driving while intoxicated' (DWI) offenders appeared to be more likely to counteract boredom by being with friends, consuming alcohol, and drinking before driving. Jonah (1997) reported that, of the few studies comparing the subscales of the SSS, the Disinhibition subscale was found to correlate most strongly with drinking and driving (Arnett, 1990b).

Beirness (1993) contended that the Sensation Seeking (SS) construct described by Zuckerman (1979), "is perhaps the personality characteristic most closely associated with risk-taking behaviour" (p.131). With such an assertion in mind, the studies by Klepp and Perry (1990) and Jessor (1987; both in Beirness, 1993) appear to support the findings in terms of the relationship between SS and the tendency to drink drive. Jessor (1987; in Beirness, 1993) reported that risk-taking while driving was positively correlated with high-risk behaviours such as marijuana use, delinquency, drunkenness and driving after drinking. In addition, Klepp and Perry (1990; in Beirness, 1993) found that a measure of 'risk-taking' behaviour was significantly related to drinking and driving. In a study investigating further related personality factors, Clark *et al* (1990; in NHTSA, 1995) reported that higher scores on 'venturesomeness' and 'impulsivity' were related to higher levels of dangerous driving and substance abuse.

Furthermore, in a study of 'expected alcohol consumption', even high Sensation Seekers who only *thought* that they had consumed alcohol (but had not) tended to have more scores above the median on lane changes and cars passed than high SSs who thought they had *not* consumed alcohol (McMillen *et al*, 1989; in NHTSA, 1995). Beirness (1993) added to McMillen *et al*'s (1989) findings by arguing that, from the evidence available, it would appear that increased risk-taking following alcohol consumption may primarily be a function of expectancy, i.e. the belief that alcohol increases risk-taking. The literature reviewed by Beirness (1993) also led to his

suggestion that personality may interact with expectancies about the effects of alcohol to enhance aggressive (see 'Aggression / Anger and Alcohol Usage' section) and thrill-seeking behaviour.

The research discussed thus far, in this section, has consistently found that those individuals scoring highly on the SS factor of personality show a greater tendency to drive under the influence of alcohol and / or drugs. In contrast, Beirness (1993) noted that literature has also examined the belief that alcohol increases the willingness to take risks and to engage in thrill-seeking behaviour. This appears to be a similar association, but the direction of causation is, in fact, reversed. Beirness (1993) further reported that a number of studies (i.e. Wilde *et al*, 1991; Joly & Wilde, 1987; Stein & Allen, 1987) have investigated this effect, using laboratory tasks, simulators, and closed-course driving, and failed to find that alcohol increased risk-taking behaviour. This effect will need to be researched further, however, this observed lack of an association might be because individual's, scoring high on SS, are more inclined to drive after drinking, rather than alcohol itself inducing higher risk-taking across all levels of personality traits, even those scoring low on SS.

Self-confidence, as a personality factor affecting alcohol usage and driving, was only investigated by one study (Klepp & Perry, 1990; in NHTSA, 1995), which found that those reporting a lack of self-confidence in avoiding an impaired driving situation were more likely to drink and drive.

In his 1993 literature review, Beirness also identified depression as a characteristic prevalent among high-risk drivers, particularly 'driving while intoxicated' (DWI) offenders. The author went on to note that the correlation between depression and alcoholism / drinking makes it difficult to determine the extent to which each contributes to risk of crash involvement. However, Donovan *et al* (1986; in Beirness, 1993) observed that the depressed group in their sample reduced their level of driving risk with improvements in their affective state. Beirness therefore argued that the type of depression associated with problem driving may be, "a more transient, state-like form of depression rather than associated with a more enduring trait" (p.134).

## **7.5 PERSONALITY AND SEAT-BELT USE**

Research investigating seat-belt use and personality considers personality in terms of risk-taking and thrill-seeking traits. Begg and Langley (2000) conducted a study on seat-belt use and related behaviours among young adults, finding that male users generally displayed lower risky driving behaviours, but did not differ significantly as far as thrill-seeking activity is concerned. Conversely, Jonah (1997) observed significant differences between male front seat-belt users and non-users in their enthusiasm for thrill-seeking activities. Wilson (1990; in Beirness, 1993) also reported that scores on the Sensation Seeking Scale (SSS) were significantly higher among those who never or inconsistently used seat-belts, in comparison to those who always wore seat-belts.

Begg and Langley (2000) suggested that the lack of thrill-seeking differentiation, between the seat-belt users and non-users found in their study, might be explained in terms of the type of thrill-seeking activities that they measured. The thrill-seeking activities measured by the authors consisted of such activities as sky diving, bungee jumping, and white-water rafting, which are all legal and socially acceptable past times. Begg and Langley therefore suggested that it was the illegality and possible consequences of the risky driving practices which differentiated the seat-belt users from the non-users, rather than the desire for risk-taking or thrill-seeking, in their study.

Evans and Wasielewski (1983; in Beirness, 1993) reported one example of risk-taking by observing that those drivers who leave smaller headways between themselves and the car in front are less likely to wear seat-belts. Wilson (1990) and Wilson and Jonah (1985; both in Beirness, 1993) both found that drink drivers are also less likely to wear seat-belts, with this also being a possible example of risk-taking behaviour. Preusser *et al* (1991) and Jonah (1990; both in Begg & Langley, 2000) corroborated this in their observations that those who do not use seat-belts tend to engage in other risky driving behaviours, such as speeding and alcohol-impaired driving, and are also more likely to have previous traffic convictions. Begg and Langley (2000) additionally evidenced that the males who did not use a rear seat-belt were nearly twice as likely to drive after drinking as the rear seat-belt users. Furthermore, Porter and England (2000) investigated seat-belt use as a potential predictor of red-light running behaviour (another example of a risk-taking behaviour) and found that unbuckled drivers were 1.32 times as likely as buckled drivers to run red-lights. This finding was supported by Deutsch, Sameth, and Akinyemi (1980; in Porter & England, 2000), who confirmed that red-light runners were less likely to wear seat-belts. Retting and Williams (1996; also in Porter & England, 2000) also observed driver behaviour at intersections, subsequently suggesting that unbuckled drivers were more likely to run red-lights.

## **7.6 PERSONALITY AND SOCIAL DEVIANCE**

The review has already discussed driving violations, alcohol and drug usage, seat-belt use and the associations of each of these factors with various traits of personality. Such factors can all be viewed as socially deviant behaviours if one tends to drink and drive, commit violations, speed and / or drive without wearing a seat-belt.

In terms of looking more specifically at personality and social deviance, the literature has repeatedly found problem drivers to be emotionally unstable and / or maladjusted (e.g. Mayer & Treat, 1977; Selzer *et al*, 1977; Harano, 1974; McGuire, 1972; Schmidt *et al*, 1972; Shaw, 1965; Tillman & Hobbs, 1949; all in Beirness, 1993). Beirness (1993) commented that these studies portray high-risk drivers as social deviants, who are emotionally labile, irritable, oversensitive to criticism, and may also be experiencing personal problems.

Suchman (1970; in Beirness, 1993) identified that students who had suffered accidental injuries were also more likely to find it thrilling to ride in a fast car, to report that having fun was more important than worrying about the future, and to get a kick out of taking chances, even if it meant getting hurt. The author interpreted these findings, within the young sample, as being evidence of “deviance” which may predispose them to risks, such as an increased risk of crash involvement when driving.

## **7.7 PERSONALITY AND GENDER**

The literature consistently demonstrates that males are more likely to exhibit the risk-taking factors of personality (e.g. Jonah, 1997; Meadows & Stradling, 1996b; NHTSA, 1995; Meadows, 1994; Furnham & Saïpe, 1993; Evans, 1991; Tsuang *et al*, 1985; Zuckerman, 1979). Again, the majority of research considers the effects of personality using Zuckerman’s Sensation Seeking Scale (SSS). For a description of this scale, see the ‘Age and Personality Factors’ section of this review.

Zuckerman (1979; in NHTSA, 1995) observed that young males who are likely to engage in risky driving (including drink driving) are often characterised by high scores on the Thrill and Adventure Seeking (TAS), Disinhibition (Dis) and Boredom Susceptibility (BS) subscales of the SSS. Furthermore, Meadows and Stradling (1996b), Meadows (1994), and Evans (1991; all in Meadows *et al*, 1998), all found evidence suggesting that young and male drivers were more likely to behave in a risk-taking and thrill-seeking manner than other types of drivers.



Furnham and Saipe (1993) conducted a study investigating the personality correlates of convicted drivers and found that males with more convictions and higher scores on Eysenck's Psychoticism dimension and Zuckerman's TAS and BS scales also scored highly on the risk-taking factor in the Driver Behaviour Questionnaire utilised. Overall, findings showed that males tended to score more highly on Psychoticism, TAS, and BS, but lower on Neuroticism and they also had more convictions than females. These observations were corroborated by Parker *et al*'s (2001) study which not only reported that female drivers scored more highly on the Neuroticism scale than did males, but that the males in the study again tended to score higher on the Psychoticism scale. In addition, however, Parker *et al* (2001) also noted that the females scored more highly on the Extraversion and Lie scales than did the male drivers.

Craske (1968; in Beirness, 1993) conducted a study of clinic patients with minor trauma, finding an association between Extraversion and crash rates, which was again apparent for males, but not for females. Jonah (1997), in his literature review, also observed Sensation Seeking (SS) to be higher in males than in females. The vast majority of the 40 studies Jonah reviewed showed positive relationships between SS and risky driving, and these relationships were particularly apparent for males. Additionally, Jonah's review also found that the relationship between SS and drinking and driving was generally stronger among men than women.

Tsuang *et al* (1985; in NHTSA, 1995) also conducted an extensive review of the literature, finding that those who were involved in crashes displayed a tendency towards risk-taking, and that this relationship was stronger for males rather than females. Similarly, Storie's (1977; in Elander *et al*, 1993) study also reported that males were more likely to be involved in crashes caused by unwarranted risk-taking.

## **7.8 PERSONALITY AND RISK PERCEPTION**

Several of the studies investigated, in Jonah's (1997) literature review, noted that those participants scoring high on Sensation Seeking (SS) showed a tendency to perceive less risk, in various driving situations, and that perceived risk and risky driving are negatively correlated (Horvath & Zuckerman, 1993; Yu & Williford, 1993; Heino *et al*, 1992; Arnett, 1990b; all in Jonah, 1997). Those scoring high on SS or risky driving therefore tended to have low risk perception. Jonah (1997) argued that these findings suggest that risk perception may mediate the relationship between SS and risky driving. The author then went on to propose that high Sensation Seekers may perceive themselves to have superior driving skills, and therefore feel able to speed, follow closely, or drink and drive safely. Additionally, Jonah also proposed an alternative explanation whereby high SSs initially partake in risky driving to experience the thrill of it, and then lower their perceived risk of the situation when the risky driving does not result in negative consequences - therefore engaging in the behaviour more frequently.

Alm and Lindberg (2000) also investigated perceived risk and personality characteristics, however they employed very different personality characteristics in their study, meaning the results are not comparable to the SS findings observed in the above studies reviewed by Jonah (1997). The personality characteristics measured consisted of ratings for 'safety awareness', 'personal control over events', 'ability to take care of oneself', 'nervousness', 'ability to handle new situations', 'shyness', 'self-confidence', 'insecurity' and 'general feeling of safety' (Alm & Lindberg, 1999; Spielberger, 1983; both in Alm & Lindberg, 2000). Overall, Alm and Lindberg (2000) found that the relationship between these different personality characteristics and the ratings of perceived risk were generally quite weak. However, Hendrickx *et al*, (1992; in Alm & Lindberg, 2000) found that participants who had an internal locus of control (the belief that the participant can control certain events her / himself) reported a lower degree of perceived risk than those with an external locus of control (belief that the control is positioned outside the individual).

## 7.9 PERSONALITY AND DRIVING CONFIDENCE

One study, which investigated the effects of driving confidence with personality dimensions, was conducted by Parker *et al* (2001), and considered confidence through a self-report measure of the levels of nervousness when driving. The authors employed Eysenck's Personality Questionnaire (EPQ) and found that driving confidence was associated with a low score on the Neuroticism scale and a high score on the Extraversion scale. More specifically, relatively stable individuals (i.e. those scoring low on the Neuroticism scale) and those individuals who were relatively extraverted tended to be less nervous drivers. Furthermore, the study also included a measure of self-rated ability and found that when both Extraversion and driving confidence were considered together in relation to self-rated ability, the relationship between confidence and ability was only partially mediated. The authors therefore concluded that there was a relationship between confidence and self-rated driving ability, which was independent of the level of Extraversion. In addition, the level of Neuroticism had no impact on the association between confidence and ability. Therefore, personality was not found to mediate the relationship between driving confidence and self-rated driving ability in this study. In addition, Beirness *et al* (1993; in Norris *et al*, 2000) also investigated self-confidence as a factor of personality, and subsequently found that the crash group displayed a lower degree of self-confidence than the no-crash group, in each year that the study was carried out.

## 7.10 PERSONALITY AND FATIGUE

The research between these two factors is quite sparse and only one paper, which covered the associations between personality and fatigue, was identified. Verwey and Zaidel (2000) conducted a study investigating drowsiness accidents from personal attributes, eye blinks, and ongoing driving behaviour. Researchers tend to use several labels (e.g. drowsiness, sleepiness, fatigue and inattentiveness) to refer to the cause of performance deterioration when driving for extended periods of time. Verwey and Zaidel (2000) recognised this and decided to stick to using the term 'drowsiness' to refer to, "the psychological and physiological state that leads to a deterioration of performance when driving for a long time, at night, in a monotonous environment" (p.124).

Wylie *et al* (1996) and Artaud *et al* (1994; both in Verwey & Zaidel, 2000) both revealed large individual differences in drivers' susceptibility to becoming drowsy, which therefore led Verwey and Zaidel to question what individual differences differentiate between these drivers. Previous research has identified various personality factors that appear to be related to vigilance performance, such as the personality dimension of Extraversion-Introversion (Koelega, 1992; Davies *et al*, 1983; Eysenck, 1967), Boredom Susceptibility / BS (Sawin & Scerbo, 1995; Thackray *et al*, 1977), 'evening versus morning types' (Moog & Hildebrandt, 1985), locus of control / LOC (Sanders *et al*, 1976; Rotter, 1966), and Sensation Seeking / SS (Zuckerman, 1971; Zuckerman *et al*, 1964; all studies in Verwey & Zaidel, 2000).

Verwey and Zaidel (2000) found that those drivers scoring high on an "Extraversion-Boredom" personality cluster were more likely to depart from the road due to falling asleep, whilst those scoring high on a "Disinhibition-Honesty" cluster were more likely to cross solid lane markings but did not seem to fall asleep. The observation that drivers scoring high on the Disinhibition-Honesty cluster had relatively few eye closures was supportive of the finding that Sensation Seekers would need little sleep (Feij *et al*, 1985; in Verwey & Zaidel, 2000). Verwey and Zaidel (2000) suggested that the lane crossing errors displayed by these disinhibited drivers were not necessarily associated with drowsiness and may reflect a tendency to explore the limits of driving stimulation. The finding that people scoring high on Extraversion experienced more road departure errors was supported by Koelega's (1992; in Verwey & Zaidel, 2000) vigilance study.

Verwey and Zaidel (2000) also included an “Optimism-Stability” component as a measure of personality, yet drivers who had a stable and optimistic attitude did not feel very sleepy and also did not differ with respect to their driving errors. Furthermore, the authors identified that people with an external locus of control (LOC) also had more road departures, and therefore suggested that LOC may also have predictive value, for vigilance performance, in the driving environment. ‘Morningness’ did not reveal any significant relationships within Verwey and Zaidel’s study.

Smith (1981; in Verwey & Zaidel, 2000) argued that it is better to have people indicate directly how susceptible they are to drowsiness and boredom, when investigating driving, yet others (e.g. Itoi *et al*, 1993; in Verwey & Zaidel, 2000) have doubted this as an acceptable measure. Verwey and Zaidel’s (2000) study contradicted Smith’s argument by finding that the participants’ own judgements, on susceptibility to drowsiness, was a poor predictor of actual performance.

### **7.11 PERSONALITY AND EXPERIENCE**

The presence of a possible relationship between personality and experience was only referred to in Furnham and Saipé’s (1993) study - which reported that those scoring high on the risk-taking factor tended to be male, young, with fewer years driving, more driving convictions, and higher scores on Psychoticism, Thrill and Adventure Seeking (TAS), and Boredom Susceptibility (BS). As the risk-taking factor has been observed to be closely associated with certain personality characteristics, particularly Sensation Seeking / SS (in Beirness, 1993), it may be proposed that fewer years driving experience are associated with higher scores on those personality characteristics most closely associated with risk-taking behaviour (refer back to previous personality sections).

### **7.12 PERSONALITY AND EDUCATION**

The NHTSA (1995) noted Zuckerman’s (1979) research findings that young males, who are likely to engage in risky driving (including drunk driving), are often characterised by poor academic performance, legal difficulties, and high scores on the Thrill and Adventure Seeking (TAS), Disinhibition (Dis), and Boredom Susceptibility (BS) subscales of the Sensation Seeking Scale (SSS).

In addition, Jonah (1997) observed that SSS scores generally tend to increase with level of education and occupational status of the individuals and that of their parents, although the relationship was not reported to be linear.

### **7.13 PERSONALITY AND PHYSIOLOGY**

Szlyk (1995) investigated the relative effects of age and compromised vision, on driving performance, and found that older drivers (aged 50 and above) and those with compromised vision had reduced risk-taking scores, as measured by a self-report questionnaire. This finding suggests an association between personality and physiology, as risk-taking has been closely linked with various measures of personality in the literature (e.g. Beirness, 1993; Furnham & Saipé, 1993; Zuckerman, 1979).

## 8. AGGRESSION

### 8.1 AGGRESSION / ANGER AND CRASH INVOLVEMENT

The majority of the literature demonstrates that aggressive drivers tend to be involved in more traffic accidents ([Matthews *et al*, 1991; in Furnham & Saipe, 1993]; [Gulian *et al*, 1989; Wilson & Jonah, 1988; Donovan & Marlatt, 1982; Selzer & Vinokur, 1974; Zelhart, 1972; Pelz & Schuman, 1968; Schuman *et al*, 1967; Selzer, 1961; Conger *et al*, 1959; all in Beirness, 1993]; [Macmillan, 1975; Parry, 1968; both in Novaco, 1989]; [Beirness *et al*, 1993; in Norris *et al*, 2000]; also Norris *et al*, 2000; Underwood *et al*, 1999; Beirness, 1993).

In 1959, Conger *et al* (in Beirness, 1993) concluded that one factor accounting for crash involvement was a reduced capacity to manage or control hostility. Tsuang *et al* (1985, in the NHTSA, 1995) also asserted that those involved in crashes generally displayed less control of hostility and anger. Zelhart (1972; in Beirness, 1993) corroborated this by observing that the greatest number of traffic accidents were reported by a subgroup characterised by aggressive and unsocialised tendencies. In addition, Pelz and Schuman (1968) and Schuman *et al* (1967; both in Beirness, 1993) found that young drivers with several accidents and violations displayed more physical aggression tendencies than those with no accidents or violations; whilst Underwood *et al* (1999; in Lajunen & Parker, 2001) also found a link between anger and subsequent near accidents.

In 'Aggression on Roadways', Novaco (1989) reported Parry's (1968) findings that high aggression was related to higher accident liability. Macmillan's (1975; in Novaco, 1989) findings that an "aggressive" attitude towards driving resulted in significant differences for motoring offences and accidents were also reported. Norris *et al* (2000) investigated the characterological risk factors for motor vehicle accidents (MVAs) and found that high hostility, in combination with poor self-esteem, was one predictor of future MVAs. The authors found that the drivers with this combination of characteristics were strikingly more likely to be in an accident than drivers who had neither characteristic.

Some of the research has utilised the Buss-Durkee Hostility Inventory, which is a scale that measures aggression and hostility as personality constructs. Selzer and Vinokur (1974; in Beirness, 1993) reported a significant relationship between scores on the Buss aggression scale and crash involvement, in samples of alcoholic and non-alcoholic drivers. In addition, Donovan and Marlatt (1982; in Beirness, 1993) found that those drivers with the greatest number of crashes and violations had elevated scores on all 5 of the Buss-Durkee scales, as well as on a scale of driving-related aggression. Wilson and Jonah (1988; in Beirness, 1993) who correlated a combination of the Buss 'Assaultiveness' and 'Verbal Hostility' scales with an index of crashes, violations, and suspensions, also supported these findings.

Furthermore, Gulian *et al* (1989; in Beirness, 1993) reported that those drivers who had been involved in minor crashes scored higher on the "Driver Aggression" component of the Driver Behaviour Inventory, when compared to drivers reporting either no crashes or moderate to serious crash involvement. The authors accounted for these differences between crash severity by proposing that, "a driver high in aggression may be sufficiently impatient to risk a low-speed collision, but not a serious crash" (in Beirness, 1993, p.134). Matthews *et al* (1991; in Furnham & Saipe, 1993) also found that minor accident involvement was associated with more aggression and tension, which was apparent when the driver was overtaking another vehicle.

In considering the research evidence, Beirness (1993) concluded that hostile and aggressive tendencies appear to influence driving behaviour in a manner that increases the likelihood of

crash involvement. However the review of the literature did identify two studies which contradicted the overall findings. Furnham and Saipé (1993) failed to find a significant correlation between their “aggression” factor and either accidents or convictions, whilst Panek *et al* (1978) did not find an association between accidents and ‘Hand Test’ aggression scores (in Novaco, 1989).

## **8.2 AGGRESSION / ANGER AND ALCOHOL USAGE**

Beirness (1993) noted that studies (e.g. Pelz & Schuman, 1973) have shown interactions between alcohol and personality measures such as hostility. Donovan and Marlatt (1982, in Novaco, 1989) investigated the personality traits of drunk drivers and found an aggressive subtype that displayed a significantly higher number of traffic accidents. In addition, Beirness (1993) noted that the literature has also investigated increased power and aggression, as a common expectancy of alcohol consumption. Beirness (1993) reported George *et al*’s (1989) findings which showed that, when alcohol was expected but not actually consumed, individuals displayed more violent tendencies than when alcohol was not expected. Furthermore, this effect was found to be strongest among those individuals who had higher levels of the hostility personality trait. Beirness (1993) therefore proposed that these findings suggest an interaction between personality and pre-existing beliefs or expectancies about the effects of alcohol, enhancing the probability of aggressive and / or violent behaviour.

Selzer (1961, in Beirness, 1993) suggested that alcoholics might drink as a means to releasing behaviour motivated by underlying hostility and aggression, and that this results in more traffic crashes and violations. In addition, McCord (1984; in Novaco, 1989) found that those convicted of ‘driving while intoxicated’ were more likely to have reported getting into fights and to be more likely to act rather than talk when angry. Farrow (1988, in the NHTSA, 1995) also reported that overall anger / hostility scores were high for the ‘driving while intoxicated’ and juvenile offender groups.

## **8.3 AGGRESSION AND EDUCATION**

Research in this area was found to be very sparse, but Norris *et al* (2000) reported a study by Mizell (1997) which observed that education was one of the factors associated with aggression. Results revealed that the majority of aggressive drivers were poorly educated.

## 9. THOROUGHNESS IN DECISION-MAKING, CRASH INVOLVEMENT, AND SPEEDING

The research consistently shows that hastily made decisions are associated with an increased risk of crash involvement ([West *et al*, 1993; Reason *et al*, 1991; West *et al*, 1991; all in Parker *et al*, 1995]; [West *et al*, 1992a, in Elander *et al*, 1993]; also Parker *et al*, 1995;). Parker *et al* (1995) underlined that one would expect that a lack of thoroughness in decision-making would contribute to accident risk, if, for example, a driver pulls out into traffic before looking carefully or considering the consequences of the conditions.

West *et al* (1992a; in Elander *et al*, 1993) reported that individuals who frequently made decisions without carefully considering the costs and benefits displayed a higher crash risk. Elander *et al* (1993) further noted that this relationship has consistently been found to be independent of age, gender, and mileage.

However, the relationship between lack of thoroughness in decision-making and an increased accident risk has also been observed to be mediated by faster driving ([Reason *et al*, 1991; West *et al*, 1991; both in Parker *et al*, 1995]; & [West *et al*, 1992a; in Elander *et al*, 1993]). West (1991; in Parker *et al*, 1995) additionally reported a relationship between faster driving and lower thoroughness in decision-making. Hasty decision-making therefore appears to be linked to both faster driving and higher crash risk (Parker *et al*, 1995). Reason *et al* (1991) and West *et al* (1991; both in Parker *et al*, 1995) also found that a tendency to commit driving violations, fast driving, and lack of thoroughness in decision-making have all been reliably associated with increased accident risk. Furthermore, West *et al* (1993; in Parker *et al*, 1995) revealed an association between lack of thoroughness and social deviance. As social deviance is itself linked with accident risk, Parker *et al* (1995) subsequently concluded that the relationship between hasty decision-making and higher crash rates is still unclear.

## 10. LOW SELF-CONTROL AND SOCIAL DEVIANCE

Hirschi and Gottfredson (1993; in Lawton *et al*, 1997) proposed low self-control as the mechanism which triggers deviance, suggesting that those people who are low on self-control tend to succumb to the benefits of deviant behaviour. Hirschi and Gottfredson further contended that the level of self-control which militates against deviant behaviour comes from a set of internalised sanctions which, it is claimed, are much stronger than social and legal sanctions, meaning that these latter factors are unnecessary in accounting for the conformity of most people. Jessor and Jessor (1977; in Meadows *et al*, 1998, & Lawton *et al*, 1997) also argued that there is an underlying motive, or propensity, which accounts for various deviant behaviours. The authors therefore proposed a theory of problem behaviour among adolescents and young adults, which included a variety of behaviours such as alcohol and drug use, criminal behaviour, and dangerous driving. The purport by Hirschi and Gottfredson (1990, 1993) was that a lack of self-control was the underlying factor proposed by Jessor and Jessor (1977). Lawton *et al* (1997) noted that one source of evidence for Hirschi and Gottfredson's lack of self-control theory is that the same demographic, social, and psychological correlates underlie a wide range of deviant acts.

Junger and Tremblay (1994; in both Meadows *et al*, 1998, & Lawton *et al*, 1997) conducted a study investigating traffic accidents in light of Hirschi and Gottfredson's above theory. Findings showed a relationship between accidents and crime in a sample of teenage boys. The likelihood of being involved in a traffic accident was 43% for the boys with the lowest score on the delinquent scale, and 67% for the most delinquent boys. The study found that social disadvantage, parental supervision, and inattentiveness were related to both delinquency and accident involvement, and were all factors they assumed to be reflective of a lack of self-control. Junger and Tremblay's study was therefore seen as proving indirect evidence that self-control accounts for the relationship between delinquency and accidents (in Meadows *et al*, 1998).

However, Lawton *et al* (1997) pointed out that, although deviant acts have been found to be related to accident involvement, the direction of causation is not specified, meaning that it is hard to apply the findings. Furthermore, Lawton *et al* (1997) also noted that there was currently only weak support for lack of self-control as the explanatory factor. Lack of self-control had not been measured directly, it was merely assumed to reflect factors such as inattentiveness in Junger and Tremblay's (1994) study. It was therefore concluded that the suggestion that lack of self-control is the underlying factor is plausible, but not directly evidenced (Lawton *et al*, 1997). The authors went on to observe that Hirschi and Gottfredson's argument has mainly been applied to more seriously deviant behaviours such as delinquency and crime; where as the majority of the behaviours included in the social deviance and violation scales, although socially undesirable, are much less serious.

Meadows *et al* (1998) reported that associations between diverse forms of deviance (extreme and mild social deviance, high preferred speed and road traffic violations) support Jessor and Jessor's (1977; in both Meadows *et al*, 1998, & Lawton *et al*, 1997) argument that there is one underlying motive or propensity accounting for a variety of deviant behaviours. Again, it is noted that Hirschi and Gottfredson's theory (1993; in Lawton *et al*, 1997) would suggest that this underlying propensity is a lack of self-control. Although this may be intuitive, Meadows *et al* (1998) also reported that whether or not a lack of self-control accounts for the association between traffic accidents and crime has yet to be evidenced and is a topic for future research.

## **11. DRIVING CONFIDENCE, DRIVING VIOLATIONS, AND CRASH INVOLVEMENT**

Parker *et al* (2001) considered driving confidence in terms of drivers' self-reported levels of nervousness, in relation to a measure of driving violations, errors, and lapses (i.e. the Driver Behaviour Questionnaire / DBQ). Results showed that scores on the violation scale and the error scale were significantly predictive of levels of nervousness, therefore indicating that those drivers committing more violations were less nervous drivers, and those committing more errors were more nervous. Such findings, regarding the association between being less nervous and committing more violations, may be suggested to be linked to Furnham and Saïpe's (1993) proposal - that violations would tend to be performed by those who show little stress when driving fast, or violating the law (refer to the 'Stress and Personality' section of this review). Returning to Parker *et al*'s (2001) study, the authors additionally reported that the best single predictor of nervousness was score on the self-reported DBQ lapse scale, in that those who reported a relatively high level of lapses also reported a relatively high level of nervousness. Overall, a higher level of driving confidence was therefore found to be associated with a high level of violations and a low level of lapses and errors.

In addition, Beirness *et al* (1993; in Norris *et al*, 2000) investigated self-confidence in relation to crash involvement, and found that the crash group displayed a lower degree of self-confidence than the no-crash group, in each year that the study was carried out.



## **12. ATTITUDES**

### **12.1 ATTITUDES, CRASH INVOLVEMENT, AND DRIVING VIOLATIONS**

The research that considers associations between attitudes, crash involvement, and / or driving violations varies according to the different ways in which attitude is measured. For example, Macmillan (1975; in Novaco, 1989) investigated 'competitive' and aggressive' driver attitudes, finding that males, across all age groups, who were categorised as 'competitive' had significantly higher convictions for motoring offences and higher numbers of accidents. Similarly, those with an 'aggressive' attitude towards driving also displayed significantly higher numbers of accidents and convictions for motoring offences. Rothengatter (2000), however, considered attitudes towards high and low-risk violations and observed that those drivers who regularly commit traffic violations, such as speeding, have a positive attitude towards committing these violations. Parker *et al* (1992; in the NHTSA, 1995) corroborated this finding by observing that younger drivers endorsed positive aspects of speeding and dangerous driving more strongly than did older drivers. It has previously been noted that younger drivers are more likely to speed than older drivers are (refer to 'Age and Speeding' section), but this study also underlines a difference, in attitudes towards speeding, between younger and older drivers. Furnham and Saipé (1993) additionally found an association between attitudes to law-breaking and convicted driving.

Parker *et al* (1992; in Elander *et al*, 1993) further reported that violators tended to have a higher than average opinion of their own skill, and were less constrained by others' opinions of them, and by the possible negative consequences of their behaviour. Stradling (2000) also investigated attitude and skill, but from a different angle, considering the effects on crash likelihood. Results showed that a driver's violations score was a much better predictor of crash involvement than their error or lapse score. The author therefore suggested that, above a certain minimum level of competence at vehicle handling and road reading, it is drivers with inappropriate attitude, rather than poor skill, who are more likely to crash. Furthermore, this was argued to apply to both active and passive crashes.

Quimby and Watts (1981; in Elander *et al*, 1993) also found that scores on a questionnaire which measured attitude towards driving behaviours and road safety were associated with crash involvement. However, Elander *et al* (1993) noted that other studies (Hakkinen, 1979, 1958; Preston & Harris, 1965) had failed to find associations between driving attitudes and crash involvement. In contrast, Schuster and Guildford (1962; in Elander *et al*, 1993) found that associations between driving attitudes and crash involvement existed, but were less strongly predictive than biographical variables.

### **12.2 ATTITUDES TOWARDS DRINK DRIVING**

Baum (2000) conducted a study that compared the attitudes and knowledge of drink driving offenders and the general community. The author noted previous studies that had dealt with the attitudes and knowledge of drink driving offenders and non-offenders, and had found significant differences, in the attitudes that existed, between the 2 groups (Holubowczyk & Lean, 1995; Macdonald & Dooley, 1993; Turrisi & Jaccard, 1992). Macdonald and Dooley's study (1993; in Baum 2000) employed a matched sample of offenders and non-offenders, and found that the 'driving while impaired' offenders were more likely to believe that: a) some people drive better after drinking, b) it takes more alcohol to be legally impaired, and c) there is an excuse for drink

driving. In addition, Turrissi and Jaccard (1992; in Baum, 2000) also investigated a sample of offenders and non-offenders, and found that the offenders were more likely to be aware of the negative consequences of drink driving, and were also less likely to consider certain alternatives to driving under the influence.

Baum's (2000) study measured three separate issues which consisted of: a) knowledge of safe drinking and blood alcohol consumption (BAC) levels, b) attitudes towards strategies for avoiding drink driving, and c) general attitudes regarding drink driving. Findings for the knowledge measure showed only small differences between the offenders and the general community, with the community sample generally having slightly higher levels of correct knowledge. Offenders were almost half as likely to provide the correct answer to the question dealing with the number of drinks someone with a provisional licence can have before they are over the limit. However, the offenders were also more than four times as likely to provide a correct answer to the question regarding the legal BAC for someone on an open licence.

In terms of the sample's willingness to undertake strategies to reduce drink driving, Baum also recorded few differences between the two groups, with both groups reporting high levels of agreement, except for the strategy of drinking low-alcohol beer. Offenders were almost half as likely as the community sample were to: a) agree that they would leave their car when they had had too much to drink, and b) keep track of their drinks and stay under the limit, if driving.

Baum (2000) suggested that the study's most important findings were in relation to the general attitudes regarding drink driving, where results revealed that the community respondents displayed a much more negative view of drink driving than did the offenders. Offenders were more likely to agree that: a) the risks of drink driving are overrated, b) they will drive after drinking, c) they would get picked up (by the police) if they drive after drinking, and d) everybody drinks and drives once in a while. In comparison to the offender sample, a higher proportion of the community sample agreed for the need for harsher legal sanctions. This therefore led the author to conclude that drink driving offenders do not hold the same views as the wider community.

The Insurance Institute for Highway Safety issued a Status Report (2000) which articulated a survey investigating the high 'driving under the influence (DUI) of alcohol' death rates among some Hispanic groups. The report stated that the Mexican Americans, who had been arrested for DUI, were more likely to say they believed they could drive safely after drinking, than were the comparison group who had actually reported a similar level and frequency of drinking. The report also found that knowledge of drinking and driving laws was generally lacking (in both Mexican American and Caucasian ethnic groups). It was noted that a previous report (1993; in the 2000 report) showed that, not only did people generally underestimate the number of drinks it takes to reach the threshold (above which it's illegal to drive), but some also overestimated the number of drinks it takes to become an unsafe driver. Mexican Americans estimated 8 to 10 drinks on average, compared to 4 to 5 drinks, as estimated by Caucasians. The report argued that this suggests a lack of practical understanding as to what 0.08 % reflects, particularly in the Mexican American group. Burns (in the 2000 Status Report) asserted that, although the Mexican Americans think a couple of beers takes them to the 0.08 BAC level, they do not think that they'll be impaired, or drunk, until they have drunk many times that number of beers. Furthermore, the report also observed that the majority of men, who had already been arrested for DUI (both Mexican American and Caucasian), said that they think it is unlikely that they will be stopped by the police if drinking. The comparison respondents had a much higher expectation of enforcement.

### **12.3 ATTITUDES AND FATIGUE**

Verwey and Zaidel (2000) conducted the only study, within this literature review, that considered possible associations between attitudes and fatigue. The authors examined the prediction of drowsiness accidents from personal attributes, eye blinks, and ongoing driving behaviour. Results showed that drivers who had a stable and optimistic attitude rated sleepiness as low, but that they were no different with respect to driving errors. Therefore, although some people rated that they would not be drowsy, they did not differ in actual driving performance.

## **13. RISK PERCEPTION**

### **13.1 RISK PERCEPTION AND ALCOHOL USAGE**

Jonah's (1997) literature review investigated Sensation Seeking (SS) and risky driving, finding that those participants scoring high on SS displayed a tendency to perceive less risk in a variety of risky driving situations (refer to 'Personality and Risk Perception' section for further details). Driving after drinking was examined as one such type of risky driving situation. Arnett (1990; in Jonah, 1997) observed that students who drove drunk were also less likely to perceive that such behaviour would result in collisions or traffic tickets. Driving after drinking was therefore associated with a lower level of risk perception. Klepp and Perry (1990; in the NHTSA interim report, 1995) further noted that those who perceived that they could safely drive after drinking were more likely to tolerate riding with an impaired driver.

### **13.2 RISK PERCEPTION AND EXPERIENCE**

The literature is sparse in its investigation of potential associations between experience and risk perception with respect to driving behaviour. Elander, West, and French (1993), however, reviewed behavioural findings of research in the area of road-traffic crash risk and concluded that distant hazard perception appears to improve with driving experience, and that this may contribute to any decreases in crash frequency with increasing experience. Ganton and Wilde (1971; in Elander *et al*, 1993) observed that driving experience was positively related to the level of 'in-automobile ratings of perceived risk'. It therefore seems that an increased level of driving experience is associated with an increased level of risk perception. This finding is corroborated by Finn *et al* (1985; in the NHTSA interim report, 1995) who reported that younger drivers perceived speeding to be less dangerous than experienced drivers did.

### **13.3 RISK PERCEPTION AND EDUCATION**

Alm and Lindberg (2000) conducted a study investigating perceived risk and feelings of safety and employed 'level of education' ("less than high school", "high school" and "university") as one of their variables. Findings showed that the participant's level of education had no significant effect on either perceived risk or feelings of safety.

### **13.4 RISK PERCEPTION AND PREVIOUS EXPERIENCE OF ACCIDENTS**

Alm and Lindberg (2000) conducted a study that investigated 'perceived risk, feelings of safety and worry associated with different travel modes'. The authors reported a study, by Hendrickx *et al* (1989), which found that those participants who had personal experience of accidents (i.e. more than five times) with different risky activities, actually reported a lower risk perception, of these activities, than did those participants who had no or little experience of such accidents.

### **13.5 RISK PERCEPTION AND CULTURAL DIFFERENCES**

Hayakawa, Fischbeck, and Fischhoff (2000) investigated 'traffic accident statistics and risk perceptions, in Japan and the United States', with a view to clarifying the different traffic risk environments in the two countries, as possible explanations for cross-national differences in risk perceptions. The authors noted that previous studies (Kleinhesselink & Rosa, 1994, 1991; Hinman *et al*, 1993; Slovic, 1992, 1987; Fischhoff *et al*, 1978) had found both similarities and differences in risk perceptions between the two countries, reflecting different risk cultures. The

similarities were that the cognitive representations of risk in the two countries had the same two underlying dimensions often called 'dread' and 'unknown risk'. Overall, findings generally showed that automobile accidents were significantly more dreaded in Japan than in the US (in Hayakawa, Fischbeck, & Fischhoff, 2000). Another study conducted by Hayakawa *et al* (2000) investigated automobile risk perceptions and insurance-purchasing decisions in Japan and the United States, and found that, unlike American drivers, the Japanese tended to overestimate the risk of accidents and see themselves as more likely to be at fault than not. Furthermore, whereas the American subjects tended estimate greater monetary losses for both collision and liability accidents, the Japanese tended to focus on injury and death.

Hayakawa *et al*'s (2000) consideration of accident statistics showed that nearly 60% of Japanese traffic-accident deaths were among non-car users, compared to 20% in the US (ITARDA, 1997; in Hayakawa *et al*, 2000). Such accident statistics are reflective of the differences in risk environments, in that there is a poor separation between cars and other traffic users in Japan (Koshi, 1988; in Hayakawa *et al*, 2000). Conversely, the driving environment is very different in the US where car users' death rates are always higher than non-car users' for all age groups. This is reflective of the American driver's greater reliance on motor vehicles and also their greater separation from other traffic users (Koshi, 1988; in Hayakawa *et al*, 2000).

Hayakawa *et al* (2000) argued that the differences observed in the two countries' traffic environments, can explain some of the cross-national differences in automobile risk perceptions. In the authors' other study (which was also conducted in 2000), Japanese subjects had given much higher estimates for the probability of an accident causing injuries to others, and of being at fault personally, when compared to the Americans - who tended to focus more on the economic issues. Traffic accidents in Japan also tended to be less lethal (ITARDA, 1997; NHTSA, 1997; both in Hayakawa *et al*, 2000). The authors, therefore, argued that such cross-national differences may be reflective of the higher traffic congestion in Japan, with the lower lethality (which Hayakawa *et al*, 2000, suggested may be a result of the congestion limiting the speed of the vehicles). Austin (1996; in Hayakawa *et al*, 2000) further pointed out that the Americans' greater focus on monetary losses may also be indicative of their well-known fear of lawsuits and is often their primary reason for buying automobile insurance (Hayakawa *et al*, 2000).

Hayakawa *et al* (2000) therefore surmised that the nature of traffic accidents in Japan, where accidents tend to involve more non-car users, is more likely to induce feelings of dread than in the US - where fatal accidents tend to either kill the drivers themselves or other, equally-protected, drivers. Furthermore, studies have shown that the Japanese generally have less unrealistic optimism than Americans, for both negative and positive future life events (Heine & Lehman, 1995; Alloy & Ahrens, 1987; Svenson *et al*, 1985; Weinstein, 1980; all in Hayakawa *et al*, 2000). Subsequently, Hayakawa *et al* (2000) therefore noted that the Japanese greater 'dread' in relation to automotive risk is understandable. In addition, as previous aforementioned studies have also observed different risk cultures across Japan and the US, Hayakawa *et al* (2000) proposed that, "objective differences in risk environments combine with cultural influences to produce cross-national differences in risk perceptions" (p.834).

## 14. SOCIAL DEVIANCE

### 14.1 SOCIAL DEVIANCE AND DRIVING VIOLATIONS

Parker *et al* (1992; in Parker *et al*, 1995) evidenced that those drivers who reported a greater disposition to committing driving violations tended to regard the potentially negative consequences of such violations as less important. These drivers also showed that they perceived less social disapproval for the commission of violations, and tended to feel that such behaviour was less under voluntary control. Furthermore, Rothengatter (2000) found that traffic violations were significantly related to antisocial behaviour and subsequently suggested that the driver's willingness to commit traffic violations, and thus crash involvement, may be indicative of a general disregard for the law. McCord (1984; in Novaco, 1989) supported these findings by observing that those drivers convicted for 'driving while intoxicated' (DWI) were more likely to have reported getting into fights and be more likely to act rather than talk when angry. These DWI convicted drivers were also more likely to have been convicted for serious crimes against property and against persons. Such measures of behaviour were argued to represent a history of antisocial behaviour, therefore providing another association between antisocial behaviour and driving violations. In addition, Furnham and Saipé (1993) noted that 'attitudes to law-breaking' was one factor that was closely associated with convicted driving. All these studies have considered various forms of behaviour, representing examples of social deviance, which have shown associations with driving violations. Macmillan (1975; in Novaco, 1989) also corroborated this in a study which found a relationship between social deviance and motoring offence convictions.

Two studies that particularly investigated the role of social deviance and violations, in predicting traffic accidents, were conducted by Meadows *et al* (1998) and Lawton *et al* (1997). The relationship between these three factors will be further discussed in the 'Social Deviance, Crash Involvement, and Driving Violations' section of this review, the immediate interest in this section, however, is on the relationship between social deviance and violations. Lawton *et al* (1997) found a strong relationship between social deviance and violation scores, also evidencing that respondents with higher social deviance scores were especially likely to score highly on violations. These findings were supported by Meadows *et al's* (1998) study, which observed that extreme social deviance was a strong predictor of violation score. The authors further noted that offenders under remand for driving-related offences tended to have relatively high scores on the violation and extreme social deviance factors. Meadows *et al* (1998) additionally found that the effect of extreme social deviance on accident involvement was partly mediated by violations, leading the authors to suggest that violating behaviour is one way in which social deviance is expressed whilst driving.

Meadows *et al* (1998) did note that the observation that violations affected accident involvement, independently of the effects of social deviance, might lead to the suggestion that drivers may not consider the violation of traffic laws to be deviant behaviour. However, they further argued that, the association between scores on the violation factor and scores on the extreme and mild social deviance factors militates against this possibility.

## 14.2 SOCIAL DEVIANCE AND CRASH INVOLVEMENT

Tilman and Hobbs (1949; in Lawton *et al*, 1997) conducted a study which investigated crash involvement and a form of social deviance. Findings showed that those drivers who had been involved in four or more crashes were approximately seven times more likely to have had contact with one or more social agencies (which included adult and juvenile courts, social services, credit bureaux and public health). Junger and Tremblay (1994; in Meadows *et al*, 1998; & Lawton *et al*, 1997) identified a relationship between accidents and crime. The authors reported that the likelihood of being involved in a road traffic accident was 43% for the boys with the lowest score on the delinquency scale measure, and 67% for the most delinquent boys.

Novaco (1989) reviewed literature investigating accident liability and found that accident repeaters had antisocial tendencies. Furthermore, Suchman (1970; in Beirness, 1993) employed a self-report questionnaire and personal interview to measure traffic crashes and social deviance. Results showed that those students who has suffered accidental injuries were also more likely to: a) find it thrilling to ride in a fast car, b) report that having fun was more important than worrying about the future, and c) get a kick out of taking chances, even if it meant getting hurt. Suchman interpreted these findings as evidence of social deviance, which therefore adds further support to the observed relationship between social deviance and traffic accidents.

Elander, West and French (1993) reviewed behavioural correlates of individual differences in crash risk and found that relationships between antisocial motivation and crash involvement were remarkably consistent (e.g. West, Elander, & French, 1992b; McGuire, 1976; Haviland & Wiseman, 1974; all in Elander *et al*, 1993). The authors reported that Haviland and Wiseman (1974) had observed that jailed criminals were 5.5 times more likely to have been involved in damage or injury crashes, and 19.5 times more likely to have been in crashes that involved a fatality, when compared to the general population. McGuire (1976; in Elander *et al*, 1993) additionally noted that being antisocial was one factor associated with involvement in highway crashes. West *et al* (1992b; in Elander *et al*, 1993) further supported the importance of antisocial motivation by finding an association between a mild social deviance scale and crash rates. Meadows *et al* (1998) referred to the studies reviewed by Elander *et al* (1993) and noted that, although many of these early studies were methodologically flawed, their results consistently suggested that there was a positive association between accident involvement and deviance. In addition, Lawton *et al* (1997) also evidenced that social deviance was a significant predictor of accident rate in their study.

## 14.3 DRIVING VIOLATIONS AND CRASH INVOLVEMENT

Both Lawton *et al* (1997) and Meadows *et al* (1998) proposed that the significant relationship between social deviance and violations suggests that violating behaviour is one way in which social deviance is expressed whilst driving. However, Lawton *et al* (1997) additionally pointed out that, as those individuals who reported that they would behave in a socially deviant manner, if the threat of negative consequences were taken away, also consequently reported committing violations more frequently, this proposal does not imply that *all* violators are socially deviant. The relationship between violations and crash involvement has also been researched, with the majority of findings showing that those with a tendency to commit violations tend to be involved in more traffic accidents (e.g. Rothengatter, 2000; Lawton *et al*, 1997; Parker *et al* 1995a, 1995b). Parker *et al* (1995a, 1995b; in Meadows *et al*, 1998 & Lawton *et al*, 1997) found that violations, i.e. behaviours that involve deliberate deviations from safe driving practice, correlated with both past (Parker *et al*, 1995a) and future (Parker *et al*, 1995b) accident rates. Lawton *et al* (1997) corroborated this by reporting that violation score was a significant predictor of accident rate in their study. Rothengatter (2000) further supported this association

by noting that those drivers who regularly committed traffic violations were more involved in road crashes than were other drivers.

#### **14.4 SOCIAL DEVIANCE, CRASH INVOLVEMENT, AND DRIVING VIOLATIONS**

As previously referred to, Meadows *et al* (1998) and Lawton *et al* (1997) conducted studies investigating the role of social deviance and violations in the prediction of road traffic accidents. West *et al* (1993a; in Lawton *et al*, 1997) reported that the relationship between mild social deviance and accident rates was partly mediated by faster driving speed. This study subsequently led Lawton *et al* (1997) to investigate whether or not a broader measure of road traffic violations would fully mediate the relationship between mild social deviance and accident rates. Findings confirmed the relationship between mild social deviance and accident rates, reporting that it appeared to be mediated by the propensity to commit driving violations and unspecified factors associated with age (refer to 'Age, Social Deviance, and Driving Violations' section for further details). Lawton *et al* (1997) found that social deviance was a significant predictor of both violation score and of accident rate. Violation score was also found to be a significant predictor of accident rate. Furthermore, social deviance remained a significant predictor of accident rate, even when violations were controlled for. Overall, these results therefore indicate that violation score mediates the effect of mild social deviance to some extent, but that social deviance also has an effect independent of driving violations.

Meadows *et al* (1998) replicated and extended Lawton *et al*'s (1997) study, noting that Lawton *et al*'s study found a stronger independent relationship between violation score and accident involvement than they did between mild social deviance score and accident involvement. Meadows *et al*'s findings revealed that scores on the extreme social deviance factor and the violation factor significantly and independently predicted accident involvement. That is, those participants who scored highly on extreme social deviance, or highly on violations, were more likely to report accidents than were those participants with low scores on each of these two factors. However, the participant's scores on the mild social deviance factor failed to make a significant independent prediction of accident involvement in this study. Findings also revealed that extreme social deviance was a strong predictor of violation factor score. Similar to Lawton *et al*'s (1997) study, social deviance still remained a significant predictor, even when the effect of violation score was controlled for. Overall, results therefore indicated that violation factor score mediated the effect of extreme social deviance to some extent, but that extreme social deviance also had a direct effect on accident involvement that was independent of driving violations. Further still, when the effects of potentially confounding variables (i.e. mild social deviance, mean preferred speed, and annual mileage) were controlled for, extreme social deviance still significantly affected accident involvement, directly and indirectly, via violations.

To summarise, Meadows *et al*'s (1998) study found that both the propensity to commit driving violations and extreme social deviance predicted accident involvement. However, the relationship between extreme social deviance and accident involvement was partly mediated by a tendency to commit driving violations. Meadows *et al*'s and Lawton *et al*'s findings both reported that violations and social deviance predicted accident involvement, but in Meadows *et al*'s study, it is extreme, not mild, social deviance which predicts accident involvement.

In other research, Elander *et al*'s (1993) review of the literature similarly concluded that crash risk is consistently related to social deviance, both at the extremes and within the normal range, and that this relationship is partly mediated by faster driving or more frequent violations (e.g. West *et al*, 1992b; in Elander *et al*, 1993). Norris *et al* (2000), whose findings showed that risky behaviour (primarily in the form of non-compliance with traffic rules and speed limits) also increased the likelihood of experiencing a crash, therefore supporting the general consensus of



results in this area of the literature. Norris *et al* (2000) also noted that their results were consistent with those of Donovan *et al* (1988) and Treat (1980; both in Norris *et al*, 2000).

#### **14.5 SOCIAL DEVIANCE AND ALCOHOL AND DRUG USAGE**

The NHTSA (1995) interim report on ‘understanding youthful risk taking and driving’ reported a study by Klepp and Perry (1990) which attempted to determine the predictors of impaired driving in 10<sup>th</sup> and 11<sup>th</sup> graders. Findings showed that those students who were prone to impaired driving reported more involvement in the following: a) intentions to drink and drive, b) experiences with riding with an impaired driver, c) marijuana use, and d) problems with parents, friends, or school because of drinking. Such findings appear to point towards a relationship between social deviance and alcohol and drug usage that is also associated with impaired driving. Farrow’s study (1988; in the NHTSA, 1995) observed that ‘driving while intoxicated’ (DWI) offenders and delinquents tended to endorse assaultive behaviour and feelings of hatred towards others, which also suggests an association between alcohol use and social deviance (if one considers endorsing assaultive behaviour to be a form of social deviance).

#### **14.6 SOCIAL DEVIANCE AND AGGRESSION**

Norris *et al* (2000) reported a finding by Mizell (1997) which observed that the majority of aggressive drivers were relatively young, poorly educated males, who had criminal records, histories of violence, and alcohol problems. These latter three factors may all be viewed as forms of social deviance, therefore displaying an association between social deviance and aggressive driving.

## **15. EXPERIENCE AND PREVIOUS MOTOR VEHICLE ACCIDENTS**

Norris *et al* (2000) evidenced that prior motor vehicle accidents (MVAs) were one of the best factors found, in predicting future MVAs. In addition, the authors observed that prior MVAs appeared to predict accident severity as well as accident occurrence. However, Waller *et al* (2001) investigated changes in crash patterns over time and found that previous crash experience was not predictive of whether a future crash would be at-fault. The authors pointed out that, whether a crash is the first or the fourth, the likelihood of it being at-fault remains the same. Instead, Waller *et al* (2000) reported that it was duration of licence, rather than prior MVAs, that was related to the likelihood of crash being at-fault. Furthermore, this likelihood was observed to decrease as duration of licence increased, that is, drivers with more experience were less likely to be involved in an at-fault crash. It may be noted, therefore, that the MVAs recorded in Norris *et al's* (2000) study were taken as a whole, and not split according to at-fault crashes and not at-fault crashes, which may account for the differences in results between the two studies.

## **16. STRESS**

### **16.1 STRESS AND CRASH INVOLVEMENT**

Norris *et al* (2000) considered the characterological, situational, and behavioural risk factors for motor vehicle accidents (MVAs) and reported that they observed high job stress to be one of the best predictors of future MVAs. Cartwright *et al* (1996; in Norris *et al*, 2000) further found that ‘accident-involved’ drivers had experienced more stressful work environments than ‘accident-free’ drivers did, which adds credence to the association between stress and MVAs. Additionally, Norris *et al* (2000) reported a study, by Selzer and Vinokur (1974), that found an inverse relationship between income and MVAs. This led Norris *et al* (2000) to suggest that financial stress may also play a role and, in fact, the authors subsequently found that financial stress increased the likelihood of involvement in more serious accidents. More specifically, the study noted that a much larger percentage of Blacks (43%) had economic worries when compared to White drivers (20%); thus concluding that their greater financial stress explained the greater severity of Black drivers’ MVAs.

Dobson *et al* (1999) also included stress as a factor in their study of MVAs and corroborated the above results by finding that stress, feeling rushed, and lower life satisfaction scores were all factors associated with increased rates of accidents. The authors reported that stress was directly related to feeling rushed and inversely related to lower life satisfaction scores. In addition, Matthews *et al* (1991; in Furnham & Saipé, 1993) found that participants who had reported minor accident involvement reported the highest levels of general stress, whereas participants who had major or no accident involvement scored relatively low levels of stress. Furthermore, levels of general stress were lower in participants reporting a speeding conviction than in those reporting minor accident involvement.

### **16.2 STRESS AND DRIVING BEHAVIOUR**

Dobson *et al* (1999) investigated women drivers’ behaviour and found that riskier driving behaviour, among young women (aged 18-23 years), was associated with stress. In the mid-age group (aged 45-50 years), feeling rushed, more hours of work, and shift and night work, were all associated with poorer driving behaviour. Higher levels of stress were additionally associated with higher lapse and speed scores in the mid-age group. Time pressures (e.g. feeling rushed / pressured) were also associated with higher lapse, error, violation, and speed scores in the younger drivers.

### **16.3 STRESS AND PERSONALITY**

Furnham and Saipé (1993) reported a study by Matthews *et al* (1991) which investigated personality correlates of driver stress, using Eysenck’s EPQ dimensions of personality. Results showed that high scores on the Neuroticism scale were the strongest single predictors of stress (correlating with factors of aggression, dislike of driving, and general stress) and hence minor accident involvement. Eysenck and Eysenck (1975; in Furnham & Saipé, 1993) also suggested that high Psychoticism scores indicate low susceptibility to stress, since a high Psychoticism scorer is said to be lacking in feeling. Furnham and Saipé (1993) subsequently attributed their observed association, between convictions and higher scores on the Psychoticism scale, to this suggestion, arguing that violations would tend to be performed by those who show little stress when driving fast, or when violating the law.

In other research, Donovan *et al* (1986; in Beirness, 1993) considered depression, as a factor of personality, and its association with traffic crash involvement. The authors suggested that only transient forms of depression are related to crash involvement, and that these temporary depressive states might arise as a result of a major life stress. Consequently, Donovan *et al* (1986; in Beirness, 1993) proposed that, in such circumstances, depression might be a measure of the extent to which stressful life events are interfering with normal functioning, including driving.

Dobson *et al* (1999) also observed that stress was associated with higher thoroughness (in decision-making) scores in the younger age group (aged 18-23 years), but not in the mid-age group (aged 45-50 years).

#### **16.4 STRESS AND AGGRESSION / ANGER**

In the course of this literature review, only one source was found that was relevant to considering the relationship between stress and aggression. Matthews *et al* (1991; in Furnham & Saipe, 1993) reported that participants showed elevated aggression and tension when driving, which was noted to be reflective of McGuire's suggestion (1970; in Furnham & Saipe, 1993) that stress may play a part in accident involvement.

#### **16.5 STRESS AND FATIGUE**

The literature regarding the relationship between stress and fatigue was found to be sparse, yet Norris *et al* (2000) reported findings by Pack *et al* (1995) and Treat (1980) who noted that both 'being in a hurry' and driver fatigue have been shown to adversely influence driving behaviour. In addition, Norris *et al* (2000) suggested that transient situational factors, such as job stress, may increase risk by contributing to states (rather than traits) of fatigue, 'distractability', irritability, and self-doubt.

## 17. LIFE EVENTS / FACTORS AND DRIVING BEHAVIOUR

Some of the research in the literature has observed relationships between various life factors, or events, and certain measures of driving behaviour. Dobson *et al* (1999), in particular, included life factor measures and found that poorer driving behaviour scores, in their mid-age group, were related to lower life satisfaction scores.

In the same study, higher life event scores were associated with higher scores for violations, in the young age group. Comparatively, in the mid-age group, higher levels of life satisfaction were associated with lower lapse, violation and speed scores. Furthermore, increased life satisfaction was related to a lower risk of accidents in the mid-age group.

In terms of more specific life factors, Dobson *et al* (1999) noted that, in the younger age group, having a permanent partner was associated with lower violation and speed scores, as well as a lower risk of accidents. With respect to life events, Norris *et al* (2000) found that recent relocation was one of the best predictors of future motor vehicle accidents. In addition, Mizell (1997; in Norris *et al*, 2000) observed that the majority of aggressive drivers had recently suffered an emotional or professional setback. Another life event found to have an effect on driving was that of experiencing legal difficulties. Zuckerman (1979, in NHTSA, 1995) noted that legal difficulties was one of the factors often reported by those young males who were more likely to engage in risky driving. Furthermore, the NHTSA (1995) referenced a study by Farrow (1988), which found that the 'driving while intoxicated' (DWI) offenders and juvenile offenders experienced more negative life events than the high school students comparison group.

## **18. FATIGUE**

The relationships between fatigue and prolonged driving, and between fatigue and crash involvement, are somewhat out of the scope of this literature review, which is concerned with the fatigue-related aspects from the point of view of individual differences and the type of person who would suffer from fatigue whilst driving. As a result, these two sections have only been included out of a matter of interest and are by no means extensive reviews of those particular areas of the literature.

### **18.1 FATIGUE AND CRASH INVOLVEMENT**

McCartt *et al* (1999) reported the NTSB's (1995) research which has linked sleepiness-related driving and / or crashes to the quantity and quality of sleep (which included the duration of a driver's last sleep period, the total sleep obtained during the 24 hours preceding the crash, and fragmented sleep patterns).

### **18.2 FATIGUE AND PROLONGED DRIVING**

McCartt *et al* (1999) noted that driving is a type of task which is known to be fatiguing (Williamson *et al*, 1996; Monk & Folkard, 1979; both in McCartt *et al*, 1999). Hakkanen and Summala's (2000) study, on driver sleepiness-related problems, health status, and prolonged driving among professional heavy-vehicle drivers, evidenced that prolonged driving was associated with sleepiness-related problems while driving (e.g. difficulties in remaining alert, dozing off, or near miss situations). McCartt *et al* (1999) noted that the frequency of violating the drivers' hours of service regulations had the greatest relative effect on drowsy driving, i.e. as the frequency of these violations increased, so did the frequency of drowsy driving.

### **18.3 FATIGUE AND EXPERIENCE**

Only one study, within this literature review, considered the relationship between fatigue and experience, and this was conducted by McCartt *et al* (1999). The authors investigated the causes of sleepiness-related driving among long-distance truck drivers and found that, when controlling for age, the frequency of drowsy driving decreased as experience increased. Drivers with more experience were therefore less likely to encounter drowsy driving. For further details of this study, refer to the 'Age and Experience' section of this review.

### **18.4 FATIGUE AND ALCOHOL USAGE**

Narain (1999; in 'Causes of Road Traffic Accidents Update', 1997-2000) reported that the single greatest cause of driver fatigue is alcohol consumption. Furthermore, Green (2000) found that staying awake for 18 hours had the same effect on driving performance as a 0.05 blood alcohol concentration (BAC). In addition, those participants who had not slept in 24 hours were as impaired as drinkers with a 0.096 BAC.

### **18.5 FATIGUE AND PHYSIOLOGY**

Hakkanen and Summala (2000) conducted a study that investigated driver fatigue, health, and prolonged driving. Results showed that drivers who reported their health to be no more than satisfactory had experienced more frequent difficulties in remaining alert, dozing off, and following near-miss situations while driving. In addition, a significantly larger proportion of drivers, with no more than satisfactory health, also had more than a 1 hour average sleep deficit, compared to drivers with self-perceived good or excellent health. Driver sleepiness-related

problems therefore further increased if sleep deficit occurred along with lower perceived health. Such findings were argued to be partly supported by previous studies (Fairclough and Graham, 1999; Reyner & Horne, 1998; Lipser *et al*, 1986; all in Hakkanen & Summala, 2000) which found increased subjective sleepiness and decreased driving performance after sleep deprivation. In terms of difficulties in remaining alert, the frequency of this increased by 4.44 times, if the driver's self-perceived health was no more than satisfactory health, compared to excellent health.

Hakkanen and Summala (2000) also considered the prevalence of chronic illnesses among the drivers, and found that drivers with an illness also reported more difficulties in remaining alert, and dozing off, while driving. Of the drivers with an illness, 23 had more than a 1-hour average sleep deficit compared to 17% of drivers with no illness. However, when the authors controlled for other relevant factors (e.g. age, driving time), perceived health status better explained sleepiness-related problems while driving, whilst the chronic illness effect was no more significant (the authors suggested that this may be partly as a result of the heterogeneous nature of illnesses in the study). Overall, however, Hakkanen and Summala (2000) concluded that their results appeared to indicate that sleepiness-related problems, whilst driving, seemed to be associated with the interactive effect of prolonged driving, sleep deficit, and subjective health status.

In other research, Green (2000) reported that the use of 'seemingly benign medications' is one of the leading contributors to sleep-related crashes – noting such drugs as minor tranquilizers, drugs that treat depression and other psychological conditions, and analgesics, as all being drugs which can cause drowsiness. Green (2000) also noted that antihistamines frequently impair driving.

Dureman and Boden (1972; in Elander *et al*, 1993) studied the effects of fatigue on simulated automobile driving performance and found effects on psychomotor skills. In addition, Brown (1967; also in Elander *et al*, 1993) evidenced perceptual decrements after 7 hours of driving. Elander *et al* (1993) subsequently reported that different types of drivers might be more or less likely to continue to drive while tired, which is a factor worth taking into consideration.

## 19. PHYSIOLOGY

### 19.1 PHYSIOLOGY AND CRASH INVOLVEMENT

Szlyk (1995) investigated the relative effects of age and compromised vision on driving performance and found that compromised vision and visual field loss predicted real-world accidents in their study population. The behavioural compensation, made by older drivers, for their visuocognitive / motor deficits, was referred to in the 'Age and Physiology' section of this review. It is worth reiterating Szlyk's point, however, that compromised vision (specifically visual field loss) is not as easily compensated for as some of the age-related losses of driving skills, given that compromised vision predicts accident involvement. Gale (1999; in 'Causes of Road Traffic Accidents Update', 1997-2000) also reported that reduced visual acuity appears to be more important than age as a factor influencing driving restriction and ultimately accident involvement.

The NHTSA (2000) investigated medical conditions and crash risk, considering restrictions on licences, and found that, overall, drivers who were licensed with medical conditions had higher risks of crashes, violations, and at-fault crashes than comparison drivers did. Comparisons were made between medical condition categories, with findings showing that all drivers in the 'vision' and also the 'alcohol and other drugs' categories consistently displayed higher risks for crashes and at-fault crashes. Furthermore, the article identified priority categories for re-evaluating the level of licence restriction, due to the high crash risk factors observed, these categories were: learning, memory, and other communication disorders; psychiatric and other emotional conditions; alcohol and other drugs; and musculoskeletal abnormalities.

The majority of associations between driving after drinking and the various individual differences are covered across the other sections of this review. However, Dobson *et al*'s (1999) measure of alcohol consumption related to 'habitual' intake, rather than to driving-related alcohol intake, and thus will be discussed separately in this section. Findings showed that habitual alcohol consumption was associated with riskier driving, and poorer driving behaviour scores. More specifically, higher lapse, violation, and speed scores were associated with higher levels of alcohol consumption. A higher risk level of habitual alcohol consumption was also associated with an increased accident risk, within the younger age group in the study.

In other research, Hakkanen and Summala (reported in Hakkanen & Summala, 2000) analysed trailer-truck drivers' fatal crashes, and evidenced that the probability of being at-fault for the accident was 3.5 times higher if the driver had a chronic illness.

### 19.2 PHYSIOLOGY AND EXPERIENCE

The research in this area was also sparse, but Elander *et al* (1993) reported a useful study by Mourant and Rockwell (1972) who found differences in visual fixation and scanning patterns, between novice and experienced drivers. Results showed that novice drivers tended to search the road close in front of the vehicle. Elander *et al* (1993) subsequently suggested that poorer perceptual processing, in the driving situation, might be partly a function of lack of experience at detecting objects in the traffic environment and predicting their likely behaviour.



## **20. ETHNICITY**

### **20.1 ETHNICITY AND CRASH INVOLVEMENT**

The NHTSA (1995) noted that there is little literature published regarding the relationship between ethnicity / race and crash involvement rates. Norris *et al* (2000), however, investigated such associations and found that Black American respondents were no more likely than White American respondents were to have accidents, but that when they did, these accidents tended to be more severe. Baker *et al* (1992; in NHTSA, 1995) reported that Native Americans had the highest crash fatality rate when compared to other ethnic and racial groups. However, the authors pointed out that this could be as a result of the fact that Native Americans often live on reservations, only accessible by rural roads, which may tend to be more dangerous than other types of road.

Further to these findings, Dobson *et al* (1999) examined factors that affected driving behaviour and accident rates in women in Australia. Findings revealed that, those women born in non-English speaking countries showed a significantly higher risk of accidents, when compared with those women born in Australia. The authors observed a higher risk of accidents for those women drivers who were born overseas.

### **20.2 ETHNICITY AND DRIVING VIOLATIONS**

Research pertaining to associations between ethnicity and driving violations is also very scarce, although two relevant sources were observed during this literature review. Porter and England (2000) investigated the prediction of red-light running behaviour, in the U.S., and found that ethnicity was one of the important factors in predicting such violating behaviour. Results revealed that Non-Caucasians ran red-lights with greater frequency than Caucasians. More specifically, Non-Caucasians were 1.19 times as likely as Caucasians to run red-lights.

Whereas, in the above section, Dobson *et al* (1999) found that women born in non-English countries had a significantly higher risk of accidents when compared to women born in Australia, the results were different in the case of driving violations. Findings showed that those women, who were born in non-English speaking countries, did not report higher levels of violations, speeding, lapses, or errors.

### **20.3 ETHNICITY AND ALCOHOL USAGE**

Ethnicity has often been found to be associated with driving after drinking (e.g. Padilla & Morrissey, 1993; Howard *et al*, 1989; May, 1989; Caetano, 1984), as noted by Caetano and Clark (2000). Studies by Lapham *et al* (1998), Ross *et al* (1991), and Perrine *et al* (1989; all in Caetano & Clark, 2000) have all observed Hispanics, in the U.S., to be over-represented among drunk drivers in roadside surveys, fatal crashes, and arrests for driving under the influence (DUI). Perrine & Arce-Quinones (1994; in Caetano & Clark, 2000) also noted that those Hispanics arrested for DUI seem to be different from their white counterparts, being younger and having a history of multiple offences. In addition, Padilla and Morrissey (1993; in Caetano & Clark, 2000) found that Hispanics were more likely to report that they drank their last drink, prior to DUI arrest, at home or at a friend's house; whereas Whites were more likely to report that a bar was the last place they drank.

Conversely, the 1984 U.S. National Alcohol Survey (in Caetano & Clark, 2000) reported that the rates of DUI arrest, within the year prior to the survey, were *not* statistically different between the Whites and Hispanics, within gender groups (i.e. 1% for White men, 2% for Hispanic men; 0.1% for White women, 0.2% for Hispanic women). Furthermore, the survey noted that a greater proportion of Whites than Hispanics actually reported that they would have been in trouble, driving under the influence, if stopped by the police (i.e. 21% of White, 12% of Hispanic men; 7% of White women, 2% of Hispanic women). Taken together, these findings present a somewhat mixed picture with regards to DUI among US Hispanics, yet Caetano and Clark (2000) suggested that comparisons across studies might be difficult, due to varying 'operational definitions and assessments of ethnicity'. More specifically, in some studies, participants themselves directly indicated their ethnicity, whereas in others, researchers may have made an educated guess about an individual's ethnic membership. Furthermore Caetano and Clark (2000) noted that there are 3 main Hispanic subgroups in the US (i.e. Mexicans and Mexican Americans, Cubans and Cuban Americans, and Puerto Ricans), who may demonstrate different patterns of alcohol consumption, car ownership, and driving.

Caetano and Clark (2000) also conducted a study that investigated the associations between 'driving under the influence (DUI) of alcohol' and different ethnic groups. The authors measured self-reported alcohol-impaired driving among Hispanics (as a whole group), Blacks, and Whites, in the U.S.. Findings showed that, self-reported rates of driving a car after having drunk enough 'to be in trouble if stopped by the police' were highest among White and Hispanic men (22% and 21% respectively), as were lifetime arrest rates for driving under the influence of alcohol (13% for White men, 19% for Hispanic men). Rates of ever having been arrested for DUI were therefore highest among Hispanic men. Furthermore, Caetano and Clark (2000) also found that US-born Hispanics were approximately three times more likely than Hispanics born abroad (the study was conducted in the US) to engage in drinking and driving. However, the authors pointed out that this could be as a result of US-born Hispanics having a higher rate of automobile ownership, and driving more miles in a given time frame, than those Hispanics who are born abroad.

The Insurance Institute for Highway Safety Status Report (2000) surveyed Mexican American and Caucasian men who were arrested for DUI in California. Roadside surveys revealed that the percentage of Hispanic drivers with blood alcohol concentrations (BACs) exceeding 0.10% were twice as high in 1996 as in 1973. However, at the same time, these rates declined among both Caucasian and African American drivers (Status Report, 1997; from 2000 Status Report). Furthermore, the survey observed that Hispanics displayed higher rates of DUI arrests and fatal crashes involving drivers with high BACs. The rates varied, however, across the different Hispanic groups, in that alcohol-related deaths were found to be more prevalent among Mexican Americans than they were among Caucasians, but this was not the case for the Cuban and Puerto Rican Americans. In addition, the survey also found that Mexican Americans reported heavier and more frequent drinking compared with Caucasians - a finding that the report also noted was consistent with other research.

Another study that considered the association between ethnicity and alcohol usage, when driving, was conducted by Abdel-Aty and Abdelwahab (2000) in the U.S.. Results showed that Whites tended to have higher accident proportions with DUI, followed by Hispanics (taken as a whole group in this study), whilst Blacks and the 'Other' races were found to have the least percentage of accidents while DUI. Additionally, young white drivers (<45 years old) had higher alcohol-related accident involvement, while the other races (non-white) displayed higher rates for ages 45 and above. In contrast, Popkin and Council (1991; in NHTSA, 1995) found that alcohol-related crash rates were lower for White Americans than for a group of predominantly black non-white Americans, in most age groups studied - although the younger drivers (aged 16-24) were an exception to this, which therefore partly supports Abdel-Aty and

Abdelwahab's (2000) findings. In other research, the NHTSA (1995) reported a study, by Baker *et al* (1992), which observed that Native Americans had the highest crash fatality rate, compared to the other ethnic and racial groups in their study. The NHTSA (1995) further reported that this rate, amongst Native Americans, had also often been attributed to alcohol.

## 21. REFERENCES

- Abdel-Aty, M., Chen, C., Radwan, E. & Brady, P. (1999). Analysis of Crash-Involvement Trends by Drivers' Age in Florida, ITE Journal on the web (February).
- Abdel-Aty, M. A. & Abdelwahab, H. T. (2000). Exploring the Relationship Between Alcohol and the Driver Characteristics in Motor Vehicle Accidents. *Accident Analysis & Prevention*. 32, 505 - 515.
- Abdul-Aty, M. A., & As-Saidi, A.H. (2000). Using GIS to locate the High-Risk Driver Population. *Traffic Safety on 2 continents*. 111 - 126.
- Alexander, E. A., Kallail, K. J., Burdsal, J. P., & Ege, D. L. (1990). Multifactorial causes of adolescent driver accidents: investigation of time as a major variable. *Journal of Adolescent Health Care* 11, 413-417.
- Alm, C., & Lindberg, E. (2000) Perceived Risk, Feelings of Safety and Worry Associated with Different Travel Modes. Pilot Study. *KFTS Meddelande*. 7, 1 - 34.
- Anderson, Simon & Ingram, Dave. (2001). Drinking and Driving: prevalence, decision-making and attitudes. NFO System Three Social Research. Development Department Research Programme: Research Findings No. 128. Scottish Executive Central Research Unit.
- Attewell, R. (1998). Women behind the wheel: A statistical overview of road crash involvement. Federal Office of Road Safety, Canberra, Australia.
- Baum, Scott. (2000). Drink Driving as a Social Problem: Comparing the Attitudes and Knowledge of Drink Driving Offenders and the General Community. *Accident Analysis & Prevention*. 34, 689 - 694.
- Begg, D. J. & Langley, J. D. (2000). Seat-belt Use and Relative Behaviours Among Young Adults. *Journal of Safety Research*, Volume 31, Number 4, 211 - 220.
- Beirness, Douglas J. (1993). Do We Really Drive As We Live? The Role of Personality Factors in Road Crashes. *Alcohol, Drugs and Driving*. Volume 9, Numbers 3 - 4, 129-143.
- Beirness, D. J. & Simpson, H. M. (1997). Study of the profile of high-risk drivers. Ottawa, Canada: Transport Canada & Traffic Injury Research Foundation.
- Bragg, B. W. E., & Finn, P. (1982). Younger driver risk taking: Technical report of experimental study (Rep. No. HS-806-375). Washington, DC: US Department of Transportation, NHTSA.
- Braver, E. R., Preusser, C. W., Preusser, D. F., Baum, H. M., Beilock, R., & Ulmer, R. (1992). Long hours and fatigue: a study of tractor-trailer drivers. *Journal of public Health Policy* 13, 3, 341-366.
- Brorsson, B., Rydgren, H., & Ifver, J. (1993). Single-vehicle accidents in Sweden: A comparative study of risk and risk factors by age. *Journal of Safety Research*, 24, 55-65.
- Brown, I. D. & Groeger, J. A. (1988). Risk Perception and decision taking during the transition between novice and experienced driver status. *Ergonomics*, 31: 585-597.

Burgess, M. & Lindsey, T. (1997). Alcohol Involvement in Fatal Traffic Accidents 1995. Technical Report DOT HS 808-547. NHTSA, US Department of Transportation, Washington DC.

Caetano, R., & Clark, C. L. (2000). Hispanics, Blacks and Whites Driving Under the Influence of Alcohol: Results from the 1995 National Alcohol Survey. *Accident Analysis & Prevention*, 32, 57 - 64.

Causes of Road Traffic Accidents Update. (1997 - 2000). November 2000. A selection of abstracts on specific subjects from TRL Library's Database of Worldwide Published Information. *Current topics in Transport*. Number 1, 7 - 17.

Chen, C. (1997). Statistical Analysis of the Effect of Demographic and Roadway Factors on Traffic Accident Involvement. MS thesis. Department of Civil & Environmental Engineering, University of Central Florida, Orlando, FL.

Chipman, M. L., MacGregor, C. G., Smiley, A. M., & Lee-Gosselin, M. (1992). Time Vs Distance as Measures of Exposure in Driving Surveys. *Accident Analysis & Prevention*. Volume 24, Number 6, 679 - 684.

DeJoy, D. M. (1992). An examination of gender differences in traffic accident risk perception. *Accident Analysis & Prevention*, 24, No. 3, 237-246.

Dekker, D. K., Kotwal, B. M., & Lerner, N. D. (1994). Understanding driver performance variability and perception of risk. Technical Report for Federal Highway Administration.

Dobson, A., Brown, W., Ball, J., Powers, J., & McFadden, M. (1999). Women Drivers' Behaviour, Socio-demographic Characteristics and Accidents. *Accident Analysis & Prevention*, 31, 525 - 535.

Drottz-Sjoberg, B. M. & Sjoberg, L. (1990a). Trains and Transports: Perceived and real risks. Stockholm: Centrum for Riskforskning, Handelshogskolan. (Manuscript).

Drottz-Sjoberg, B. M. & Sjoberg, L. (1990b). Risk Perception and Worries After the Chernobyl Accident. *Journal of Environmental Psychology*, 10, 135-149.

Elander, J., West, R., & French, D. (1993). Behavioural Correlates: Individual Differences in Road-Traffic Crash Risk: An Examination of Methods and Findings. *Psychological Bulletin*, Volume 113, Number 2, 279 - 294.

Evans, L. & Wasielewski, P. (1983). Risky driving related to driver and vehicle characteristics. *Accident Analysis & Prevention* 15, 121-136.

Evans, L. (1991). *Traffic Safety and the Driver*. New York: Van Nostrand Reinhold.

Farrow, J. A. (1987a). The use of vignette analysis of dangerous driving situations involving alcohol to differentiate adolescent DWI offenders and high school drivers. *American Journal of Drug and Alcohol Abuse*, 13 (1&2), 157-174.

Farrow, J. A. (1988). Personality factors associated with driving while intoxicated: A comparison study of adolescent drivers. *Journal of Alcohol and Drug Education*, 34, No. 2, 21-32.

Finn, P. & Bragg, W. E. (1986). Perception of the risk of an accident by young and older drivers. *Accident Analysis & Prevention*, 18, No. 4, 289-298.

French, D., West, R., Elander, J., & Wilding, J. M. (1992). Decision-making style, driving style and self-reported involvement in road traffic accidents. *Ergonomics*.

- Furnham, A., & Saipie, J. (1993). Personality Correlates of Convicted Drivers. *Personality & Individual Differences*. Volume 14, Number 2, 329 - 336.
- Glendon, A. I., Dorn, Lisa, Davies, D. R., Matthews, Gerald, & Taylor, Ray G. (1996). Age and Gender Differences in Perceived Accident Likelihood and Driver Competencies. *Risk Analysis*. Volume 16, Number 6, 755-762.
- Green, S. D. (2000). Sleepy, Groggy, Angry: Drinking isn't the Only Road to Impairment. *Traffic Safety*. Number 1, 16 - 17.
- Groeger, J. A. & Brown, I. D. (1989). Assessing one's own and others' driving ability: Influences of sex, age, and experience. *Accident Analysis & Prevention*, 21, No. 2, 155-168.
- Hakkanen, H., & Summala, H. (2000). Driver Sleepiness-Related Problems, Health Status, and Prolonged Driving Among Professional Heavy-Vehicle Drivers. *Transportation Human Factors*. 2 (2). 151 - 171.
- Hayakawa, H., Fischbeck, P. S. & Fischhoff, B. (2000). Automobile risk perceptions and insurance-purchasing decisions in Japan and the United States. *Journal of Risk Research* 3, 51-67.
- Hayakawa, H., Fishbeck, P. S., & Fischhoff, B. (2000). Traffic Accident Statistics and Risk Perceptions in Japan and United States. *Accident Analysis & Prevention*. 32. 827 - 835.
- Henderson, R. & Burg, A. (1974). Vision and audition in driving (Tech. Rep. No. TM [L] – 5297/000/00). Washington, DC: Department of Transportation.
- Hills, B. L. & Burg, A. (1977). A re-analysis of California driver vision data: General findings (Rep. No. 768). Crowthorne, England: Transport and Road Research Laboratory.
- Hofstetter, H. W. (1976). Visual acuity and highway accidents. *Journal of the American Optometric Association*, 47, 887-893.
- Ingram, Dave, Lancaster, Becki, & Hope, Steve. (2001). Recreational Drugs and Driving. Prevalence Survey. System Three Social Research. Development Department Research Programme: Research Findings No. 102. Scottish Executive Central Research Unit.
- Insurance Institute for Highway Safety. (2000). New Survey Looks at High DUI, Death Rates Among Some Hispanic Groups. 2000. Status Report, Volume 35, Number 8, 5 - 6.
- Johnson, V. & Raskin White, H. (1989). An investigation of factors related to intoxicated driving behaviours among youth. *Journal of Studies on Alcohol*, 50, 320-330.
- Jonah B. (1986). Accident risk and risk-taking behaviour among young drivers. *Accident Analysis & Prevention*, 18, No. 4, 255-271.
- Jonah, B. A. (1990). Age differences in risky driving. *Health Education Research*, 5, 2, 139-149.
- Jonah, B. A. (1997). Sensation Seeking and Risky Driving: A Review and Synthesis of the Literature. *Accident Analysis & Prevention*. Volume 27, Number 5, 651 - 665.
- Lancaster, Rebecca, & Ward, Rachel. (2001). Management of Work-related Road Safety: Research Report. HSE Contract Research Report: HSE Books.
- Lajunen, T., & Parker, D. (2001). Are Aggressive People Aggressive Drivers? A Study of the Relationship between Self-reported General Aggressiveness, Driver Anger, and Aggressive Driving. *Accident Analysis & Prevention*. 33, 243 - 255.

- Lawton, R., Parker D., Stradling, S.G., & Manstead, A. (1997). Predicting Road Traffic Accidents: The Role of Social Deviance and Violations. *British Journal of Psychology*, 88, 249 - 262.
- Lerner, N., Williams, A., & Sedney, C. (1988). Risk Perception in highway driving. (Contract No. DTFH61-85-C-00143). Washington, DC. US Department of Transportation, Federal Highway Administration.
- Mason, J., Fitzpatrick, K., Seneca, D., & Davinroy, T. (1992). Identification of inappropriate driving behaviors. *J. Transport. Eng.* 118, 2.
- Matthews, M. L. & Moran, A. R. (1986). Age Differences in Male Drivers' Perception of Accident Risk: The Role of Perceived Driving Ability. *Accident Analysis & Prevention*. 18. 299-313.
- Maxim, P. S. & Keane, C. (1992). Gender, age, and risk of violent death in Canada. *Canadian Review of Sociology & Anthropology* 29, 329-345.
- Maycock, J. Lockwood, C. R. & Lester, J. F. (1991). The Accident Liability of Car Drivers (Rep. No. 315). Crowthorne, England: Transport and Road Research Laboratory.
- Mayhew, D. R., Warren, R. A., Simpson, H. M. & G. C. (1981). Young driver accidents: Magnitude and characteristics of the problem. Ottawa, Ontario, Canada: Traffic Injury Research Foundation of Canada.
- Mayhew, D. R., Donelson, A. C., Beirness, D. J. & Simpson, H. M. (1986). Youth, alcohol, and relative risk of crash involvement. *Accident Analysis & Prevention* 18, 4, 229-313.
- Mayhew, D. R. & Simpson, H. M. (1990) New to the Road: Young Drivers and Novice Drivers: Similar Problems and Solutions? Traffic Injury Research Foundation of Canada, Ottawa, Ontario.
- McCartt, A. T., Wright, B. E., Rohrbaugh, J. W., & Hammer, M.C. (1999). Causes of Sleepiness-Related Driving Among Long-Distance Truck Drivers, Including Violations of the Hours of Service Regulations. *Traffic Safety on 2 Continents*. 155 - 172.
- McCormick, I. A., Walkey, F. H., & Green, D. E. (1986). Comparative Perceptions of Driver Ability – A Confirmation and Expansion. *Accident Analysis & Prevention*, 18, 205-208.
- McGwin, G. J. R. & Brown, D. B. (1999). Characteristics of traffic crashes among young, middle-aged, and older drivers. *Accident Analysis & Prevention* 31, 3, 181-198.
- Meadows, M. L. (1994). Psychological correlates of road crash types. Unpublished PhD thesis. University of Manchester.
- Meadows, M. L. & Stradling, S. G. (1996b). Violation and thrill in predicting types of road traffic crashes. *International Conference on Traffic and Transport Psychology*, May, Valencia, Spain.
- Meadows, Michelle L., Stradling, Stephen, G., & Lawson, Susanna. (1998). The Role of Social Deviance and Violations in Predicting Road Traffic Accidents in a Sample of Young Offenders. *British Journal of Psychology*, 89, 417 - 431.
- Michiels, W. & Schneider, P. (1984). Traffic offences: another approach to description and prediction. *Accident Analysis & Prevention* 16, 223-238.
- National Highway Safety Administration (NHTSA). (1991). Alcohol and Highway Safety 1989: A Review of the state of Knowledge. US Department of Transportation, Washington, DC.

- NHTSA. (1992). Traffic Safety Facts 1992: A compilation of Motor Vehicle Crash Data from the Fatal Accident reporting System and the General Estimates System. US Department of Transportation, Washington DC.
- NHTSA. (1993c). National survey of drinking and driving attitudes and behaviour. Unpublished 1993 data. Washington DC: US Department of Transportation, NHTSA.
- NHTSA. (1995). Understanding Youthful Risk-Taking and Driving. Interim Report. COMSIS Corporation. 1 - 147.
- NHTSA. (2000). Medical Conditions and Crash Risk: Do Restrictions on Licences Have an Impact on Public Safety? Technology Transfer Series. Traffic Technology. Number 219.
- Norris, F. H., Matthews, B. A., & Riad, J. K. (2000). Characterological, Situational, and Behavioural Risk Factors for Motor Vehicle Accidents: A Prospective Examination. *Accident Analysis and Prevention*, 32, 505 - 515.
- Novaco, Raymond, W. (1989). Aggression on Roadways. Reprint No. 16. The University of California Transportation Center.
- Owsley, C., Ball, K., Sloane, M. E., Roenker, D. L. & Bruni, J. R. (1991). Visual/cognitive correlates of vehicle accidents in older drivers. *Psychology and Aging*, 6, 403-415.
- Parker, D., Manstead, A.S. R., Stradling, S. G., & Reason, J. T. (1992). Determinants of intention to commit driving violations. *Accident Analysis & Prevention*, 24, no. 2, 117-131.
- Parker, D., Reason, J. T., Manstead, A. S. R. & Stradling, S. (1995a). Driving errors, driving violations and accident involvement. *Ergonomics*, 38, 1036-1048.
- Parker, D., West, R., Stradling, S., & Manstead, A. (1995b). Behavioural Characteristics and Involvement in Different Types of Traffic Accident. *Accident Analysis & Prevention*, Volume 27, Number 4, 571 - 581.
- Parker, D., McDonald, L., Sutcliffe, P., & Rabbitt, P. (2001). Confidence Among Older Drivers. DETR. Behavioural Research in Road Safety: Tenth Seminar.
- Pelz, D. C. & Schuman, S. H. (1971). Are young drivers really more dangerous after controlling for exposure and experience? *Journal of Safety Research*, 3, 68-79.
- Pendleton, O., Hatfield, N., & Bremer, R. (1986). Alcohol Involvement in Texas Driver Fatalities: Accident Reports Versus Blood Alcohol Concentration. Transportation Research Board 1068.
- Porter, B. E., & England, K. J. (2000) Predicting Red-light Running Behaviour: A Traffic Safety Study in Three Urban Settings. *Journal of Safety Research*. Volume 31, Number 1, 1 - 8.
- Preusser, D. F., Williams, A. F. & Lund, A. K. (1991). Characteristics of belted and unbelted drivers. *Accident Analysis & Prevention*, 23, 475-482.
- Reason, J. T., Manstead, A. S. R., Stradling, S. G., Baxter, J. S. & Campbell, K. (1990). Errors and violations on the road: A real distinction? *Ergonomics*, 33, 1315-1332.
- Rothgatter, T. (2000). Attitudes Towards High and Low Risk Violations. *Traffic Safety on 2 Continents*. 103 - 105.



- Salter, D., Carthy, T., Packham, D., Rhodes, Dafty N., & Silcock D. (1993). Risk on the Roads: Perceptions of Risk and Competition. *Traffic Engineering and Control*. Volume 34, Number 5, 236 - 241.
- Shinar, D. (1977). Driver visual illuminations: Diagnosis and treatment (Contract No. DOT-HS-5-1275). Washington, DC: Department of Transportation.
- Shinar, D., Schechtman, E., & Compton, R. (2001). Self-reports of Safe Driving Behaviours in Relationship to Sex, Age, Education and Income in the US Driving Population. *Accident Analysis and Prevention*. 33, 243 - 255.
- Sivak, M., Soler, J., Trankle, U., & Spagnol, J. M. (1989). Cross-cultural differences in driver risk-perception. *Accident & Analysis Prevention*, 21, No. 4, 355-362.
- Statistisches Bundesamt Wiesbaden (Hrsg.). (1987): Strassenverkehrsunfalle 1986, Fachserie 8, Reihe 3.3. Stuttgart: Kohlhammer.
- Stewart, D. E. & Sanderson, R. W. (1984). The measurement of risk on Canada's roads and highways. In S. Yagar (Ed.), *Transport risk assessment* (pp. 1-21). Waterloo, Ontario, Canada: University of Waterloo Press.
- Storie, V. J. (1977). Male and female car drivers: Differences observed in accidents (Rep. No. 761). Crowthorne, England: Transport and Road Research Laboratory.
- Stradling, S. (2000). Drivers who Speed. *Impact* 9. Number 2, 30 - 41.
- Summala, H., (1987). Young driver accidents: risk taking or failure of skills? *Alcohol, Drugs and Driving* 3, 79-91.
- Svensson, O. (1981). Are we less risky and more skillful than our fellow drivers? *Acta Psychologica* 47, 143-148.
- Szlyk, Janet P., Seiple, W., & Viana, M. (1995) Relative Effects of Age and Compromised Vision on Driving Performance. *Human Factors*, 37 (2), 430 - 436.
- Trankle, U., Gelau, C. & Metker, T. (1988). Situationsbezogene Risikoeinschätzung junger Fahrer. Bericht FP8307/3 für die Bundesanstalt für Strassenwesen, Münster.
- Trankle, U., Gelau, C. & Metker, T. (1990). Risk Perception and Age-Specific Accidents of Young Drivers. *Accident Analysis & Prevention*. Volume 22, Number 2, 119 - 125.
- Tsuang, M. T., Boor, M., & Fleming, J. A. (1985). Psychiatric aspects of traffic accidents. *American Journal of Psychiatry*, 142, No. 5, 538-546.
- Verwey, W. B., & Zaidel, D. M. (2000). Predicting Drowsiness Accidents from Personal Attributes, Eye Blinks and Ongoing Driving Behaviour. *Personality and Individual Differences*. 28. 123 - 142.
- Waller, P. F., Elliot, M. R., Shope, J. T., Raghunathan, T. E., & Little, R. J. A. (2001). Changes in Young Adults Offence and Crash Patterns Over Time. *Accident Analysis and Prevention*. 33, 117 - 128.
- Waxweiler, R. J., Harel, Y. & O'Carroll, P. W. (1993). Measuring adolescent behaviours related to unintentional injuries. *Public Health Reports*, 108, 11-14.
- West, R. (1993). Accident script analysis: Parts 1 and 2. Report to Department of Transport: Contract No. N06100. London: Department of Transport; 1993.

Zuckerman, M. (1979). *Sensation Seeking: Beyond the optimal level of arousal*. Hillsdale, NJ: Erlbaum.



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