



Sex differences in driving and insurance risk

An analysis of the social and psychological differences between men and women that are relevant to their driving behaviour

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Executive Summary

Men and women exhibit different driving behaviours that affect their attitudes, safety and insurance risk. Many factors underpin these differences, including neurochemical structures and hormonal processes shaped by evolution, and global socialisation practices. Each plays a part in explaining why men and women drivers have very different records in relation to accidents and insurance claims.

- Differences between male and female drivers in terms of crash rates are evident in a wide range of countries, including the United States, Europe, Asia and Africa, with males being significantly more at risk than females.
- Similar differences are evident regarding male and female pedestrians and accidents in the home and workplace.
- The differences are not easily explained in terms of levels of competence and driving skill of men and women. They derive from more fundamental differences in specific areas of behaviour and psychological functioning.
- There is extensive evidence to show that men, and young men in particular, tend to be more aggressive than women (in all known cultures) and they express aggression in a direct, rather than indirect, manner. This has a very significant impact on driving – encouraging more competitive and hostile behaviour with consequent higher probabilities of crashing.
- Levels of deviant (rule-breaking) behaviour are significantly higher in men than in women. This manifests itself in a greater frequency of violation of traffic regulations, including speed limits, traffic controls, drink-driving, etc.
- Men also exhibit, on average, higher levels of sensation-seeking and risk-taking in a wide variety of settings. The basis for this well-established sex difference has a hormonal and neurochemical basis – it is not simply a product of socialisation or experience.
- The differences between the sexes in terms of their risk-proneness while driving can be explained, at least in part, using an evolutionary psychology perspective. This proposes that much of neural circuitry of the human brain evolved to meet the requirements of societies and cultures very different from our own – that of the hunter gatherer – that existed for over 99% of our evolution as a species. Our 21st century skulls contain essentially ‘stone-age’ brains, and the brains of men and women are different in certain crucial respects.
- Stone-age man did not drive. But the legacy of his hunting, aggressive and risk-taking past – qualities that enabled him to survive and mate, thereby passing on his genes to future generations – are still evident in the way in which he typically drives his car.
- A report published by the Department of Gender and Women’s Health at the World Health Organisation has called for recognition of these fundamental differences between men and women drivers and the development of gender-differentiated policies in relevant areas.

Introduction

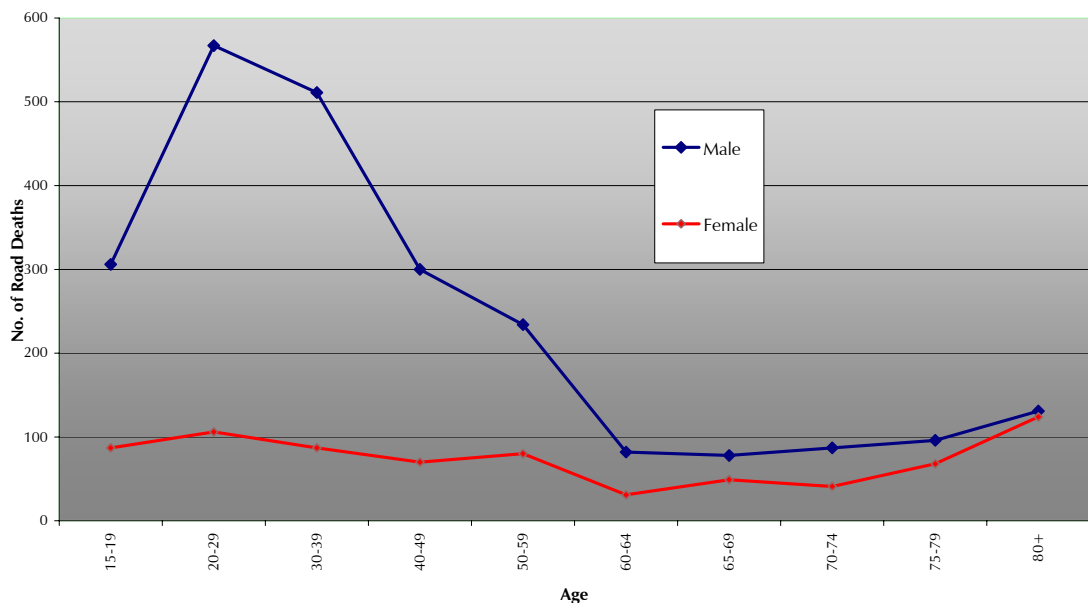
Differences between men and women in terms of their driving behaviour and accident rates have long been demonstrated in the UK, mainland Europe, the United States, Australia and in many other countries. In all studies and analyses, without exception, men have been shown to have a higher rate of crashes than women. This gender difference is most marked in the population under the age of 25 years, but is also evident among older drivers. The difference between the sexes in terms of the number of fatalities resulting from road crashes is similarly marked. (See, for example, Evans (1991), McKenna *et al* (1998), Parker *et al* (1995), Abel-Aty and As-Saidi (2000), Waller *et al* (2001), Waylen and McKenna (2002), Lancaster and Ward (2002)).

The scale of this difference between the sexes is very substantial. Chipman *et al* (1992), for example, show that men have double the number of crashes (per 1,000 drivers) than women. Waller *et al* (2001) also note that in addition to having a higher number of crashes, men incur their first crash earlier in their driving career and are more likely than women to be held to blame for the incident. Norris *et al* (2000) and others attribute this greater level of crash-proneness to higher driving speeds among men and less regard for traffic laws.

Waylen and McKenna (2002) note that the pattern of road accident involvement also differs between the sexes. Men are more likely than women to be involved in crashes that occur on bends, in the dark or those that involve overtaking. Women, on the other hand, have a greater frequency of crashes occurring at junctions than men. This supports the suggestion by Storie (1977) that men are more at risk from accidents involving high speed while women are more likely to be involved in accidents resulting from perceptual judgement errors.

The figures from the UK Department for Transport for all road deaths in 2001 are summarised in Figure 1. below.

Figure 1. Road deaths, 2001



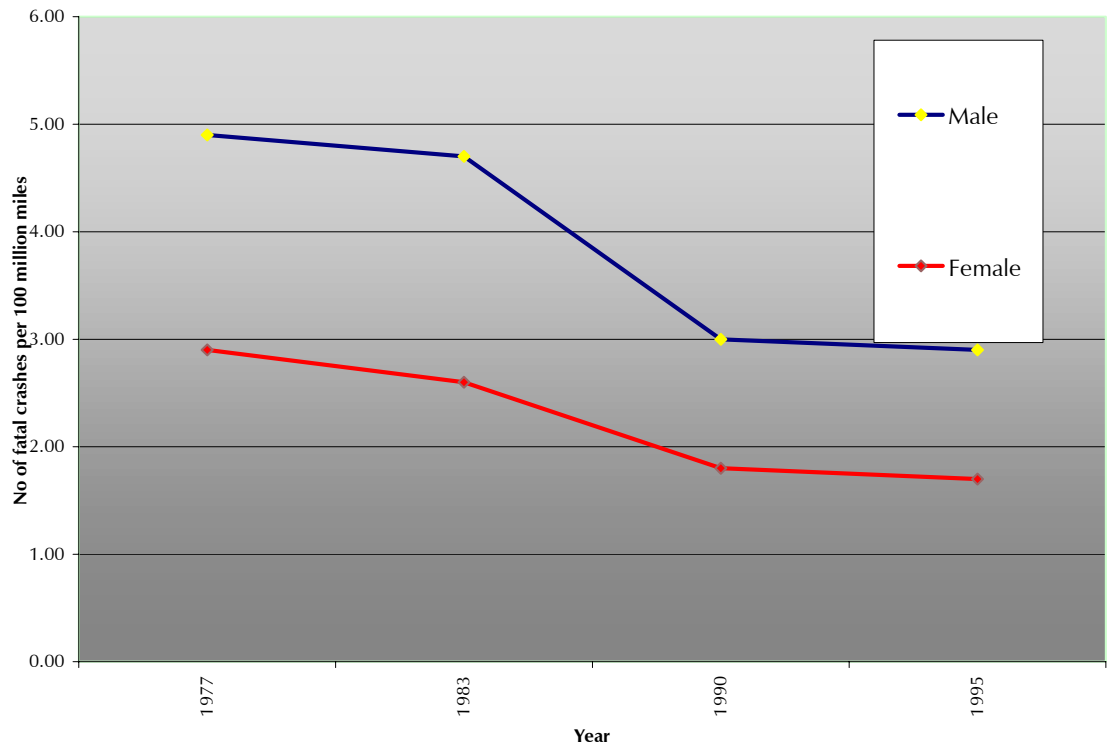
From Figure 1. we can see that in the age category 20-29 years the fatality rate for males (including drivers, passengers, pedestrians, cyclists, etc.) was 535% greater than that of females. The difference between the sexes declined sharply with age – the difference between men and women in their sixties and older being insignificant. This is consistent with the findings of Maycock *et al* (1991) that the greatest difference between males and females in this context is in the 16-20 and 21-24 age groups.

This increased level of risk among young men is not confined to driving. The WHO (1999) and (2002) report that men are also more likely to die from falls, drowning, poisoning and a range of other events. Only in the case of deaths in fires are women slightly more over-represented than men. The report also notes that injury and fatality rates are higher among men for every type of road injury victim in several developing countries. In Kampala, Uganda, for example, males outnumbered females by between 2 and 7 to 1 among injured vehicle drivers, passengers and pedestrians. In the United States male drivers are much more likely than females to be injured or killed in road accidents – they account for 71% of all driver fatalities. This figure has remained virtually constant since 1975.

To some extent, of course, these differences may be partially explained by the greater exposure of males to potential accidents due to the relatively higher number of licensed drivers and greater annual mileages. If such factors were at work, however, we would expect a sharp difference between the level of male driver injuries and fatalities and those resulting from being a pedestrian, passenger, cyclist etc. Such a difference is not evident, and the risk-proneness of men while driving is directly reflective of their risk in a wide range of other contexts. This is demonstrated in Figure 2 below, derived from the US Insurance Institute for Highway Safety report, 2001.

The data illustrated in Figure 2 relate to driver deaths per 100 million miles driven, thus controlling for differential exposure to risk. While the number of driver deaths fell substantially between 1977 and 1995, the relative male/female ratios remained substantially the same throughout the period. (See also Mayhew *et al* (2003).

Figure 2. Drivers in fatal crashes per 100 million miles, 1977-95



The WHO (2002) report noted above highlights factors that might be of relevance to explaining this marked gender difference, including greater propensity towards risk-taking, alcohol use, anti-social behaviour etc.

“‘Masculinity’ may be hazardous to health. Gender role socialisation and the association of masculinity with risk-taking behaviour, acceptance of risk and a disregard of pain and injury may be factors leading to the hazardous actions on the part of men. These include, for example, excessive consumption of alcohol, drug use, aggressive behaviour, to be in control of situations, and risky driving.”

Further research is proposed to identify such factors more precisely and, in particular, the report concludes:

“Research is needed to examine the potential benefits of gender and age-differentiated policies for issuance of driving licences and related issues.¹”

The fact that this WHO report was prepared by the Department for Gender and Women’s Health suggests that driving-related policies that differentiate between genders are not seen as cutting across broad notions of equality in this context.

¹ WHO (1999), p4

The WHO report and other research documents put forward various reasons to explain the observed sex differences in the risk of injury or death while driving. These, overall, fall into three distinct groups, indicating differential levels of:

- aggression
- speeding and violation of traffic laws
- sensation-seeking and risk-taking

These and related factors are considered below.

Sex differences in aggression and driving behaviour

There is a vast literature concerning studies of sex differences in aggression focusing on biological, physiological, evolutionary, developmental, social and cultural factors. There is an overwhelming consensus that human males are more aggressive, and display aggression in different ways, compared with their female counterparts. The greatest differences are seen from puberty to early adulthood although differences are evident from the age of two years. Parallel sex differences are found in virtually all other species of animal, from the sabre-toothed tiger to the five-spined stickleback. The hamster may be one of very few exceptions.

It is beyond the scope of this review paper to consider even a small fraction of this material. An excellent, but now slightly dated, review can be found in Björkqvist, K. (1994). See also Marsh and Campbell (1986).

A definitive study by Rita Simon and her colleagues (1991) examined violent crime rates in 31 countries across a time period of 18 years. They found no time period or country where female aggression exceeded that of males.

Baker (1992) found that homicide rates are between 5 and 10 times higher for males than for females. The differences between the sexes were the greatest between the ages of 15-19 and 20-34 (see also Runyan and Gerken (1991)).

Some social scientists have challenged the allegedly simplistic account of aggression and sex differences based on measures of physical violence. They argue that aggression may also underlie behaviours that do not involve physical expressions – e.g. manipulation, exclusion, gossip, etc. (See, for example, Crick and Grotpeter (1995)). They suggest that levels of aggression as a whole may not be significantly different between the sexes, rather it is the manner in which it is expressed that is gender-specific. While there may be a valid point here (see Paquette and Underwood (1999)), it relies on a broadening of the definition of aggression to include a wide range of additional social behaviours that are not ordinarily defined as aggressive. For the purposes of this review, therefore, the more conventional definition of aggressive behaviour will be retained.

While the literature on sex differences in aggressive behaviour is very extensive, that which focus on such differences in aggressive driving is substantially smaller. It is also the case that some less than convincing proxies for aggressive behaviour have been used in some studies. Doob and Gross (1989), for example, used horn-honking as an indirect measure for aggression. They found that males honked their horns three times more quickly than females when, for example, drivers in front did not move on a green traffic light.

More convincing evidence of sex differences in driving behaviour comes from Mizell (1997) who studied police and news reports of aggressive driving incidents and found that males were much more frequently involved in such behaviours than females.

An earlier study in the UK by Parry (1998) examined the attitudes and behaviours of 279 British motorists. The analysis of scaled items designed to measure 'aggressiveness' indicated that the highest scores for aggression on the road were associated with male drivers aged 17 to 35. Their average aggression scores were twice those recorded for middle-aged males. Females aged 17 to 35 had average aggression scores comparable to those of middle-aged male drivers.

A study by Lajunen and Parker (2001) used self reports of subjects' levels of aggressive driving and found significant gender and age effects. Among men, aggressive driving was most associated with the lower age groups. Among women, however, who reported fewer behaviours of this type, age was a much less significant factor, in line with the results obtained by Parry above.

Stradling and Meadows (1999) report that while aggressive driving in males does, indeed, decline with age, the levels are greater than those for females in all age categories.

A more general discussion of these issues is contained in Marsh and Collett (1986). They invoke the notion of the 'territorial imperative' and associated aggressive defence behaviour to explain the high levels of aggression displayed by males when driving. They compare the car to both 'home turf' and to an extension of body space. When these private zones are 'invaded' by, for example, tailgating or other manoeuvres, defensive aggression is triggered that matches the patterns of male territorial defence seen in humans across all cultures and in other species of animal. The authors note (page 162 ff):

"While territorial defence is largely a male prerogative, it is young men in particular who make the most use of the car as a weapon. In many cases this is because the automobile is their only personally owned territory. In Europe and America, getting one's own car is an important step on the road to independence. The family home is a territory dominated by parents. The car, on the other hand, is one that the fledgling adult can control himself. Because it is so closely related to self definition, the prospect of its being defended is greatly increased. Later on in life, when other territories such as a home or one's own office are acquired, the significance of the car in this respect becomes slightly diminished ... The territorial component of the car helps us to understand the cause of the very high rate of car crashes involving young men."

There are, it must be acknowledged, a small number of studies that have failed to find sex differences in aspects of aggressive driving behaviour. Hauber (1980), for example, found no significant differences between men and women in terms of their horn honking and other behaviours (but note that the caveats raised above in relation to horn honking as a measure of aggression also apply here). Novaco (1989) also concludes that 'self-endangering' and provocative behaviours are characteristic of both male and female drivers. The overwhelming evidence, however, from both experimental and observational studies indicates that differences between the sexes in levels of aggressive driver behaviour are consistent with the differences in accident rates. The only real area of contention is in relation to the explanation of these differences – i.e.

the extent to which they are the product of genetic, social, developmental or experiential factors. A brief discussion of these issues is contained in the final section below.

Sex differences in traffic regulation violations

In the UK, Home Office statistics show that in 2002 88% of all driving offences, and 83% of speeding offences, were committed by men. There is also a strong consensus in the research literature that males are more likely to exceed speed limits and commit other traffic offences than females. Storie (1977), found that men were more likely than women to be involved in accidents resulting from excessive speed. Michiels and Schneider (1984) attributed the higher driving speeds of men, and young men in particular, to their higher involvement in deviant and anti-social behaviours in general. Exceeding speed limits was just one manifestation of this broader pattern. This is supported by Elander *et al* (1993).

In Germany, the Statistisches Bundesamt (the Federal Statistics Office) analysed accident data in 1986 and reported that females were significantly less involved than males in accidents caused by speeding and by veering off road lanes. Norris *et al* (2000) confirmed these findings in the United States and suggested that pre-existing 'characterological', situational, and behavioural risk factors could explain the observed sex and age differences in accident rates. The authors of this report also noted that a proportion of the higher accident rates for male drivers could be explained by their greater tendency to disregard speed limits and other traffic rules.

Stradling and Meadows (1999) and Stradling (2000) similarly note that male drivers are not only more likely to drive faster, they are also more likely to commit a range of Highway Code violations.

A number of other studies confirm these consistent findings – e.g. Trankle *et al* (1992), French *et al* (1992), Parker *et al* (1992), Furnham and Saipé (1993), etc. The exception to this pattern is a study by Wasielewski (1984), whose observational study failed to detect a significant difference in speed between male and female drivers.

For other types of traffic violation, Waller *et al* (2000) report that men are twice as likely than women to breach regulations and receive citations from the police. They also tend to commit their first offence at a younger age. Lawton *et al* (1997) found the same effect and suggested that differences between the genders in terms of accident rates could almost entirely be explained by the differential tendency to commit driving violations. Once the relationship between gender and driving violations was removed, gender was no longer predictive of accidents.

A study by Yagil (1998) in Israel, conducted among university students, indicated that females had a stronger sense of obligation to obey traffic laws. They were also more likely to evaluate traffic laws positively. The observed gender differences were particularly pronounced among young drivers. Women were more likely than men to view the content of traffic laws as important, clear and reasonable. This resulted in a stronger sense of obligation to obey traffic laws. Women reported that they would comply with traffic laws even in situations where non-compliance was not perceived as risky. Men, on the other

hand, tended to overestimate their driving ability and feel more confident in complying selectively with traffic laws. Young males in particular were more likely to evaluate traffic laws negatively and to underestimate the risks associated with traffic violations.

Parker and Stradling (1998) found that in the UK 40% of male drivers could be classed as 'high violators', compared with 20% of female drivers. Violations included such behaviours as crossing lights on red, driving close to the vehicle in front, driving over the legal limit for blood alcohol, being involved in unofficial races with other drivers, etc. as well as exceeding speed limits. For speeding, the authors found, on the basis of national surveys of drivers, that twice the number of males had been stopped by the police for speeding compared with females. When presented with the statement 'I disregard the speed limits late at night or very early in the morning', 22% of male drivers agreed with the statement, compared with only 8% of females. Males also reported higher feelings of excitement when driving fast.

Extensive support for such findings exists in other studies, including Reason *et al* (1990), Meadows (1994), Furnham and Saipe (1993), etc.

In addition to speeding and other driving violations, males, and young males in particular, are the most likely group to drive after drinking – see, for example, Storie (1977), Caetano and Clark (2000), Anderson and Ingram (2001). This group is also the most likely to drive under the influence of drugs – see, for example, Lancaster and Ward (2001). Home Office statistics show that of those convicted of drink driving offences in 2002, 97% were male.

Shinar *et al* (2001) found that in the United States, based on self-report data, women were significantly more likely than men to abstain from drinking before driving. Similar results were obtained in an earlier study by the National Highway Traffic Safety Administration, NHTSA (1995).

While not necessarily linked directly to accident rates, but possibly to injuries sustained in accidents, a number of studies have shown that seat-belt wearing tends to be less frequent among male drivers than among females – see, for example, Jonah (1990), Waxweiler *et al* (1993), Shinar *et al* (2001). Begg and Langley (2000) also note that failure to wear a seat belt is often associated with other 'deviant' behaviours such as drug use, drinking, etc.

Sensation seeking and risk-taking

There is a very substantial research literature that clearly demonstrates broad sex differences in risk-taking and sensation-seeking behaviours. Virtually all studies show that men engage in these activities far more frequently than women and that these tendencies are spread across a wide range of behaviours, including driving. Sensation-seeking, as a measurable personality trait defined by Zuckerman (1979, 1994, 1996), Zuckerman *et al* (1978), has frequently been shown to correlate with various types of anti-social conduct. Such findings are confirmed by, for example, McCourt *et al* (1993), Wagner (2001), Pyszczyński (2002), etc.

The phenomenon has been studied from a variety of perspectives, including social, psychological and economic approaches – see Oetting *et al* (1998), Deery and Fildes (1999), Fromme *et al* (1999), etc. Many of these include a specific focus on driving behaviour. Increasingly, however, the focus is turning towards biosocial explanations of both the phenomenon of sensation-seeking and the observed sex differences – e.g. McCourt *et al* (1993).

Daitzman *et al* (1978) conducted an early investigation into the relationship between sensation-seeking and risk-taking and levels of male testosterone. This has been followed by further investigations conducted by, among others, Daitzman and Zuckerman (1980), Dabbs and Morris (1990), Bogaert and Fisher (1995), Gerra *et al* (1999), etc. All of these have found a positive correlation between sensation-seeking and testosterone levels, providing a very simple explanation of why men are more prone to engage in such behaviours, independent of child-rearing, socialisation, education and other factors. A study by Wang *et al* (1997) is one of the few exceptions in an otherwise consistent corpus of knowledge.

Other studies have examined the additional roles of neurotransmitters such as dopamine and serotonin in the mediation of sensation-seeking and risk-taking behaviours, finding positive correlations in most cases – e.g. Gerra *et al* (2000), Netter *et al* (1996), etc. The stress hormone, cortisol, has also been shown to be associated with levels of sensation-seeking – see Rosenblitt *et al* (2001).

The relationship between hormone levels and both sensation-seeking and risk-taking is, of course, rather more complex than the image of ‘testosterone-fuelled young male drivers’ might suggest. Zuckerman (1991), for example, has found that levels of testosterone can be influenced by situational factors such as aggression and conflict. Nonetheless, it is the case, as Ridley (1999) has noted that while females have, on average, 40 nanograms of testosterone in each decilitre of their blood, males have 300 to 1000 nanograms of testosterone per decilitre of blood. This, he argues, is the basis of the observed sex differences. Other studies have also shown that although the levels of testosterone are very much lower on average in women, certain types of female behaviour are related to variations in the level of the hormone. In a study by Dabbs *et al* (1988) female prisoners who had committed violent crimes which were unprovoked were found to have higher levels of testosterone than females who had

committed violent crimes due to provocation or had committed non-violent crimes.

The conclusion, then, must be that at least some of the variation between the sexes in the context of risk-taking and sensation-seeking is accounted for by variations in levels of testosterone (in interaction with other hormones and neurochemical changes) and by the very large differences in average testosterone levels between the sexes.

The perspective of evolutionary psychology

It is clear from the evidence that substantial differences between the sexes exist in the context of aggression, sensation-seeking and risk-taking and in tendencies toward rule violation. These express themselves in driving behaviour as much as they do in other areas of life. The remaining question concerns the origins of these clear differences.

The term ‘evolutionary psychology’ (EP) was coined by Barkow, Cosmides and Tooby (1987) and presented as a more coherent discipline in Cosmides and Tooby (1992). One of its major achievements has been to shift debate away from the old nature vs. nurture distinction in explaining individual and group differences to a focus on the roots of certain types of behaviour in terms of their evolutionary and adaptive functions and the cognitive mechanisms that underlie them.

To understand the relevance of EP in explaining differences between men and women in driving and related behaviours it is necessary to consider some of its essential principles. First, the brain is seen as being a physical system that functions much like a computer. Its circuits are designed to generate behaviour that is appropriate to environmental circumstances. Second, the circuits of the brain developed through natural selection to solve problems that our ancestors faced during our evolutionary history. Third, our 21st century skulls house essentially stone age minds.

The process of natural selection is slow and neural circuits require very long periods of time to develop and adapt. The conditions under which they developed were very different from those that surround us today. Well over 99% of our species’ history has been spent in small hunter-gatherer societies – a pattern of life that Cosmides and Tooby describe as “a camping trip that lasted an entire lifetime, and this way of life endured for most of the last 10 million years.” Our species lived as hunter-gatherers 1000 times longer than as anything else.

In essence then, our brains have not been designed specifically to deal with the very different kinds of social, environmental and agricultural conditions in which we now find ourselves. Our brains have not caught up with the very rapid shift away from the patterns of living that characterised our world until a mere 5,000 or so years ago. While young children show natural fear of snakes, they have to be taught to fear electrical sockets, even though the latter poses much more of a threat in modern urban environments.

From this perspective, we need to understand ‘modern’ types of behaviour as being predicated upon neural circuits that were of relevance to our success in hunting and gathering settings and which have not had sufficient time to adapt specifically to, say, driving motor cars. As Cosmides and Tooby comment:

“A necessary (though not sufficient) component of any explanation of behaviour – modern or otherwise – is a description of the design of the computational machinery that generates it. Behaviour in the present is

generated by information-processing mechanisms that exist because they solved adaptive problems in the past – in the ancestral environments in which the human line evolved.”

Evolutionary psychology does not pretend to answer all of the questions relating to complex and varying behaviours and patterns of interaction in modern settings. It does, however, take us forward in understanding what, on the surface, may seem to be irrational and self-defeating actions, such as driving fast in inappropriate road conditions or racing away from traffic lights before they have barely changed to green.

In early hunter-gather communities there were basic requirements for survival – physical protection and an adequate food supply. Those communities that were successful in achieving these conditions were able to reproduce at a faster rate than those who were not. Thus the genes that helped to shape the neural circuits that were the most effective in this sense were passed on in greater numbers.

To achieve an adequate food supply it was necessary to develop the skills for both hunting and for gathering wild fruits, nuts, etc to provide additional sources of nutrients. At the same time, children needed to be born and raised. Since women were often in a state of near permanent pregnancy and infant caring for most of their child-bearing years, a separation of roles between the sexes developed and males, with the additional advantage of slightly greater body size, took on the role of hunters while women took on the role of carers and gatherers.

From this point the neural circuits of men evolved to ensure appropriate skills for hunting – speed, spatial abilities, navigation to hunting grounds, etc. The circuits of women evolved to provide appropriate child-rearing, communication and social skills. This may sound very crude, but the legacy of such early developments is still apparent in known differences between the sexes in terms of visual-spatial and language abilities – see, for example, Blum (1997), Kimura (1999), Sapolsky (1999).

During the vast majority of our evolution it was also necessary to defend communities from potential attack from rival groups seeking hunting opportunities and access to an additional pool of women with whom to mate. In addition, the more an individual male could find sexual partners, the more his genes could be passed on to the future. So, basic patterns of aggression, calculated risk-taking and ‘infidelity’ among men arose as a ‘natural’ consequence of these basic requirements. Today, risk-taking men are still seen as more attractive by women – a more suitable opportunity to father their children who will be protected from the consequences of inappropriate engagement in risk primarily by women.

The account of the origins of basic human sex differences and the EP approach to explaining them is, of course, much more complex than this. It also needs to consider some of the moral and philosophical issues that the perspective generates – the ‘biology is not destiny’ argument in particular. (See Kenrick and Luce (2004) for a useful overview of recent developments in EP). It does, however, help us to see why male drivers are more at risk on the roads than

females. Their 'stone age' brains which were moulded on the 'thrill of the chase', targeted aggression and a degree of 'lawlessness' – very effective in early hunter-gatherer communities – are not those that any sane person would design for dealing with the conditions on the M40 motorway.

Evolution, of course, is a continuous and continuing process. Eventually the design of our neural circuits will catch up with the conditions that prevail now, rather than long ago in the past. Then, perhaps, we will see quite a different kind of male motorist. The only problem, of course, is that this will probably take a few million years.

Conclusion

Men and women are different. In terms of driving behaviour, the differences can be seen clearly in the greater propensity of males to take risks, exhibit aggression and seek thrilling sensations. The results of these differences are highlighted very clearly across the globe in higher accident statistics, more expensive and frequent insurance claims and higher rates of convictions for offences such as dangerous and drink-driving.

These differences may be shaped by socialisation, but they are rooted in more fundamental factors. Evolutionary psychology provides a strong basis for sourcing many of these back to the little-changed cognitive structures required by our hunter-gather ancestors.

In conclusion, the authors believe there is overwhelming evidence that propensities towards certain types of behaviour, including less-safe driving, are 'hard wired' in men. We agree with the conclusion of the Department of Gender and Women's Health at the World Health Organisation. The department has called for recognition of the fundamental differences between men and women drivers and the development of gender-differentiated policies in relevant areas. In the UK, motor insurance underwriting takes such gender-differentiation into account to ensure each gender effectively pays for its own class of claims at different ages. Young men are charged more than young women because they cause more frequent and expensive accidents. In our view, this is justified on the basis of the evidence that we have reviewed.

References

- Abdel-Aty, M. A. and Abdelwahab, H. T. (2000). Exploring the relationship between alcohol and the driver characteristics in motor vehicle accidents. *Accident Analysis and Prevention*, 32, 505 - 515.
- Alexander, E. A., Kallail, K. J., Burdsal, J. P., and 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., and Lindberg, E. (2000) Perceived Risk, Feelings of safety and worry associated with different travel modes. Pilot study. *KFTS Meddelande*, 7, 1 - 34.
- Anderson, S. and Ingram, D. (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.
- Arnett, J. (1992). Reckless behavior in adolescence: A developmental perspective. *Developmental Review*, 12, 339-373
- Atzwanger, K (1995) Biological Aspects of Aggressive Driving Behavior. Paper presented at the *Human Behavior and Evolution Conference*, Santa Barbara, June 1995
- Baker, S., O'Neill, B., Ginsburg, M. J. and Li, G. (1992) *The Injury Fact Book*. New York: Oxford University Press.
- Barkow, J., Cosmides, L. and Tooby, J. 1992. *The Adapted Mind: Evolutionary psychology and the generation of culture*. NY: Oxford University Press.
- Björkqvist, K. (1994). Sex differences in physical, verbal, and indirect aggression: A review of recent research. *Sex Roles*, 30, 177-188.
- Blum, D. (1997) *Sex on the Brain: The Biological Differences between Men and Women*. Deborah, New York: Viking Press.
- Bogaert, A. F., and Fisher, W. A. (1995). Predictors of university men's number of sexual partners. *Journal of Sex Research*, 32, 119-130.
- 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 and Prevention*, 32, 57 - 64.
- Chipman, M. L., MacGregor, C. G., Smiley, A. M., and Lee-Gosselin, M. (1992). Time vs. distance as measures of exposure in driving surveys. *Accident Analysis and Prevention*, 24:6, 679 - 684.
- Cosmides, L. and Tooby, J. (1987). From evolution to behavior: Evolutionary psychology as the missing link. In J. Dupre (Ed.), *The latest on the best: Essays on evolution and optimality*, Cambridge, MA: MIT Press.
- Crick, N.R., & Grotpeter, J.K. (1995). Relational aggression, gender, and social-psychological adjustment. *Child Development*, 66, 710-722.

- Dabbs, J. M., Ruback, R. B., Frady, R. L., Hopper, C. H., and Sgoutas, D. (1988). Saliva testosterone and criminal violence among women. *Personality and Individual Differences*, 9:2, 269-275
- Dabbs, J. M., and Morris, R. (1990). Testosterone, social class, and antisocial behavior in a sample of 4,462 men. *Psychological Science*, 1, 209–211.
- Daitzman, R., Zuckerman, M., Sammelwitz, P., and Ganjam, V. (1978). Sensation seeking and gonadal hormones. *Journal of Biosocial Science*, 10, 401–408.
- Daitzman, R., and Zuckerman, M. (1980). Disinhibitory sensation seeking, personality and gonadal hormones. *Personality and Individual Differences*, 1, 103–110.
- Deery, H. A., and Fildes, B. N. (1999). Young novice driver subtypes: Relationship to high risk behavior, traffic accident record, and simulator driving performance. *Human Factors*, 41, 628–643.
- Deffenbacher, J. L., Lynch, R. S., Filetti, L. B., Dahlen, E. R., and Oetting, E. R. (2003). Anger, aggression, risky behavior, and crash-related outcomes in three groups of drivers. *Behaviour Research and Therapy*, 41, 333-349.
- Dobson, A., Brown, W., Ball, J. and Ncfadden, M. (1999) Women drivers' sociographic characteristics and accidents. *Accident Analysis and Prevention*, 31, 525-535.
- Elander, J., West, R., and French, D. (1993). Behavioural Correlates: Individual Differences in Road-Traffic Crash Risk: An Examination of Methods and Findings. *Psychological Bulletin*, 113:2, 279 – 294.
- Evans, L. (1991) *Traffic Safety and the Driver*. New York: van Nostrand Reinhold.
- Evans, L. and Wasielewski, P. (1983). Risky driving related to driver and vehicle characteristics. *Accident Analysis and Prevention*, 15, 121-136.
- French, D., West, R., Elander, J. and Wilding, J. M. (1993). Decision-making style, driving style and self-reported involvement in road traffic accidents. *Ergonomics*, 36:6, 627-644.
- Fromme, K., D'Amico, E. J., and Katz, E. C. (1999). Intoxicated sexual risk taking: An expectancy or cognitive impairment explanation. *Journal of Studies of Alcohol*, 60, 54–63.
- Furnham, A., and Saipé, J. (1993). Personality correlates of convicted drivers. *Personality and Individual Differences*, 14:2, 329 – 336.
- Gerra, G., Avanzini, P., Zaimovic, A., Sartori, R., Bocchi, C., Timpano, M., Zambelli, U., Delsignore, R., Gardini, F., Talarico, E., and Brambilla, F. (1999). Neurotransmitters, neuroendocrine correlates of sensation seeking temperament in normal humans. *Neuropsychobiology*, 39, 207–213.
- Gerra, G., Zaimovic, A., Timpano, M., Zambelli, U., Delsignore, R., and Brambilla, F. (2000). Neuroendocrine correlates of temperamental traits in humans. *Psychoneuroendocrinology*, 25, 479–496.
- Home Office (2004) *Crime in England and Wales, 2001-2002*.

- Ingram, D., Lancaster, B. and Hope, S. (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 (2001) *Status Report*, 36:10.
- Jonah, B. A. (1990). Age differences in risky driving. *Health Education Research*, 5:2, 139-149.
- Kenrick, D. T. and Luce, C. L. (2004) *The Functional Mind: Readings in Evolutionary Psychology*, Boston: Pearson/Allyn & Bacon.
- Kimura, D. (1999) *Sex and Cognition*. Michigan: MIT Press.
- Lajunen, T. and 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
- Lancaster, R., and Ward, R. (2001). *Management of Work-related Road Safety*. Research Report. HSE Contract Research Report: HSE Books.
- Lancaster, R., and Ward, R. (2002). *The Contribution of Individual Factors to Driving Behaviour: Implications for managing work-related road safety*. Research Report. HSE Contract Research Report: HSE Books.
- Lawton, R., Parker D., Stradling, S.G., and Manstead, A. (1997). Predicting road traffic accidents: The role of social deviance and violations. *British Journal of Psychology*, 88, 249 – 262.
- Marsh P. and Campbell, A. (Eds.) (1982) *Aggression and Violence*. Oxford: Blackwell.
- Marsh, P. and Collett. P. (1986) *Driving Passion: The Psychology of the Car*. London: Cape
- Maxim, P. S. and Keane, C. (1992). Gender, age, and risk of violent death in Canada. *Canadian Review of Sociology and Anthropology*, 29, 329-345.
- Maycock, J. Lockwood, C. R. and Lester, J. F. (1991). *The Accident Liability of Car Drivers* (Rep. No. 315). UK, Crowthorne: Transport and Road Research Laboratory.
- Mayhew, D. R. Ferguson, S. A., Desmond, K. J. and Simpson, H. M. (2003) Trends in fatal crashes involving female drivers, 1975-1998. *Accident Analysis and Prevention*, 35:3, 407-415.
- McCourt, W. F., Gurrera, R. J., and Cutter, H. S. (1993). Sensation seeking and novelty seeking: Are they the same? *Journal of Nervous and Mental Disorders*, 181, 309–312.
- McKenna, F. P. (1993) It won't happen to me: Unrealistic optimism and the illusion of control. *British Journal of Psychology*, 84:1, 39-50.
- McKenna, F. P, Waylen, A. E. and Burkes, M. E. (1998) *Male and Female Drivers: How Different Are They?* UK, Basingstoke: AA Foundation for Road Safety.

- Meadows, M. L. (1994). *Psychological correlates of road crash types*. Unpublished PhD thesis. University of Manchester.
- Meadows, M. L. and Stradling, S. G. (1996). Violation and thrill in predicting types of road traffic crashes. *International Conference on Traffic and Transport Psychology*, May, Valencia, Spain.
- Michiels, W. and Schneider, P. (1984) Traffic offences: Another approach to description and prediction. *Accident Analysis and Prevention*, 16, 223-238.
- Mizell, L. (1997). *Aggressive driving*. Washington, D.C.: American Automobile Association Foundation for Traffic Safety.
- Netter, P., Henning, J., and Roed, I. S. (1996). Serotonin and dopamine as mediators of sensation seeking behavior. *Neuropsychobiology*, 34, 155–165.
- NHTSA. (1995). *Understanding Youthful Risk-Taking and Driving*. Interim Report. COMSIS Corporation.
- Norris, F. H., Matthews, B. A., and 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, R. (1991). Aggression on roadways. In Baenninger, R. (Ed.). *Targets of violence and aggression*. North Holland: Elsevier.
- Oetting, E. R., Deffenbacher, J. L., and Donnermeyer, J. F. (1998). Primary socialization theory. The role played by personality traits in the etiology of drug use and deviance II. *Substance Use and Misuse*, 33, 1337–1366.
- Paquette, J. and Underwood, M. (1999). Gender differences in young adolescents' experiences of peer victimization: Social and physical aggression. *Merrill-Palmer Quarterly*, 45, 242-265.
- Parker, D., Reason, J. T., Manstead, A. S. R. and Stradling, S. (1995). Driving errors, driving violations and accident involvement. *Ergonomics*, 38, 1036-1048
- Parker, D., West, R., Stradling, S., and Manstead, A. (1995). Behavioural characteristics and involvement in different types of traffic accident. *Accident Analysis and Prevention*, 27:4, 571 – 581.
- Parker, D and Stradling, S.G. (1998). Influencing driver attitudes and behaviour. *Report to Department of Environment, Transport and the Regions*.
- Parry, M. H., (1968) *Aggression on the Road*, London: Tavistock.
- Pyszczynski, T. L. (2002) Gender differences in the willingness to engage in risky behavior: A terror management perspective. *Death Studies*, 26, 117-142.
- Reason, J. T., Manstead, A. S. R., Stradling, S. G., Baxter, J. S. and Campbell, K. (1990). Errors and violations on the road: A real distinction? *Ergonomics*, 33, 1315-1332.
- Ridley, M. (1999). *Genome: The autobiography of a species in 23 chapters*. London: Fourth Estate.

- Rosenblitt, J. C., Soler, H., Johnson, S. E. and Quadagno, D. M. (2001) Sensation seeking and hormones in men and women: Exploring the link, *Hormones and Behaviour*, 40, 396-402.
- Runyan, C. W., and Gerkenm E. A. (1991) Injured. In W. Hendee (Ed) *The Health of Adolescents*. 302-333. San Francisco: Josey-Bass.
- Sapolsky, R. M. (1999) *The Trouble with Testosterone: And Other Essays on the Biology of the Human Predicament*. New York: Scribner.
- Shinar, D., Schechtman, E., and Compton, R. (2001). Self-reports of safe driving behaviours in relationship to sex, age, education and income in the US driving population. *Accident Analysis and Prevention*. 33, 243 – 255.
- Simon, R. J. and Landis, J. (1991) *The Crimes Women Commit and the Punishments They Receive*. Lexington: Lexington Books.
- Storie, V. J. (1977). *Male and Female Car drivers: Differences observed in accidents* (Rep. No. 761). UK, England: Transport and Road Research Laboratory.
- Stradling, S. G. and Meadows, L. M. (1999) Highway code and aggressive violations in UK drivers. Paper presented to the *Aggressive Driving Issues Conference*, Ontario Ministry for Transportation, Toronto.
- Stradling, S. (2000). Drivers who Speed. *Impact*, 9:2, 30 – 41.
- Statistisches Bundesamt Wiesbaden. (1987): *Strassenverkehrsunfalle 1986*, Fachserie 8, Reihe 3.3. Stuttgart: Kohlhammer.
- Trankle, U., Gelau, C. and Metker, T. (1990). Risk perception and age-specific accidents of young drivers. *Accident Analysis and Prevention* 22:2, 119 - 125.
- Wagner, M. K. (2001). Behavioral characteristics related to substance abuse and risk-taking, sensation- seeking, anxiety sensitivity and self-reinforcement. *Addictive Behaviors*, 26, 115-120.
- Waller, P. F., Elliot, M. R., Shope, J. T., Raghunathan, T. E, and Little, R. J. A. (2001). Changes in young adults offense and crash patterns over time. *Accident Analysis and Prevention*. 33, 117 - 128.
- Wang, S., Mason, J., Charney, D., Yehuda, R., Sherry, R., and Southwick, S. (1997). Relationships between hormonal profile and novelty seeking in combat-related posttraumatic stress disorder. *Biological Psychiatry*, 41, 145–151.
- Wasielewski, P. (1984). Speed as a measure of driver risk: Observed speeds versus driver and vehicle characteristics. *Accident Analysis and Prevention*, 16, 89-103.
- Waxweiler, R. J., Harel, Y. and Carroll, P. W. (1993). Measuring adolescent behaviours related to unintentional injuries. *Public Health Reports*, 108, 11-14.
- Waylen, A. and McKenna, F. (2002) *Cradle Attitudes – Grave Consequences. The development of gender differences in risky attitudes and behaviour in road use*. UK, Basingstoke: AA Foundation for Road Safety.

- West R., Elander, J. and French, D. (1993) Mild social deviance, type-A personality and decision making style as predictors of self-reported driving style and traffic accident risk. *British Journal of Psychology*, 84, 207-219.
- West, R. (1993). *Accident Script Analysis: Parts 1 and 2*. Report to Department of Transport: Contract No. N06100. London: Department of Transport.
- World Health Organisation (1999) *Injury – A leading cause of global burden of disease*. WHO Report.
- World Health Organisation (2002) *Gender and Road Traffic Injuries*. WHO, Department of Gender and Women's Health. Geneva
- Yagil, D (1998) Gender and age-related differences in attitudes toward traffic laws and traffic violations. *Transportation Research*, Part F: 1, 123-135.
- Zuckerman, M. (1979). *Sensation Seeking: Beyond the optimal level of arousal*. Hillsdale, NJ: Erlbaum.
- Zuckerman, M. (1994). *Behavioural expressions and biosocial bases of Sensation Seeking*. Cambridge: Cambridge University Press.
- Zuckerman, M. (1996). The psychobiological model for impulsive unsocialized sensation seeking: A comparative approach. *Neuropsychobiology*, 34, 125–129.
- Zuckerman, M., Eysenck, S., and Eysenck, H. J. (1978). Sensation seeking in England and America: Cross-cultural, age and sex comparisons. *Journal of Consulting and Clinical Psychology*, 46, 139–149.