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Are aggressive people aggressive drivers? A study of the relationship between self-reported general aggressiveness, driver anger and aggressive driving

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Abstract

In this study the relationships among self-reported general aggressiveness, impulsiveness, driver anger, and aggressive responses to anger-provoking situations on the road were studied. The British version of a driver anger scale (UK DAS), aggression questionnaire (AQ), and an impulsiveness questionnaire (I7) together with background questions (gender, age, annual mileage) were administered to a sample of 270 British drivers. Variation in strength of correlations between anger and aggressive reactions in the 21 UK DAS items showed that the relationship between driver anger and aggression depends in part on the characteristics of the situation. In addition, three path models for describing the relationships among the measures were constructed separately for women and men. The models suggested that the effects of verbal aggressiveness on self-reported driver aggression were mediated by driver anger whereas physical aggressiveness was directly related to aggressive behaviour. Age was negatively related to both driver anger and aggression among men whereas annual mileage was negatively related to aggression among women. The models constructed indicate that aggressive driver behaviour is a complex phenomenon with a range of psychological causes.

Keywords: Self-report; Driver anger; Aggressive driving; Aggression questionnaire; Impulsiveness; Gender differences

1. Introduction

Several surveys conducted recently in Britain suggest that a sizeable proportion of car drivers report having experienced some form of aggressive driver behaviour. In a survey by the Automobile Association (Joint, 1995), 90% of respondents reported that they had been involved in a 'road rage' incident in the previous year. The Lex Motor Group (1996) noted that 44% of drivers said that they had experienced verbal abuse in the preceding 12 months. In addition to having been the victim of an aggressive act, 60% of the motorists questioned admitted 'losing my temper' while driving (Joint, 1995). In a recent diary study, Underwood et al. (1999) found a link between anger and subsequent near accidents. The relationships between general aggressiveness, driver anger and aggressive driving behaviour are, however, still largely unknown. In the present article, structural equation modelling techniques are used to investigate how self-reported general aggressiveness, anger behind the wheel and aggressive driving are related to each other.

1.1. Different causes of driver anger: impeded progress, reckless driving, and direct hostility

According to aggression researchers, the amount of anger felt in a frustrating situation depends on both the person's interpretation of the situation and the objective situational characteristics (Berkowitz, 1993). Deffenbacher et al. (1994) developed a driver anger scale (DAS) to measure driver anger provoked by six types of situations: 'hostile gestures', 'illegal driving', 'police presence', 'slow driving', 'discourtesy' and 'traffic ob-

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structions'. When factor analysis was applied to 33 DAS items in a British sample, the result was a scale with 21 items and three factors (Lajunen et al., 1998). These new UK DAS scales were labelled as progress impeded, direct hostility, and reckless driving. The most significant difference between Deffenbacher et al.'s (1994) original DAS and the UK DAS was that every UK DAS item contained an interpersonal element, i.e. a driver whose behaviour provokes anger in an other driver, whereas the original DAS included impersonal situations too (e.g. encountering road constructions). These situations without another motorist as a deliberate actor did not evoke anger at all among British drivers, so the 'traffic obstructions' and 'police presence' scales were omitted from the UK DAS.

It can be supposed that impeded progress, witnessing reckless driving, and being the recipient of hostile gestures all give rise to anger and, possibly, aggressive driving through particular psychological mechanisms. Although anger by definition is a generalised, non-specific emotion which does not have a target (Berkowitz, 1993), behavioural reactions instigated by anger vary considerably according to the cause. Hence, different kind of situations on the road may cause varying degrees of anger, but the behavioural responses may not necessarily always depend on the amount of anger. For example, seeing someone speeding in a residential road may make the observer very angry, but may not lead him/her to express his/her feelings to that driver. On the other hand, a pedestrian or a cyclist blocking up traffic may lead drivers to express their anger by several means, from beeping the horn to a physical attack. Since anger experienced in traffic and the resulting aggressive behaviour are largely determined by situational characteristics, it is essential to measure both the amount of anger and the severity of the behavioural response in particular situations. The first aim of this study is to investigate the relations between self-reported driver anger and aggressive driving instigated by different situations.

1.2. The role of frustration and anger in aggressive driving

The majority of media reports and some traffic researchers (see Shinar, 1998) see the main cause of 'road rage' incidents as frustration caused by traffic congestion and dense traffic. In his schematic representation of the causes of the aggressive driving, Shinar (1998) suggests that frustrating situations may lead to hostile and instrumental aggression, but also to 'displaced' aggression when aggression cannot be expressed because of cultural norms or enforcement. These views about aggression as a drive date back to the classical frustration–aggression hypothesis by Dollard et al. (1939). According to the frustration–aggression hypothesis: (1) frustration, defined as blocking or thwarting of some form of ongoing, goal-directed behaviour, always leads to some form of aggression; and (2) aggression always stems from frustration (Dollard et al., 1939). In Dollard et al.'s (1939) theory frustration was not assumed to cause aggression directly but rather to induce an instigation toward aggression (aggressive drive), which then facilitates aggressive behaviour (Baron and Richardson, 1994). Although the frustration–aggression hypothesis provides in its simplicity an appealing explanation of aggression, it has been widely criticised as being far too sweeping in scope, ignoring the fact that human aggression is a highly complex form of behaviour (for a review see Baron and Richardson, 1994; Berkowitz, 1993). Closer evaluation of the aggression–frustration hypothesis shows that the first claim by Dollard et al. (1939) ('frustration always leads to aggression') is simply not true in many cases. As pointed out by Baron and Richardson (1994), frustrated individuals do not always engage in aggression against each other, but may instead demonstrate a wide variety of behaviours ranging from resignation and despair to active attempts to overcome the obstacle. For example, a driver stopped by the police because of speeding might regret his/her behaviour rather than get angry with the police. In addition, Dollard et al.'s second claim ('aggression always stems from frustration') is too far reaching. For example, material or social rewards related to an aggressive act may explain certain behaviours better than frustration and anger. A young male driver, for example, might drive aggressively mainly because of social pressure and the need for approval from peers.

In the context of aggressive driver behaviour, the frustration–aggression hypothesis may explain anger and aggressive behaviour caused by impeded progress quite well. In these situations, a driver's goal-directed behaviour is blocked, which may cause anger and, in turn, aggressive behaviour. Hence, the thwarting of one's progress can lead to both emotional aggression aimed at expressing one's anger to the frustrator but also to instrumental aggression aimed at simply removing the obstacle from one's way. It should be noted, however, that in the latter case no anger is necessarily involved and the aggressive reaction is related not to the degree of frustration but rather to the situational characteristics. It can be claimed that the usefulness of the frustration–aggression hypothesis is limited to those forms of aggressive driving which stem from anger caused by thwarting one's behaviour.

In addition to frustration caused by impeded progress, aggressive driver behaviour may be seen as a reaction to an insult by a fellow-driver or as an expression of moral disapproval of another motorist's reckless driving. These reactions correspond to the direct hostility scale and the reckless driving scale of the UK DAS.

Neither of these cases involve frustration or thwarting of on-going goals. In the former case, an other motorist calls into question one's skills as a driver which may lead to emotional aggression. In the case of reckless driving, while the act is not targeted directly at the observer, it violates a traffic code or a social norm. The observing driver may feel obliged to 'teach a lesson' to the reckless fellow motorist. In some cases the reaction to reckless driving may be fuelled by anger (emotional aggression), in other cases by moral 'obligation' to correct other driver's behaviour (instrumental aggression). In conclusion, these few examples show that aggressive driver behaviour is a complex phenomenon resulting from various situations and psychological factors.

1.3. Individual determinants of aggressive behaviour on the roads: personality, age, driving experience and gender

A common allegation in media reports of 'road rage' is that the personality of some people changes when they get behind the wheel: normally reasonable and mild 'Dr Jekyll' turns to aggressive and violent 'Mr Hyde'. According to the aggression literature, however, a tendency (a trait or a learned response pattern) to aggress is fairly stable, so that the characteristics related to a person's aggressive behaviour persist over time and across a variety of situations (Baron and Richardson, 1994; Berkowitz, 1993; Scheier et al., 1978). In addition, highly aggressive persons display their aggressiveness in a variety of ways (Berkowitz, 1993). It seems, therefore, justifiable to claim that these individual differences in aggression proneness would be reflected in traffic behaviour. Furthermore, it can be supposed that a person who usually engages in a particular type of aggression (e.g. verbal or physical) would also follow that inclination behind the wheel. Similarly, it can be expected that an anger-prone person gets angry in traffic easily. In his review of studies about personality factors and driving behaviour, Beirness (1993) concluded that hostile and aggressive tendencies can influence driving behaviour in a manner that increases the likelihood of crash involvement. In addition to anger and aggression, impulsiveness might be related to the frequency and degree of aggressive reactions in a provoking situation. Since impulsive persons tends to act on the spur of the moment, often without considering every aspect of the situation and possible consequences of behaviour, it can be hypothesised that impulsive persons are more prone to interpret other drivers' behaviour as provocation and to respond according to that interpretation. The second aim of this study is to investigate how self-reported verbal and physical aggressiveness, anger and impulsiveness are related to anger experienced while driving and driver aggression.

A further general finding in the literature is that of increased accident liability among young drivers (see Elander et al., 1993; Parker et al., 1995; Summala, 1987). There is evidence from observational studies that young drivers have a more risky driving style than older drivers. For example, they drive faster, use shorter following distances and are more likely than older drivers to violate traffic lights (see Summala, 1987). In addition to observational studies, self-reported violating behaviour seems to be strongly related to being young (Åberg and Rimmo, 1998; Blockley and Hartley, 1995; Lawton et al., 1997; Reason et al., 1990). It is also feasible that younger drivers are more prone to get annoyed by other drivers and react by in a more violent way than older drivers.

In addition to age, a driver's driving experience might influence the likelihood of aggressive behaviour in traffic. Life-time mileage and years spent in traffic are naturally related to a driver's age, so more experienced and, thus, older drivers can be expected to be less quick to take offence and act aggressively than young and inexperienced drivers. Alternatively, irrespective of age, driving experience and the related exposure to frustrating traffic conditions and inconsiderate fellow drivers might actually lessen a driver's likelihood of become angered in traffic. The frustration engendered by traffic congestion might actually decline over time as drivers learn to cope with congestion by changing driving style and reserving more time for the journey (see Lajunen et al., in press). Similarly, drivers with a high annual mileage probably experience more conflict situations than other drivers who do not drive often. It can be supposed that frequent exposure to conflicts might heighten a driver's threshold for getting annoyed and teach him/her to cope with frustration.

Studies about gender differences in traffic behaviour usually show that men are more frequently involved in accidents and tend to have more serious accidents than women (Evans, 1991). Maycock et al. (1991) found that women were at lower risk of having an accident than males at all ages, and the difference was greatest for young and inexperienced drivers. These differences in accident proneness between male and female drivers may be due to different driving styles: males are more likely to be involved in accidents caused by violations such as speeding, drinking and risk-taking than females (see Storie, 1977). It has been found in several studies that men commit dangerous traffic violations more frequently than women do (Åberg and Rimmo, 1998; Blockley and Hartley, 1995; Lawton et al., 1997; Reason et al., 1990). In their study about different types of traffic violations, Lawton et al. (1997) divided violations into highway code and interpersonally aggressive violations and found that men reported more aggressive violations than women did. In these studies only the frequency scores for men and women were compared.

It should be noted, however, that the way a driver experiences and, finally, expresses his/her anger might also be related to gender.

In addition to these findings concerning gender differences in traffic behaviour, several studies of general human aggression show that men are more aggressive than women on average, and more likely to engage in overt physical aggression (for a review see Berkowitz, 1993). In their meta-analytical review, Eagly and Steffen (1986) found that this sex difference in aggression was, however, not consistent across all the studies they reviewed. In addition, the magnitude of the sex difference was related to characteristics of the studies (Eagly and Steffen, 1986). For example, men were found to be more prone to aggression that produces pain or physical injury than to aggression that causes psychological or social harm (Eagly and Steffen, 1986). Women were more concerned about the outcome (harm to the target, guilt, danger to oneself) than men. Another meta-analytical study (Bettencourt and Miller, 1996) showed that provocation attenuates the difference between sexes: gender differences in appraisals of the provocation intensity and the fear of retaliation partially mediate the attenuating effect of provocation. In sum, the relationship between gender and aggressiveness seems to be very complex. In the present study, therefore, the relationships between general anger/aggression and driver anger/aggression were modelled separately for men and women.

2. Method

2.1. Participants

The data reported in the present paper were collected as a part of a large survey of aggressive driving in Britain (Lajunen et al., 1998; Parker et al., 1998). Since the aim of the survey was to collect the experiences and opinions of the driving public concerning aggressive driving, advertisements in local newspapers and radio were used to solicit drivers who would be interested in taking part in a survey. This kind of sampling strategy was chosen in order to have a sufficiently large body of data to analyse, because at least extreme forms of aggressive driver behaviour are still rare according to previous studies. Interested drivers were asked to leave their names and addresses on an answering machine dedicated to this purpose. A copy of the questionnaire together with a Freepost envelope was mailed to a total of 437 volunteers who left their names and addresses on the answer machine. Of these, 270 were returned before a cut off date some 6 weeks after mailing, a response rate of 60%. One hundred and seventy one respondents were male, 98 female and one respondent did not indicate his/her gender. The mean age of respondents was 44 years (range 22–80 years, SD = 13.6 years), and the average annual mileage driven 16 200 miles (SD = 17 400). Female drivers in this sample were younger ($M = 41.1$, SD = 12.0 years) than male drivers ($M = 46.8$, SD = 14.0 years). Women also had a lower annual mileage ($M = 10\,000$, SD = 6300 miles) than men ($M = 19\,700$, SD = 20 500 miles). The distribution of age, gender and annual mileage had all the appearances of a typical sample of UK drivers.

In the general instructions, respondents were asked to answer the questions honestly, read the questions carefully but not to spend too much time on each item. Participants were also assured that the answers would be treated in strict confidence and anonymity. Subjects were asked not to write their names on the questionnaires in order to minimise the chances of socially desirable answering.

2.2. Measures

2.2.1. Driving anger

The driving anger scale (Deffenbacher et al., 1994) consists of 33 potentially anger provoking driving situations, divided into six sub-scales: discourtesy, illegal driving, hostile gestures, slow driving, traffic obstructions, and police presence. In our previous study based on factor analysis we found, however, that the original factor structure was not feasible in a British sample (Lajunen et al., 1998). The original 'police presence' and 'traffic obstruction' scales were omitted and a new 21-item three-factor (progress impeded, reckless driving, and direct hostility) structure introduced. This new shorter DAS scale was named as UK driving anger scale (UK DAS). In the UK DAS respondents rate the amount of anger generated by each situation on a 5-point Likert scale (1, not at all angry; 2, a little angry; 3, fairly angry; 4, very angry; 5, extremely angry) as in the original DAS. UK DAS items are listed in Table 1.

The original version of the driving anger scale measured only experienced anger. However, it can be supposed that some situations may be very anger provoking, but do not generally lead to aggressive behaviour. On the other hand, the threshold of aggressive behaviour may be lower in some situations, or for some individuals. In order to measure expressed anger in addition to experienced anger, the most likely reaction by the drivers in potentially provoking situations was asked by using seven alternatives (1, no reaction; 2, beep horn and/or flash lights; 3, gesture at the other road user; 4, swear at and/or verbally abuse the other road user; 5, drive close to/follow the other road user; 6, stop your vehicle and get out, read to argue; 7, get out of car, prepared to engage physically with the other road user). The following instruction was used in UK DAS: 'The following set of statements is concerned with your reactions to the behaviour of other road

users whom you believe to be having effect on your driving. Please read each of the statements and indicate how much each of the situations would make you angry. Please indicate your most likely reaction to each of the situations'. The alpha values for the anger and reaction to anger scales are listed in Table 2, separately for women and men.

2.2.2. Aggression questionnaire

The aggression questionnaire (Buss and Perry 1992) measures physical aggression, verbal aggression, anger, and hostility. However, in this study only the scales measuring physical aggression, verbal aggression and anger were used. The physical aggression scale included nine items, like 'Once in a while I can't control the urge

Table 1
UK DAS items, means for self-reported anger and aggressive reaction together with Kendall's tau correlation coefficients between anger and aggressive reaction scales

Item	Anger mean	Reaction mean	Correlation[b]
Progress impeded			
1[a]. Someone in front of you does not move off straight away when the light turns to green.	1.70	1.69	0.24
3. A pedestrian walks slowly across the middle of the street, slowing you down.	1.74	1.44	0.46
4. Someone is driving too slowly in the outside lane, and holding up traffic.	2.47	2.00	0.38
8. Someone cuts in and takes the parking spot you have been waiting for.	3.10	2.96	0.53
9. Someone is driving more slowly than is reasonable for the traffic flow	2.17	1.59	0.41
10. A slow vehicle on a winding road will not pull over and let people pass.	2.33	1.68	0.51
15. Someone speeds up when you try to pass them.	2.60	1.89	0.47
16. Someone pulls out right in front of you when there is no-one behind you.	2.48	2.03	0.50
21. A cyclist is riding in the middle of the lane and slowing traffic.	2.06	1.64	0.36
Scale	**2.29**	**1.89**	**0.62**
Reckless driving			
2. Someone is driving too fast for the road conditions.	2.26	1.36	0.24
5. Someone is driving very close to your rear bumper.	3.09	2.08	0.33
6. Someone is weaving in and out of traffic.	2.33	1.32	0.28
7. Someone cuts in right in front of you on the motorway.	2.91	2.11	0.29
11. Someone backs out right in front of you without looking.	2.72	2.26	0.42
12. Someone runs a red light or stop sign.	2.41	1.43	0.34
13. Someone coming towards you does not dim their headlights at night.	2.46	1.89	0.27
14. At night someone is driving right behind you with bright lights on.	2.67	1.94	0.31
19. Someone is driving well above the speed limit.	2.06	1.23	0.32
Scale	**2.55**	**1.75**	**0.32**
Direct hostility			
17. Someone makes an obscene gesture towards you about your driving.	2.51	2.35	0.48
18. Someone beeps at you about your driving.	2.07	1.94	0.49
20. Someone shouts at you about your driving.	2.22	2.19	0.49
Scale	**2.26**	**2.15**	**0.25**

[a] Note: the number before the item reflects the number in the item sequence in the questionnaire sheet.
[b] $P<0.001$ for all correlation coefficients.

Table 2
Means, standard deviations and alpha reliability coefficients for three driver anger and three driver aggression (reaction) scales for women and men separately

	Number of items	Women			Men		
		M	SD	α	*M*	SD	α
Driver anger[a]							
Reckless driving	9	2.64	0.75	0.90	2.50	0.72	0.86
Direct hostility	3	2.40	0.88	0.87	2.18	0.96	0.87
Progress impeded	9	2.27	0.61	0.87	2.31	0.65	0.87
Aggressive reaction							
Reckless driving	9	1.68	0.60	0.80	1.78	0.70	0.86
Direct hostility	3	2.02	1.07	0.88	2.23	1.34	0.91
Progress impeded	9	1.81	0.67	0.76	1.94	0.79	0.84

[a] Lajunen et al. (1998).

to strike another person', 'If someone hits me, I hit back' and 'I get into fights a little more than the average person', whereas the verbal aggression scale had five items, like 'I tell my friends openly when I disagree with them', 'I often find myself disagreeing with people', and 'I can't help getting into arguments when people disagree with me'. The anger scale included seven items, e.g. 'I flare up quickly but get over it quickly', 'When frustrated, I let my irritation show', and 'Some of my friends think I'm a hothead'. Following instruction was used: 'How well do the following descriptions characterise you? Please express your agreement or disagreement with each statement, selecting a number from the scale'. The items were scrambled to avoid pile up of items from any of the factors. Responses were recorded on a five-point scale running from 0 (strongly disagree) to 4 (strongly agree). The internal consistency of the scale scores were evaluated by Cronbach's alpha (Cronbach, 1951). The alpha values for physical aggression, verbal aggression, and anger scales were 0.85, 0.74, and 0.85, respectively.

2.2.3. Impulsiveness questionnaire (I7)

It addition to general aggressiveness, impulsiveness might be related to readiness to react aggressively in annoying situations on the road. Since situations change rapidly in traffic, expressing anger, for example by honking or flashing lights, might require some degree of impulsiveness. Impulsiveness was measured by using Eysenck's impulsiveness questionnaire (I7) which measures impulsiveness, venturesomeness, and empathy (Eysenck et al., 1985). In the present study the 19-item impulsiveness scale (Cronbach's alpha was 0.82) was used. The impulsiveness scale consisted of items like 'Do you often do by things on impulse?', 'Are you an impulsive person?' and 'Do you usually make up your mind quickly?'. Respondents answered to the items by using 'yes' and 'no' answers.

3. Results

The first aim of this study was to investigate the relationships between driver anger and self-reported aggressive driving instigated by different situations. In order to study the relationships between driver anger evoked by different traffic situations and drivers' (aggressive) reactions to the provocation concerned, rank correlation coefficients (Kendall's tau) between anger and reaction scores were calculated for each of the UK DAS items.

The second objective of this study was to investigate how individual difference variables (verbal and physical aggressiveness, anger and impulsiveness) and background factors are related to anger experienced while driving and self-reported driver aggression. These factors may be related to both anger and self-reported behaviour or, alternatively, only to anger or behaviour. Hence, the influence of personality and background factors on behaviour may be either direct or mediated by anger. Multiple regression and structural equation techniques were used to construct models for describing the relationships between personality and background factors, self-reported anger and aggressive driver behaviour.

3.1. Correlations between driver anger and aggressive reaction in UK DAS situations

The means and standard deviations of the 21 UK DAS anger and aggressive reaction items together with correlation coefficients are presented in Table 1. Table 1 shows that the situation described in items 8 ('Someone cuts in and takes the parking spot you have been waiting for') and 5 ('Someone is driving very close to your rear bumper') elicited the highest amount of anger. Interestingly, having one's parking spot taken (item 8) provoked a more severe aggressive reaction than having one's rear bumper hugged (item 5) although the latter act poses a far more serious risk to safety than the former. In the former case, however, the recipient driver has more means of showing his/her annoyance to the aggressor. Variation in differences between anger and aggressive reaction means as well as in correlation coefficients in the 21 UK DAS items show that a given amount of anger does not necessarily lead to a reaction of the same severity (Table 1).

Table 1 shows that items 1 ('Someone in front of you does not move off straight away when the light turns to green') and 2 ('A pedestrian walks slowly across the middle of the street, slowing you down') seem to be the least irritating situations whereas drivers' reactions to the situations in items 19 ('Someone is driving well above the speed limit') and 6 ('Someone is weaving in and out of traffic') were the least extreme. Again, the difference between anger scores and reactions show that other motorists' risky driving might be seen as socially unacceptable and irritating, but may not provoke aggression. Hence, reactive aggression among drivers seem to depend not only on the level of anger, but also on situational characteristics and the nature of the provocative act.

3.2. Relationships between aggressiveness, anger and aggressive reaction: path models

The main aim of this study was to investigate how general anger, inclination to verbal and physical aggression in general, and age and exposure (annual mileage) are related to driver anger, and finally, to aggressive behaviour on the roads. Anger provoked by impeded

progress, direct hostility and reckless driving were modelled separately, because the psychological meanings of these three sources of anger in traffic are distinct (Lajunen et al., 1998). In addition, separate models were constructed for men and women, because the aggression literature indicates that not only the frequency and severity of aggressive behaviour but also the structure of aggression (e.g. instrumental versus emotional, verbal versus physical) might be different among men and women.

3.3. Selection of variables to the path analyses by multiple regression analysis

Prior to the path analyses, correlation and multiple regression analyses (six analyses in total) were conducted to select variables for inclusion in the models. Before regression analyses, Pearson product–moment correlations and multicollinearity statistics among independent variables were calculated. No signs of multicollinearity were found (value of the conditioning index was less than 0.30).

First, in six regression analyses (three for both genders), self-reported anger evoked by impeded progress, reckless driving and direct hostility were used as dependent variables. In each regression analysis, age and annual mileage were first forced into the model, and then scores on the aggression questionnaire scales (verbal and physical aggression and anger) and the impulsiveness scale (I7) were entered into the model by using the forward selection method (probability of F-to-enter: $P < 0.05$). These analyses were carried out to see which background and personality factors are related to anger evoked by impeded progress, reckless driving and direct hostility. The results of regression analyses showed that anger evoked by impeded progress was predicted by general anger ($\beta = 0.28$, $P < 0.05$) and verbal aggression ($\beta = 0.25$, $P < 0.05$) among women ($R^2 = 0.29$), and by age ($\beta = -0.33$, $P < 0.001$) and general anger ($\beta = 0.35$, $P < 0.001$) among men ($R^2 = 0.28$). Anger related to other drivers' reckless driving was related to mileage ($\beta = -0.25$, $P < 0.05$) and verbal aggression ($\beta = 0.34$, $P < 0.01$) in female data ($R^2 = 0.17$), and to age ($\beta = -0.23$, $P < 0.01$) and verbal aggression ($\beta = 0.27$, $P < 0.001$) in male data ($R^2 = 0.14$). Among women ($R^2 = 0.27$), anger evoked by direct hostility was predicted only by verbal aggression ($\beta = 0.42$, $P < 0.001$) whereas among men ($R^2 = 0.25$) it was predicted by general anger ($\beta = 0.44$, $P < 0.001$).

Second, six regression analyses (three analyses each for men and women) were conducted to investigate which background and personality factors were related to an aggressive reaction provoked by impeded progress, reckless driving and direct hostility. In these analyses, aggressive reaction evoked by impeded progress, reckless driving and direct hostility were used as dependent variables. Age and annual mileage were first forced into the model and then scores on the aggression questionnaire scales (verbal and physical aggression and anger) and the impulsiveness scale (I7) were entered into the model by using the forward selection method (probability of F-to-enter: $P < 0.05$). Results showed that reactions to impediment of progress were predicted by general anger ($\beta = 0.33$, $P < 0.01$) and physical aggression ($\beta = 0.26$, $P < 0.05$) among women ($R^2 = 0.34$), and by age ($\beta = -0.36$, $P < 0.001$) and general anger ($\beta = 0.33$, $P < 0.001$) among men ($R^2 = 0.30$). Reactions to other drivers' reckless driving were related to general anger ($\beta = 0.34$, $P < 0.01$) and physical aggression ($\beta = 0.28$, $P < 0.01$) among women ($R^2 = 0.36$), and to age ($\beta = -0.26$, $P < 0.01$), general anger ($\beta = 0.18$, $P < 0.05$) and physical aggression ($\beta = 0.18$, $P < 0.05$) among men ($R^2 = 0.22$). Finally, reactions to direct hostility were related to age ($\beta = -0.29$, $P < 0.01$), mileage ($\beta = -0.22$, $P < 0.05$), and verbal ($\beta = 0.30$, $P < 0.01$) and physical aggression ($\beta = 0.26$, $P < 0.01$) among women ($R^2 = 0.41$), and to age ($\beta = -0.21$, $P < 0.01$) and verbal ($\beta = 0.31$, $P < 0.001$) and physical aggression ($\beta = 0.26$, $P < 0.05$) among men ($R^2 = 0.37$).

For both sexes, the severity of aggressive reaction (average percentage for women was 37% and for men 30%) was better predicted than was level of anger (24% for women and 22% for men), from these independent variables. This result may be due to the different levels of assessment: felt anger might be more difficult to measure or express than overt behaviour in a particular situation. In addition, the results show that in each regression analysis the independent variables explained a larger amount of variance among women than among men. Hence, female anger/aggression on the roads seems to be more explicable in terms of the variables used here than that of men.

3.4. Final models for anger and aggressiveness while driving

Three path models were constructed to study how general aggressiveness, anger and impulsiveness as well as age and mileage are related to anger and aggressive reactions on the road provoked by impeded progress, reckless driving, and direct hostility. The preliminary models were based on the following assumptions: (1) the amount of driver anger determines the severity of behavioural response to some degree; (2) personality (verbal and physical aggression, general anger, impulsiveness) and background factors (age and annual mileage) may have a direct effect on aggressive driving behaviour; (3) the influence of personality and background factors on aggressive behaviour may be fully or partly mediated by driver anger; and (4) the aggression questionnaire scales (verbal, physical and anger) have

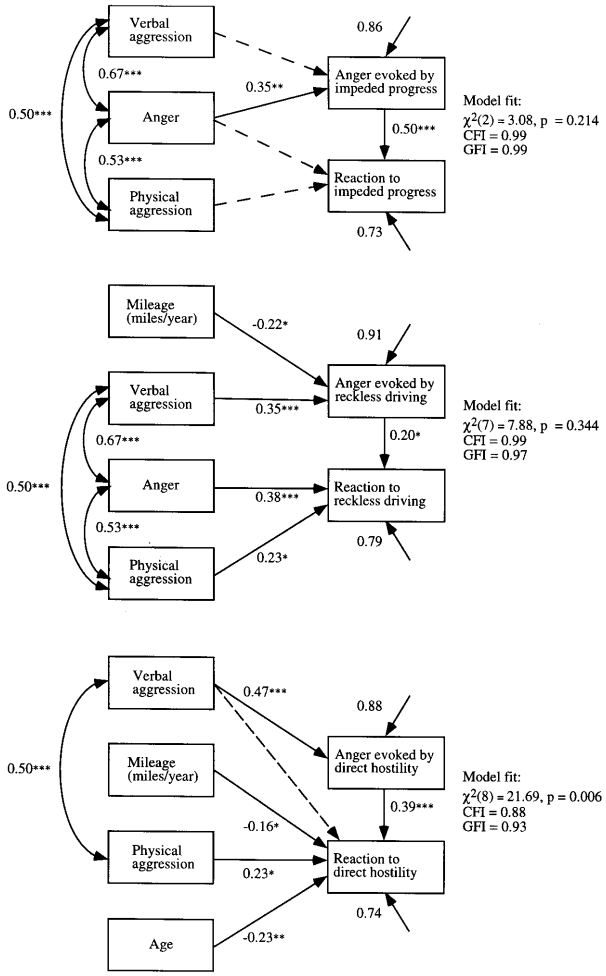

Fig. 1. Path models for relationships among aggression, age, mileage, self-reported driver anger and driver aggression in the case of impeded progress, reckless driving and direct hostility in the female data. Numbers on arrows are standardised path coefficients (* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$). Solid lines were used to mark statistically significant paths whereas statistically non-significant paths were marked with dotted lines.

strong inter-correlations. Hence, the models developed had three levels: general factors (personality factors, age and mileage), situation-specific emotion (anger), and finally, situation-specific behaviour.

Selection of variables for inclusion in the path models was based on the preliminary correlations and multiple regression analyses. Only those variables which predicted driving anger and/or aggressive driver behaviour in the preliminary regression analyses were selected for the path analyses. Hence, impulsiveness was dropped from every model among women and men, because it did not predict driver anger or aggressive behaviour in the regression analyses.

The path analyses were conducted using EQS (Bentler, 1995). Maximum likelihood estimation was employed to estimate all models. The fit of the models was assessed by using χ^2 statistics, the goodness-of-fit index (GFI), and the comparative fit index (CFI) (for a review of characteristics of different fit indices see Byrne, 1998). The χ^2 statistic was used as a measure of fit between the sample covariance and fitted covariance matrices rather than as a test statistic as proposed by Jöreskog and Sörbom (1996). Values for GFI and CFI range from 0 to 1, with values greater than 0.90 indicating an acceptable fit to data (Bentler, 1990). The cut-off point for statistically significant path coefficients was set to $P < 0.05$. Post-hoc model modifications were not applied, because they seemed not to be theoretically sound or necessary.

3.4.1. Fit of the models

Fig. 1 shows the final path models for impeded progress, reckless driving, and direct hostility for women. Corresponding models for men are displayed in Fig. 2. Fig. 1 shows that the models for predicting anger and aggression evoked by impeded progress and reckless driving fitted the data well among women, with both CFI and GFI values exceeding 0.90. The fit of the model for direct hostility was less impressive: the CFI value of 0.88 indicated a poor fit to the data. Hence, the model for explaining female drivers' anger and anger reactions evoked by direct hostility should be interpreted with caution. Fig. 2 shows that all three models had an acceptable fit to the male data. The models for impeded progress and reckless driving fitted the male data less well than the female data whereas the model obtained for direct hostility had a better fit among men than among women.

3.4.2. Models for anger provoked by impeded progress

Fig. 1 shows that only general anger predicted anger related to impeded progress among women. In addition, the influence of general anger was fully mediated by driver anger. In the male data (Fig. 2), however, the influence of general anger on aggressive behaviour was only partly mediated, i.e. there was both an indirect and a direct path to aggression. In addition to anger, a male respondent's age was related (negatively) to both driver anger and aggression (Fig. 2).

3.4.3. Models for anger related to reckless driving

In the case of anger and aggression among females arising from a fellow motorist's reckless driving, physical aggression and general anger had a direct path to driver aggression whereas the effects of mileage and verbal aggression on the reaction to reckless driving were fully mediated by driver anger (Fig. 1). Fig. 2 shows that among male drivers general physical aggression had a direct path to driver aggression and the effect of verbal aggression on driver aggression was fully mediated by driver anger. However, age seemed to be almost equally negatively related both to the level of anger and the severity of reaction among the male

drivers. Contrary to the model obtained for women, general anger among men did not seem to have a relation to aggressive behaviour provoked by reckless driving. Among men, verbal aggression was related to anger evoked by reckless driving and physical aggression predicted reactions to reckless driving.

3.5. Models for anger related to direct hostility

The last of the three models was constructed to explain anger and aggression related to direct hostility. Fig. 1 shows that among women annual mileage, physical aggression and age all had direct paths to reaction to direct hostility, and that the influence of verbal aggression on aggressive reaction was mediated by driver anger. Similarly, among male drivers physical aggression and age were directly related to the severity of reaction to direct hostility. The effect of general anger among males on aggression in response to direct hostility was fully mediated by driver anger (Fig. 2).

In conclusion, self-reported verbal and physical aggression and general anger all seemed be important factors explaining drivers' self-reported feelings and reactions to other motorists' frustrating, insulting or morally reprehensible behaviours. Interestingly, self-reported impulsiveness did not seem to relate to anger or aggression on the roads in the present data.

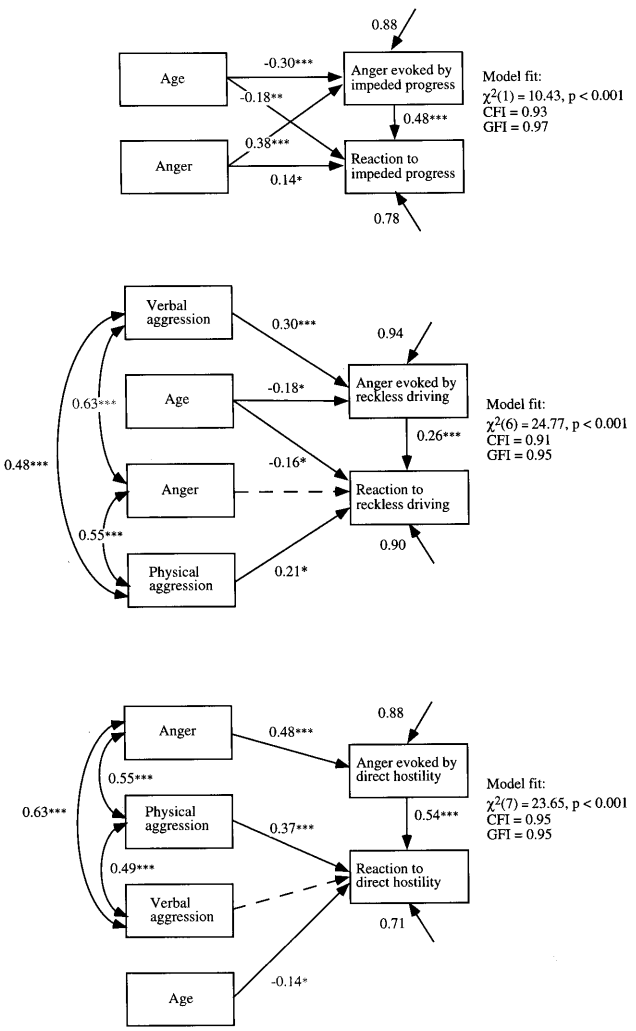

Fig. 2. Path models for relationships among aggression, age, mileage, self-reported driver anger and driver aggression in the case of impeded progress, reckless driving and direct hostility in the male data. Numbers on arrows are standardised path coefficients (* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$). Solid lines were used to mark statistically significant paths whereas statistically non-significant paths were marked with dotted lines.

4. Discussion

4.1. Anger as an incentive to aggressive driver behaviour

The objective of the present study was to investigate how self-reports of general aggressiveness are related to the self-reported anger and aggression provoked by impeded progress, other drivers' reckless driving, and direct hostility. It was supposed that these three potential sources of anger and aggression have specific psychological meanings which partly determine both the amount of anger evoked and the behavioural responses. In order to measure the links between emotion (anger) and behaviour (aggression), a new response scale was added to the British version of the driver anger scale (UK DAS) (Deffenbacher et al., 1994; Lajunen et al., 1998). Scores on this scale seemed to be internally consistent in the present data, in relation to a driver's reaction to an impediment of his/her progress, to other driver's reckless driving, and to direct hostility by a fellow motorist.

Correlations between the UK DAS anger responses and self-reported reactions ranged from 0.24 to 0.53 indicating not only that the level of anger is related to the severity of aggressive reaction in the situation concerned, but also that the strength of the anger-aggression association varies according to situational factors. For example, seeing someone speeding in a residential road may make drivers very angry without giving them the chance to express that anger. On the other hand, situations involving a higher level of interaction between drivers, like jumping the queue for a parking spot, may lead to extreme aggression. Hence, driver anger and behavioural reactions to that anger seem to depend partly on situational characteristics.

A popular explanation of aggressive behaviour on the roads claims that interpersonal aggression on the roads is a result of anger or frustration caused by thwarting one's goals. According to this view, drivers driving on congested roads accumulate frustration which then may lead to 'road rage' and violence towards a fellow road-user. Anger is, thus, seen as a drive

which drivers are unable to control. Although this application of the frustration-aggression hypothesis (Dollard et al., 1939) may be correct in some cases, on the whole drivers seem to adapt well to conditions on the roads. In their study using a diary approach to measuring driver anger, Underwood et al. (1999) did not find any relationship between congestion and reports of anger. In addition, in our previous study of the DAS (Deffenbacher et al., 1994) traffic obstructions like traffic jams or road constructions did not seem to provoke anger among British drivers (Lajunen et al., 1998). In the present study, UK DAS items describing situations where a car in front does not move off straight away when the light turns to green and being slowed down by a slow pedestrian seemed to be the least irritating situations. Obviously these kinds of impediments are so common in today's traffic in Britain that drivers can expect them to occur and therefore do not become unduly frustrated. Hence, the frustration–aggression hypothesis might be more applicable in situations where drivers' goals are dramatically blocked by a sudden and unexpected event.

In addition to frustration caused by impeded progress, other persons' reckless driving and direct hostility provoke anger and may lead to aggressive behaviour. It can be suggested, however, that the psychological processes behind the anger provoked by reckless driving or hostility are quite different. In the former case someone violates a legal and a social norm whereas in the latter case the act is clearly aggressive and aimed at the other motorist. Hence, the cases of direct hostility should lead to a more severe response than the violation of rules. In the present study the relation between anger and reaction evoked by witnessing reckless driving was indeed weaker than that between anger and aggression related to direct hostility. These results suggest, therefore, that a physical impediment may not be the only cause of anger while driving. In this data set, both the violation of a social norm and personal insult emerged as important predictors of driving anger.

4.2. General aggressiveness and aggressive driver behaviour

According to the famous slogan 'man drives as he lives' (Tillmann and Hobbs, 1949), implying that people express their personality, which may include aggressiveness, behind the wheel. In the present study the relationships between verbal and physical aggression, anger, impulsiveness and driver anger and aggression were studied using self-report methodology. Separate path analyses for female and male drivers indicated that the influence of verbal aggressiveness on aggressive behaviour was always fully mediated by driver anger. Men and women reporting themselves as being verbally aggressive in general seemed to get angered by other drivers' reckless driving and the more they got angered the more likely an aggressive response was. Verbal aggression, however, was not statistically significantly related to the level of anger/aggression evoked by having one's progress impeded. Hence, argumentative persons seem not to tolerate other drivers violations, but are not especially impatient in comparison to other, less verbally aggressive drivers.

A general tendency to resort to physical aggression and violence was found to be directly related to the severity of reaction to other drivers' reckless driving and hostility. This direct relationship was found among both men and women. The lack of relationship between physical aggression and driver anger indicates that emotion, i.e. anger, does not always precede aggressive driving behaviour. Contrary to theories seeing aggression as a result of frustration and anger, this finding supports the view that aggression may actually be used by some as a social problem-solving strategy (Baron and Richardson, 1994; Berkowitz, 1993). According to the social-cognitive information-processing approach, the development of aggressiveness can be traced back to the social learning experiences. In the context of driving, aggressive behaviour is usually well tolerated and a reaction from other drivers is unusual. It can be supposed, therefore, that some drivers may have learned to resort to aggressive behaviour in situations which do not have any emotional content. In such cases the driver uses aggressive behaviour as an instrument for reaching his/her goals — not as an expression of an intense emotion.

In conclusion, within the current data set, an inclination to verbal aggression seems to influence driver aggression via driver anger whereas physical aggressiveness directly increases the likelihood of aggressive driver behaviour. The third aggression questionnaire (Buss and Perry, 1992) scale, general anger, had more complicated relationships to driver anger and aggression. Among females, the effect of general anger on driver aggression was fully mediated by driver anger in the case of impeded progress, whereas anger had a direct path to aggressive behaviour in the case of reckless driving. Among men, however, the effect of anger on aggressive response to impeded progress was only partly mediated. In addition, driver anger mediated the influence of general anger on aggression in the case of direct hostility.

4.3. Gender differences

According to the aggression literature, the role of gender in aggressive behaviour and anger is a very complex issue. This does not, however, mean that gender differences do not exist. Even when no difference in aggression scores can be found, the structure of aggression may be different for men and women. It has been

found, for example, that men endorse instrumental beliefs about aggression to a greater extent than women whereas women endorse expressive beliefs more than men (Archer and Haigh, 1999). In addition, it has been found that men commit dangerous traffic violations and behave aggressively on the roads more frequently and than women do (Åberg and Rimmo, 1998; Blockley and Hartley, 1995; Lawton et al., 1997; Reason et al., 1990). In the present study, therefore, models of driver aggression were constructed for men and women separately.

The most remarkable difference between models constructed for men and women (Figs. 1 and 2) was that among men, respondent's age was related to aggressive behaviour measured by each of the three UK DAS scales whereas among women age was related only to aggression provoked by direct hostility. Age effects on male aggression were partly mediated by driver anger in the situations of impeded progress and reckless driving. These results are in line with the earlier findings that greater accident risk and more deviant driving styles are associated with being male and young (see Elander et al., 1993; Parker et al., 1995; Summala, 1987). According to the models constructed in the present analyses, age seems to lead to a decrease in both the amount of anger felt in traffic and the severity of aggressive reactions among men.

The second interesting difference between the models for female and male drivers is in the role of exposure to traffic conditions, i.e. annual mileage. Among women annual mileage was negatively related to amount of anger experienced when witnessing reckless driving. In addition, high mileage had a negative relation to the degree of aggressive response in the case of direct hostility. Mileage did not seem to relate to anger or aggression evoked by impeded progress. Among male drivers annual mileage was not related to the amount of driver anger or aggression in any case. These differences emphasise the different meaning of exposure to traffic for men and women. Women with high annual mileage and frequent exposure to frustrating situations seem to get less angered when seeing reckless driving and behave less aggressively when a fellow motorist is hostile. It is possible that women with high annual mileage meet reckless driving and hostility on the roads so often that they do not take it as a personal insult which they should react to. The lack of relation between mileage and aggression among men might indicate that male drivers may have more fixed views about themselves as drivers than females. Among men, increased exposure to traffic seems not to change this view.

Verbal aggression seemed to have a more important role among female drivers than among men. This might indicate that verbal aggression and being argumentative is generalised to driving behaviour as well. Surprisingly, no differences in the role of physical anger were found between men and women. It might have been expected that physical aggression would have stronger links to aggressive driver behaviour among men than women. One explanation of the similar role of general aggressiveness in driver aggression for both sexes might be that even the most aggressive respondents reported mainly mild forms of aggressive driver behaviour in the present study. Sounding the horn, flashing the lights or hand gestures are usually relatively safe ways of expressing one's anger and do not lead to physical confrontation. Since women have been found to be more concerned about the risk of retaliation and physical or psychological damage than men (Eagly and Steffen, 1986), and aggression on the roads very seldom contains severe risk, it may be that large differences between men and women in driver aggression should not be expected.

4.4. Limitations of the study

The present study has clear methodological limitations. First, the respondents were media-recruited volunteers from a single region in the UK (the Northwest). Whilst the distribution of age, sex and annual mileage had all the appearances of a typical sample of UK drivers, some caution must be urged in generalising the results. It is possible that the respondents were particularly interested in traffic matters or had unsettling experiences concerning 'road rage'. In fact, the aim of sampling used in this study was to reach those drivers who actually had experience of aggressive driver behaviour. According to previous studies (Joint, 1995; Lex Motor Group, 1996), extreme forms of aggressive driver behaviour are still rare and, therefore, a targeted sampling strategy might be the only way to reach drivers with experiences of interpersonal aggression on the roads. It should also be noted that the aim of the present paper was to construct models about relationships between general aggression and self-reported anger and aggression on the roads, not to investigate the prevalence of aggressive driving on the British roads.

Second, the data reported here were based solely on self-reports. As always with self-reports of behaviour, social desirability might have biased the data. It can be claimed that some respondents may have embellished their answers or been economical with the truth. It should be noted, however, that respondents were assured about anonymity (they did not provide their names) and confidentiality. Hence, the subjects did not have any benefits to be gained by lying. Theoretically, the only source of social desirability bias related to this study could be self-deceptive responding, because impression management, i.e. deliberate lying, occurs only when the responses are not anonymous and when re-

spondents gain something by lying (Lajunen et al., 1997; Paulhus, 1991). In the present study, the respondents volunteered to participate the study, because they found the topic important or interesting. It is difficult to understand why anyone would like to participate the study and then give deceitful answers. The possibility of respondents presenting themselves in a socially desirable way (as a good, safe driver) was minimised in this particular survey, because respondents, by taking part, had indicated that they had some experience of driver aggression, and so were perhaps just as likely to exaggerate it. In their study of self-reported and observed driver behaviour, West et al. (1993) found that self-reports of speed, carefulness and deviant driver behaviour correlated significantly with observed driver behaviour. Authors concluded that 'self-reports of certain aspects of driver behaviour can be used as surrogates for observational measures' (West et al., 1993).

In some earlier studies aggressive driver behaviour has been studied by using observations of behaviour on the road. Although in observational studies the self-selection of subjects and social desirability do not distort results, there are other serious problems in observational studies of emotional states, like anger, and aggression on the roads. First, aggressive behaviour on the roads is relatively rare and, therefore, a difficult phenomenon to catch by observation. Second, observations of driver behaviour do not usually tell anything about the motivation behind the behaviour. Since the same behaviour in traffic can often be motivated by aggressive or non-aggressive goals, it is almost impossible to study aggressive driver behaviour by using only observational data. For example, a driver can drive very close to the car in front in order to indicate his/her annoyance to a slow driver. On the other hand, close following distance is usually related to overtaking. The only way to avoid ambiguity of observations is to single the apparently aggressive drivers out from the traffic flow for an interview. This would lead to far more serious problems with social desirability than responding anonymously to a questionnaire. Third, in this study the relationships between personality factors, anger experienced in traffic and driver behaviour were studied. Although observational studies may provide a useful tool for studying prevalence of some behaviours (like speeding, seat-belt use, etc.), personality factors and emotions cannot be measured using observations. It can be claimed that the aims of the present study could not have been met without using personality assessment instruments and self-reports of behaviour.

5. Conclusions

The results presented here suggest that self-reported general aggressiveness is related to self-reported aggression on the roads. In this data set, different types of aggression were found to be related to driver aggression in different ways. The effects of verbal aggression were fully mediated by self-reported driver anger whereas inclination to physical anger had a direct path to aggression. The findings presented here suggest that in addition to the traditional frustration–aggression link (Dollard et al., 1939), driver aggression may stem from insult or moral disapproval. Moreover, the data provide some support for the idea that aggressive driving may be seen as a problem-solving strategy learned along with driving experience and exposure to a variety of traffic situations. Aggressive driving, like human aggression in general, seems to be a highly complex form of behaviour. Clearly, before any firm conclusion can be drawn, the same results would have to be reached using alternative methodology, wherever possible. In order to develop measures for reducing aggressive behaviour on the roads, wide-ranging and theoretically sound studies are needed to reveal the psychological mechanisms behind aggressive driving.

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