



UPPSALA
UNIVERSITET

*Digital Comprehensive Summaries of Uppsala Dissertations
from the Faculty of Social Sciences 8*

Driver Interaction

Informal Rules, Irritation and Aggressive Behaviour

GUNILLA BJÖRKLUND



ACTA
UNIVERSITATIS
UPSALIENSIS
UPPSALA
2005

ISSN 1652-9030
ISBN 91-554-6354-1
urn:nbn:se:uu:diva-5948

Dissertation presented at Uppsala University to be publicly examined in IV, Uppsala Universitet, Uppsala, Friday, October 14, 2005 at 10:15 for the degree of Doctor of Philosophy. The examination will be conducted in Swedish.

Abstract

Björklund, G. 2005. Driver Interaction. Informal Rules, Irritation and Aggressive Behaviour. Acta Universitatis Upsaliensis. *Digital Comprehensive Summaries of Uppsala Dissertations from the Faculty of Social Sciences* 8. 44 pp. Uppsala. ISBN 91-554-6354-1.

On a daily basis drivers have to share the roads with a great number of other road users. To make the driving task possible every driver has to take the intentions and behaviours of other road users into account. In other words, the road users have to interact with each other. The general aim of this thesis was to examine factors that regulate and influence the interaction between road users. To do so, three studies, applying a social psychological approach to driving, were conducted. In the first study it was investigated how the rules of priority, the design of the intersection, and the behaviour of other drivers influence yielding behaviour in intersections. The second study examined driver irritation and its relationship with aggressive behaviours. Finally, in the third study drivers' attributions of their own and other drivers' behaviour were investigated in relation to driver irritation. The thesis also includes a minor field study, aiming at examining to what extent informal traffic rules are used in intersections and in roundabouts, as well as measuring the validity of self-reports. The results indicate that, in addition to the formal rules, drivers rely on informal rules based on road design and on other drivers' behaviour. Drivers also differ with respect to strategies of yielding behaviour. Irritability and aggressive behaviour on the roads appear largely to depend on drivers' interactions and drivers' interpretation of the behaviour of others. Some aggressive behaviour is an expression of irritation and may provoke irritation of other drivers. This means that an irritated driver might start a chain reaction, spreading irritation and aggressive behaviour from driver to driver. To diminish irritation and aggressive behaviour on the roads it is necessary to change drivers' behaviour either by changing the road design or, which is probably a more possible remedy, by changing their general attitudes about driving. By providing drivers with insight into the cognitive biases they are subject to when judging other road users' behaviour, both driver irritation and aggressive behaviours on the roads probably would decrease.

Keywords: Driver interaction, Informal traffic rules, Driver irritation, Aggressive behaviour, Attributional biases, False consensus, Actor-observer effect

Gunilla Björklund, Department of Psychology, Box 1225, Uppsala University, SE-75142 Uppsala, Sweden

© Gunilla Björklund 2005

ISSN 1652-9030

ISBN 91-554-6354-1

urn:nbn:se:uu:diva-5948 (<http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-5948>)

List of papers

The present thesis is based on the following papers, which will be referred to in the text by their Roman numerals:

- I Björklund, G. M., & Åberg, L. (2005). Driver behaviour in intersections: Formal and informal traffic rules. *Transportation Research Part F: Traffic Psychology and Behaviour*, 8, 239-253.
- II Björklund, G. M. (2004). *Driver irritation and aggressive behaviour*. Manuscript submitted for publication.
- III Björklund, G. M. (2005). *Driver attribution and irritation*. Manuscript submitted for publication.

Reprints of Paper I were made with kind permission from Elsevier.

Contents

Introduction.....	7
Social and interpersonal factors in driving.....	8
Informal traffic rules	10
Novice drivers and informal traffic rules.....	13
Driver irritation and aggressive behaviour.....	13
Driver attributions	15
Aims of the thesis.....	17
Empirical studies.....	18
Paper I: Driver behaviour in intersections: Formal and informal traffic rules	18
Interlude	22
Informal rules in intersections and roundabouts – a field study	22
Paper II: Driver irritation and aggressive behaviour	25
Paper III: Driver attribution and irritation.....	30
General discussion	35
Acknowledgements.....	40
References.....	41

Introduction

On a daily basis road users have to share the roads with a great number of other road users, each of them with the major goal to move from one place to another, with a minimum of disruptions and at a pleasant speed (Bjørnskau, 1993; Shinar, 1998). To reach their destinations road users continuously have to negotiate with or avoid actual and potential obstacles in the traffic environment. These obstacles can be stationary (e.g., curbs, walls, trees, and parking cars) or mobile (e.g., other road users such as cars, buses, cyclists, and pedestrians, but also various animals that suddenly appear on the road).

Predicting other road users' behaviour is more difficult than predicting the road environment because other road users, in contrast to stationary objects, are in motion and the driver has to estimate their speed and direction to be able to avoid them. Furthermore, the road is often well known to the drivers, whereas other road users must be considered as unknown and therefore more unpredictable. To make the driving task possible every road user has to take the intentions and behaviours of other road users into account. In other words, the road users have to interact with each other. This would be a difficult task for the individual road user without the help of formal traffic rules that prescribe the proper way to behave in different situations. The formal rules also indicate the intentions and behaviours of other road users. However, for various reasons, road users do not always act according to road traffic regulations. Now and then, some persons do deliberately violate the formal rules to get personal favours. Some persons also use other ways to communicate and interact, that is, by means of *informal* rules and signals, to improve road user interactions. The informal rules supplement or contradict the formal rules. Some of them may facilitate interaction between road users, but some may lead to conflicts or accidents, such as when different drivers comply with different rules.

In traffic, in contrast to most other situations where people have to interact, the participants are relatively anonymous, the interactions are short and the possibilities to communicate are more restricted (Bjørnskau, 1993). Because of the limited means for communication in traffic misunderstandings and misinterpretations often occur, which may result in irritation among road users. Besides the fact that irritation as such turns drivers into "bad" drivers, irritated drivers are also disposed to act aggressively (e.g., Dahlen, Martin, Ragan, & Kuhlman, 2005; Deffenbacher, Deffenbacher, Lynch, & Richards, 2003; Lajunen & Parker, 2001). According to Shinar (1998), it is when a

person perceives the behaviour of others as unfair, against the norms, or against expected behaviour that frustration might grow into aggression directed towards these persons. Studies have shown that drivers are subject to different kinds of cognitive biases when judging the behaviour of other road users (e.g., Åberg, Larsen, Glad, & Beilinsson, 1997; Baxter, MacRae, Manstead, Stradling, & Parker, 1990; Knapper & Cropley, 1978; Manstead, Parker, Stradling, Reason, & Baxter, 1992). These biases may be the foundation to irritation in some of the encounters between road users.

Three studies, applying a social psychological view of driving, provide the empirical basis for the present thesis. In the first study it was investigated how the rules of priority, the design of the intersection, and the behaviour of other drivers influence yielding behaviour in intersections. The second study examined driver irritation and its relationship with aggressive behaviours. In the third study, drivers' attributions of their own and others' behaviour were investigated in connection with driver irritation. The thesis also includes a minor field study with two specific aims: (1) to examine to what extent informal traffic rules are used by experienced versus novice drivers in intersections and in roundabouts and (2) to measure the validity of self-reports. Before the empirical studies are presented, a background to this research area is provided, including studies of social factors in driving, informal rules, driver irritation and aggression, and attribution biases.

Social and interpersonal factors in driving

The direction of traffic research has largely been guided by the general trends in psychological research (for a review, see Englund, Gregersen, Hydén, Lövsund, & Åberg, 1998). After the Second World War, there was great interest in psychological research to measure differences between individuals. The dominating view in traffic safety research was that some road users, because of specific characteristics, were believed to be more accident-prone than others. During the 1960s, psychological research focused on human perception. Road users were then, because of limited perceptual abilities, regarded as victims in a complex traffic environment. In other words, the human being was the weaker link in the human-machine-environment system. The perceptual view was later replaced by a cognitive one, and individuals' motives to act in certain ways were of particular interest. Driving was regarded as a self-paced task, meaning that road users could, through their own choices, reduce the risks they were subject to. Finally, the fourth view emphasizes individuals' ability to automate their behaviour in many of the tasks road users have to perform.

As shown, traffic psychology research has focused for a long time on the individual road user and more or less neglected problems of social psychology in traffic. It is clear that there is still a strong need for knowledge about

how road users interact in traffic and how they influence the behaviour of each other. The present thesis aims at increasing this knowledge.

According to Zaidel (1992), every individual driver is influenced by the social environment consisting of other road users, general social norms, and formal traffic rules. At the same time, every road user is a part in other road users' social environment.

Zaidel (1992) has stated four important ways the social environment can influence a driver:

Others' behaviour can be used as a source of information

As long as the drivers share a common driving culture, the informative value of others' behaviour is high; in other cases, misunderstandings can easily occur. Observing others' behaviour in a novel situation can also be a clue to the required behaviour.

Communication with others

Communication in traffic can clarify intentions of the drivers and explain otherwise puzzling or offensive behaviour, and in that way reduce misunderstandings, frustration, and conflicts. Improved communication may facilitate co-operative behaviours among drivers, and thereby create a more positive social climate in traffic.

Others as a reference group

Drivers compare their behaviour with that of others, (e.g., in the case of speed chosen). The concept "social norms" (or informal traffic rules) might be thought of as the summary representation of the opinion of others. To the extent that individuals accept the collective expressions of opinions as their own, they hold similar norms and may share common rules of behaviour.

Imitation of others

Imitation refers to following someone else's behaviour without directly being instructed or forced to do so and with no direct communication between the imitator and the person whose behaviour is imitated. Attributes that make a group or an individual salient (e.g., behaviours that stand out or deviate in some other way) increase the likelihood of these persons being imitated. The potential imitator must have the ability to perform the behaviour and also some prior inclination to behave in that way or, at least, not having any strong objections against it.

Imitation in traffic has been found in several situations, including use of indicators, pedestrians crossing streets at red lights, running yellow and red lights, and use of safety equipment in the vehicle (see Wilde, 1978, for a review).

The mere presence of other road users could also influence drivers' behaviour. For instance, Yinon and Levian (1995) found that the probability that drivers would enter an intersection before the light turned green increased when there were other cars behind or to either side of the vehicle. The women tended to be less affected than men by the presence of other drivers.

The presence of passengers can also influence drivers in one way or another. According to Dannefer (1977), passengers heighten the driver's concern to appear competent, which may result either in greater caution and alertness or in more thrilling, high-risk driving.

It has also been shown that drivers' attitudes and intentions to commit driving violations (drinking and driving, speeding, close following, and overtaking in risky circumstances) are influenced by their beliefs concerning social expectations to perform the behaviours (Parker, Manstead, Stradling, Reason, & Baxter, 1992).

Rothengatter (1991) claims that normative behaviour becomes attractive to road users if they perceive that most other road users comply with it and those who do not are getting punished. One can expect that it is not only punishment from the road authorities, but also punishment from fellow road users that have this effect.

Informal traffic rules

To facilitate social interaction in traffic formal rules regulate road users' behaviour. However, sometimes road users do not comply with the formal rules. Reasons for failures to follow traffic laws could be a lack of motivation or a lack of knowledge about the formal rules in specific situations. Sometimes traffic laws are vague or ambiguous and are understood differently by different persons. Furthermore, some traffic rules are not congruent with the road design, or the rules are not adjusted to human requirements or natural behaviour patterns (e.g., Helmers & Åberg, 1978; Johannessen, 1984). In some situations formal rules may be too rigid and insufficiently adaptable to cope with the situation (Deehy, 1968). If behaviours, which supplement or contradict formal traffic rules, become common in a specific situation or place, it is an indication that a (social) norm might have developed (i.e., an informal traffic rule).

Informal rules are composed of expectations. When some expectations are regularly provoked in a specific situation, it indicates that an informal rule is in effect (Hjorthol, Assum, & Solheim, 1984). Informal rules (norms) have been defined by Cialdini and Trost (1998) as:

Rules and standards that are understood by members of a group, and that guide and/or constrain social behavior without the force of laws. These norms

emerge out of interaction with others; they may or may not be stated explicitly, and any sanctions for deviating from them come from social networks, not the legal system. (p. 152)

A driver's behaviour is largely determined by what he or she expects another road user to do. Expectations of other drivers' future behaviour might be based on formal traffic rules, informal traffic rules, road design (which often is the reason for developing informal traffic rules) and/or the other drivers' present behaviour.

However, sometimes drivers' expectations can be wrong. An important error in traffic is a lapse of cognitive expectation, illustrated by a failure to look for a specific type of road user, or a failure to look in the direction of the road user in question (Rumar, 1990). For instance, it has been shown that drivers entering T-junctions from the connecting road and were going to turn left both looked to the left and to the right, whereas right-turning drivers almost entirely looked to the left before they turned, although they had to cross a cycle path before turning (Summala, Pasanen, Räsänen, & Sievänen, 1996). This type of driving behaviour seems to indicate that drivers mostly concentrate on cars and other motor vehicles while ignoring or paying little attention to bicyclists. While turning left the driver has to be aware of cars coming both from the left and right; however, while turning right the driver has a conflicting path with cars coming from the left only. During a three-year period in the city of Helsinki, 69% of all collisions between bicycles and cars occurring at non-signalised intersections involved drivers making a right turn and cyclists coming from the right (Summala et al., 1996).

Lurie (1968) was one of the first claiming that there are two kinds of rules in traffic: formal and informal. He studied traffic from a game theory perspective and argued that rules do not tell us what is morally right or wrong; rather, they merely tell us whether what we are doing is part of the game. In some situations it is useful to use a formal rule while in other situations an informal rule is more appropriate. The difference between the rules is that the formal ones are legitimised and officially entered into the regulations (e.g., pedestrians must not cross on red light), whereas the informal ones prescribe acceptable behaviour under certain conditions (pedestrians may cross on a red light if there are no cars coming). According to Lurie, a higher rate of accidents would be expected as a consequence of what he called "social disorganisation". Disorganisation can arise in situations when the existing formal or informal rules are inadequate (e.g., in dense traffic where it is hard to keep legal distances to cars in front), when a situation is completely unstructured (e.g., the first snow fall, resulting in icy road surfaces), when the rules are contradictory or overlap with each other (e.g., flashing headlights when overtaking in the dark in order to inform the other driver of one's intentions, which also could blind the other driver [according to Lurie, different instruction manuals stated different behaviours]), and when the

rules are not clear (e.g., in intersections with stop signs at each corner). Social disorganisation might also occur when drivers who are relatively inexperienced drive, or when experienced drivers drive under unusual circumstances.

Conflicts between road users might arise when different participants in a specific situation act according to discrepant formal or informal traffic rules. This is because a road user's ability to correctly predict another road user's behaviour is reduced if the other road user complies with a different rule system (Wilde, 1976). According to Wilde, there are four types of behaviour in traffic: (1) behaviours that are in conformity with both the formal and the informal rules, (2) behaviours that deviate from the formal rules but conform to the informal, (3) behaviours that conform to the formal rules but deviate from the informal, and (4) behaviours that deviate from both rule systems.

In an exploratory study, Helmers and Åberg (1978) investigated the behaviour of six experienced drivers in intersections of varying design and with different priority rules. In intersections where traffic signs were set up to order which driver should yield the right of way, good concordance was found between formal traffic rules and reported driver behaviour. This was not the case, however, in intersections where drivers have to yield the right of way to traffic approaching from the right (henceforth called "the right-hand rule"). In these four-way intersections the drivers reported in 65% of the crossing situations that they would drive as if they had the right of way, though, by law, they should yield to vehicles from the right. In three-way intersections where the right-hand rule was in force and where the drivers drove on the straight through road, they reported in only 7% of the crossing situations that they would drive in accordance with traffic regulations. In the other crossing situations the drivers reported that they would drive as if they had the right of way. When the drivers drove on the connecting road, they reported in all crossing situations that they would yield to another driver even though they came from the right. The drivers' reported driving behaviour was independent of knowledge of the traffic rules. It was also found that in intersections where the drivers reported that they drove as if they had the right of way, independent of the actual traffic rule, their horizontal head movements were small in amplitude and their speed was relatively high. In the intersections where the drivers reported that they would yield to another vehicle, independent of the actual traffic rule, their head movements were large in amplitude and their speed was low. Helmers and Åberg concluded that when formal traffic rules do not correspond with the road design, informal traffic rules, based on expectations on other road users' behaviour, are developed through interaction between road users.

Drivers' behaviours are not only influenced by formal and informal traffic rules. Other normative systems in which road users are involved might also influence their driving behaviour. The novice teenage driver, for instance, might be a careful and cautious driver when alone or accompanied by par-

ents, but makes other, risky, driving decisions in the company of peers (Deehy, 1968).

Novice drivers and informal traffic rules

As mentioned, drivers' expectations are sometimes wrong. One reason for wrong expectations of other drivers' behaviour is an inadequate mental model of the traffic network. A mental model is an internal representation of a complex system that is used to predict and explain interactions with the system (McKenna & Crick, 1994). It could be expected that drivers' mental models not only vary between individuals but also within individuals across time, for example, when changing from being a novice to becoming an experienced driver.

Novice drivers learn the formal traffic rules in driving schools, whereas the informal rules are learned through interplay with other drivers (Shor, 1964). Such interplay in traffic was studied in Norway by Bjørnskau (1993). In Norway, novice drivers were taught in driving school to dip their headlights at a particular distance when meeting other vehicles in the dark. However, this dipping of the headlights was done considerably later than what was common in real traffic situations. Therefore, the experienced drivers "educated" the novice drivers to dip their headlights earlier by flashing their own headlights until the novice drivers dipped their headlights. To dip headlights at a long distance could be seen as an informal traffic rule that has been evolved by road users to avoid dazzling effects.

Driver irritation and aggressive behaviour

Interactions between road users are normally short and can simply be seen as a consequence of road users' simultaneous wish for mobility – to reach their destinations they have to interact with each other (Bjørnskau, 1993). Because of restricted possibilities for communication in traffic, misunderstandings and misinterpretations often occur, which may result in irritation among road users.

An irritated driver is a poor driver. Anger while driving may interfere with attention, perception, information processing, and motor performance and in that way increase the likelihood of an accident (Deffenbacher, Oetting, & Lynch, 1994). An irritated driver is also more disposed to perform what is called aggressive behaviours (e.g., Dahlen et al., 2005; Deffenbacher et al., 2003; Lajunen & Parker, 2001), such as weaving in and out of traffic, "cutting" in front of other drivers, tailgating, speeding, and "running" red traffic lights, some of them behaviours known to be associated with accidents (for a review, see Ulleberg, 2004). Other aggressive behaviours (such

as headlight flashing) may not be dangerous as such, but may provoke other drivers and make them irritated and behave aggressively as well.

According to Manstead (1997), the common belief that other road users exhibit a large and growing amount of aggression is founded upon people's own feelings of anger in reaction to what they *perceive* to be aggressive behaviours of other road users. In fact, at least some of these behaviours may not be aggressive; instead, what drivers are responding to is behaviours that do not conform to what ordinary road users regard as acceptable and normal behaviour on the roads (Manstead, 1997). However, there exist different definitions of the concept aggressive driver behaviour. In a review of aggressive driving, Ulleberg (2004) discussed the pros and cons of three definitions of aggressive driving. The first definition includes behaviours that harm another driver, physically or psychically, and is, according to Ulleberg, the same phenomenon that is usually called *road rage*. This phenomenon has actually little to do with traffic and is seen more as violence or criminal actions expressed in traffic rather than driver behaviour (Vaa, 2000). The second definition states that it is the *intention* to frighten, threaten, or harm other road users that characterize aggressive driving. However, it is hard to know the intention of other road users. The third definition states that driving is aggressive if it *apprehends* frightening or threatening to other road users, irrespective of the intention behind the behaviours. Ulleberg concluded that this third definition should be the most useful one, but for the sake of plainness, the term for this definition should be aggressive and *reckless* behaviours.

According to Bjørnskau (1993, 1996) and Shinar (1998), the primary reason for drivers' irritation is that other road users are obstructive. This idea has its origin in the frustration-aggression hypothesis, originally proposed by Dollard, Doob, Miller, Mowrer, and Sears (1939). This classical hypothesis states that frustration, defined as "that condition which exists when a goal-response suffers interference" (Dollard et al., 1939, p. 11), always leads to some form of aggression and that aggression is always a consequence of frustration. The increase of reported aggressive actions on the roads could therefore be a consequence of the growing amount of traffic (Shinar, 1998). Hennessy and Wiesenthal (1999) found that both driver stress and aggression were greater in high- than in low-congestion conditions. However, the connection between congestion and aggression is not clear-cut. For example, Shinar and Compton (2004) found that when congestion is coupled with a sense of urgency it induces aggressive behaviour, but not necessarily when the value of time is low. Results of other studies indicate that there is no direct relationship between traffic congestion and aggressive behaviours (Lajunen, Parker, & Summala, 1999). Some studies have shown that obstructive, or otherwise delaying, situations that do not involve some interpersonal element induce a lower amount of anger than situations in which another road user could be blamed for the obstruction (Lajunen, Parker, &

Stradling, 1998; Mesken, 2003). According to appraisal theory, the quality and intensity of emotion in a particular situation depends on how the situation is interpreted and evaluated (Lazarus, 1991). Smith and Lazarus (1993) claim that anger arises from appraisal of “other-blame”, which consists of three components: motivational relevance (the encounter is relevant to any personal goal), motivational incongruence (the encounter is inconsistent with this goal), and other-accountability (someone else could be blamed for the incongruence).

It seems to be that anger or irritation arises in interactions between road users (e.g., when another road user is obstructive). However, the degree of irritation evoked might be dependent on how the negative behaviour of other road users is interpreted, that is, how the behaviour is attributed.

Driver attributions

Attribution refers to the process by which individuals arrive at causal explanations for their own and others' behaviour (Ross, 1977). Several studies have shown that drivers are subject to attributional biases when judging the behaviour of other road users. One such bias is false consensus, which refers to a tendency of persons “to see their own behavioral choices and judgments as relatively common and appropriate to existing circumstances while viewing alternative responses as uncommon, deviant, or inappropriate” (Ross, Greene, & House, 1977, p. 280). For instance, it has been found that drivers who kept a higher speed than other drivers also perceived others to drive fast (Åberg et al., 1997; Haglund & Åberg, 2000). Further, Manstead et al. (1992) found that drivers who personally engaged in specific violations and errors perceived these behaviours as being committed by a higher proportion of other drivers than what drivers who did not commit these behaviours did. It is plausible to think that false consensus also is in effect in the case of irritation, that is, drivers who easily get irritated perceive other drivers as more irritated than these drivers actually are.

According to Baxter et al. (1990), drivers' causal attributions of others' behaviour may be a source of stress and aggression on the roads. These authors claim that if some drivers habitually assume that the aggressive behaviour of other road users is due to steady qualities of those observed, they might be more frustrated and angry than they would if they recognize that other road users, like themselves, make mistakes now and then, especially when under pressure. Conversely, drivers may underestimate the extent to which their own “bad” behaviours, which they themselves might consider relatively innocent, induce irritation in other road users (Baxter et al., 1990).

The tendency to overestimate the importance of personal or dispositional factors relative to environmental influences – even when situational factors that can account for the behaviour are available – are called the fundamental

attribution error (Ross, 1977). Closely related to this bias is the actor-observer effect, which refers to a “pervasive tendency for actors to attribute their actions to situational requirements, whereas observers tend to attribute the same actions to stable personal dispositions” (Jones & Nisbett, 1972, p. 80). Baxter et al. (1990) found tendencies in drivers to attribute their own behaviour to situational causes and the behaviour of others to more personal dispositions when explaining two relatively common traffic violations – close following and running traffic lights.

Most of the studies investigating attribution biases in traffic concern the false consensus bias, whereas the actor-observer effect has been paid less attention to. However, the results of the study by Baxter et al. (1990) indicate that the actor-observer effect exists even in traffic.

Aims of the thesis

The general aim of this thesis was to examine components in the interaction between road users, that is, factors that regulate and influence the interaction. In order to examine these factors three studies were conducted.

The primary aim of Paper I was to investigate to what extent drivers' behaviour in intersections is influenced by informal traffic rules and to what extent such rules are related to such factors as road design, other drivers' behaviour (i.e., speed), and formal traffic rules (i.e., the right-hand rule). A secondary aim was to investigate differences among drivers in their compliance with formal and informal rules.

The first aim of Paper II was to apply the UK Driving Anger Scale (the UK DAS) on a Swedish sample of drivers in an attempt to replicate the three-factor structure reported by Lajunen et al. (1998). A second aim was to investigate to what extent different situations lead to openly aggressive reactions as reported by the respondents. A third aim was to test models of relationships between drivers' irritation and aggressive behaviour.

The aim of Paper III was to investigate some of the cognitive biases drivers might be subject to when judging the behaviour of other road users in irritation-provoking situations. A comparison was made between obstructed drivers' irritation reported by the obstructed drivers themselves and estimated by obstructive drivers. The same comparison was made for obstructive drivers' botheration. Botheration in this study is defined as drivers' feelings of discomfort coming from their knowledge of being an obstruction to drivers behind them. Based on the false consensus bias, it was investigated if drivers who reported a high degree of irritation also perceive other drivers as irritated. Further, it was studied to what extent drivers attribute the behaviours of their own and other drivers according to the actor-observer effect. Finally, the relation between drivers' attribution and reported degree of irritation was examined.

Additional to these studies, a minor field study was carried out. The aim of this study was to investigate to what extent informal rules are used in intersections and roundabouts and to measure the validity of self-reports.

Empirical studies

Paper I: Driver behaviour in intersections: Formal and informal traffic rules

Helmers and Åberg (1978) have identified three variables in the traffic environment that are important to drivers when they enter an intersection: the design of the intersection, other road users' expected and actual behaviour, and the rules of priority in the intersection. Previous results indicate that all three variables appear to have an influence on the behaviour of drivers (e.g., Helmers & Åberg, 1978; Janssen, van der Horst, Bakker, & ten Broeke, 1988; Johannessen, 1984; Kulmala, 1991). If behaviours that supplement or contradict formal traffic rules become common in a particular traffic intersection, it is an indication that an *informal traffic rule* has been developed and put in practice.

The primary aim of Paper I was to investigate to what extent drivers' behaviour in intersections is influenced by road design, other drivers' behaviour (i.e., speed), and road traffic regulations (i.e., the right-hand rule). A secondary aim was to identify groups of drivers based on differences in formal and informal rule compliance.

A sample of 2,500 drivers, randomly drawn from the Swedish register of car owners, was sent a questionnaire composed of different traffic situations in which the respondents were asked to indicate how often they commit the actions described. The items were assessed on a 5-point scale with response alternatives *never* (1), *rarely* (2), *occasionally* (3), *frequently* (4), and *always* (5). Ten of the questions regarded yielding behaviour in hypothetical crossing situations. In all crossing situations the respondents were told that there was no major road, implying that they should always yield the right of way to traffic coming from the right, based on the right-hand rule. Three designs of intersections were used as scenarios (see Figure 1). Two of the intersections were four-way, in which one was with equally broad roads and one with narrower roads crossing a broader road. The third intersection was three-way with equally broad roads.

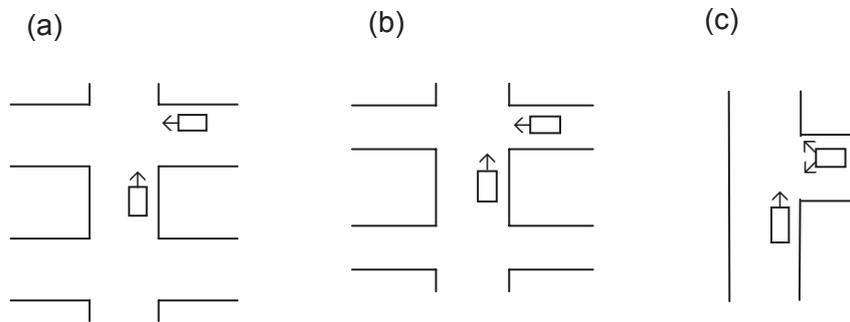


Figure 1. The three types of intersection used in the questionnaire. From the left: (a) a four-way intersection with equally broad roads, (b) a four-way intersection with narrower roads crossing a broader road, and (c) a three-way intersection with equally broad roads.

Four questions were asked to each of the two four-way intersections. The questions regarded how often the respondents would yield to another car if this car (1) was coming from the right and was slowing down, (2) was coming from the right and was maintaining its speed, (3) was coming from the left and was slowing down, and (4) was coming from the left and was maintaining its speed. Two questions were asked regarding the three-way intersection. In one of these the respondents were asked how often they would yield to a car approaching from the right on the connecting road, and in the other the respondents were asked how often they would yield to a car approaching from the left on the straight through road. In the three-way intersection the condition was such that the car on the connecting road was always slowing down. Nothing was said about the speed of the car on the straight through road. Because the right-hand rule was in force, differences in the respondents' reported behaviour when another driver was coming from the left or the right could be used as a measure of the importance of the traffic regulations. After two reminders, 1,342 completed questionnaires were returned, yielding a response rate of 54%. However, some of the respondents had not answered all the questions about the crossing situations and were removed from the analyses through listwise deletion, which reduced the number of respondents to 1,276. Of these, 52% were men and 48% were women. The mean age of the respondents was 47 years (range 18-74 years) and the respondents had held a driver's licence for a mean period of 26 years. The median mileage driven last year was in the range 10,010 to 15,000 kilometres.

The results showed a substantial variation in yielding behaviour for the different crossing situations. The proportion of drivers who reported that they always yielded varied from 27% to 76% when the other driver came from the right and from 1% to 32% when the other driver came from the left.

The least ambiguous situation was a four-way intersection with equally broad roads, where the other driver came from the right and was maintaining his or her speed. Three fourths of the drivers reported that they always yielded to the other driver in this crossing situation. This observation is not surprising as the yielding behaviour was in accordance with the law and the other driver showed no intention to yield. Furthermore, because of equal status of the roads there was no reason for any driver to experience any “psychological right of way” (e.g., Wilde, 1976).

Comparisons between intersections were analysed using two-way repeated measures analysis of variance (ANOVA). The analyses showed that the drivers reported that they yielded the right of way to a driver coming from the right more often when the other driver came from an equally broad road than when he or she came from a narrower road. When the drivers themselves were coming from the right, they reported that they yielded more often when the other driver was coming from a broader road than when the driver was coming from an equally broad road. The drivers also reported that they yielded more often when the other driver maintained his or her speed than when he or she decelerated. Finally, the drivers reported that they yielded more often when the other driver was coming from the right than when the other driver was coming from the left. Thus, the drivers’ behaviour was to some extent consistent with the right-hand rule. It was also shown that the drivers’ behaviour was more dependent on the other driver’s behaviour than on road breadth and that the right-hand rule was equally important as the other driver’s behaviour.

Four groups of drivers were identified from their reported yielding behaviour in the three-way crossing situations. Unlike the four-way intersections, the three-way intersection consisted of only two situations, which easily could be contrasted with each other. A cross tabulation of drivers that rarely yielded versus those yielding most of the time is presented in Table 1.

Table 1: *Yielding frequency in the three-way intersection when the other driver was coming from the connecting road compared with yielding frequency when the other driver was coming from the straight through road*

The other driver was coming from the right from the connecting road	The other driver was coming from the left from the straight through road		Total
	<i>Never to occasionally</i>	<i>Frequently to always</i>	
<i>Never to occasionally</i>	A: 162 (13%)	B: 353 (28%)	515 (40%)
<i>Frequently to always</i>	C: 489 (38%)	D: 272 (21%)	761 (60%)
Total	651 (51%)	625 (49%)	1,276 (100%)

The four groups of drivers were denoted as A, B, C, and D. Thirteen percent of the drivers (group A) reported that they rarely yielded, regardless of the crossing situation and traffic regulations (the “aggressive” group). The drivers in group B, accounting for 28% of the drivers, reported that they yielded when they came from the connecting road but not when they came from the straight through road. Their behaviour appears to be largely dependent on road design and not on the formal rules (the “informal” group). The largest group (group C) comprises 38% of the drivers. Their behaviour was in compliance with the traffic regulations (the right-hand rule), which implies that they reported that they yielded when they themselves came from the left but not when they came from the right (the “formal” group). Group D (21% of the drivers) includes drivers who reported that they mostly yielded, regardless of the crossing situation and traffic regulations (the “cautious” group).

Chi-square tests indicated that the four groups did not differ with regard to sex or mileage driven the previous year. ANOVAs were used to compare the groups on yielding frequency in the four-way intersection situations, speeding, and age. The drivers in the cautious group (group D) evidenced higher yielding frequencies in the four-way intersections than most of the other drivers. They also complied with the speed limits to a greater extent than the drivers in the aggressive and the informal groups and were, on average, significantly older than the other drivers. The drivers in the formal group (group C) reported that they complied with the right-hand rule to a large extent in the four-way intersections and they also reported compliance with the speed limits. The aggressive drivers (group A) reported a low yielding frequency in the four-way intersections, and like the informal drivers (group B), they reported more speeding. The connection between speeding and traffic violation in intersections supports the finding that drivers who drive fast are also likely to be involved in accidents when they had failed to yield the right of way (Parker, West, Stradling, & Manstead, 1995). In four-way intersections the informal drivers reported less yielding to drivers from the right than more formal or cautious drivers and more yielding to drivers from the left than aggressive or formal drivers.

The results of Paper I indicate that in addition to the formal rule drivers rely on informal rules based on road design (a driver from a narrower road yields to a driver from a broader road) and on other drivers’ behaviour (a driver yields if a crossing driver does not slow down). Furthermore, different drivers seem to have different strategies of yielding behaviour. Therefore, to better understand non-compliance with formal traffic rules and for improvement in traffic safety it is important to learn more about how and why road users acquire informal rules. One way to acquire new behaviours is through learning from others. When road users do not behave as expected, for example, they violate any formal or informal traffic rule, other road users may be irritated and try to educate the violators. Driver irritation and aggressive behaviour were therefore examined in Paper II. However, before proceeding

to Paper II, a short summary is provided of a field study in which it was investigated whether informal rules are used in intersections and roundabouts. The validity of self-reports was measured as well.

Interlude

In Paper I, the respondents were asked to indicate how often they commit different actions. Data from self-reports might be problematic in that it might be difficult to translate previous experiences into expected behaviour in artificial traffic situations. Therefore, a minor field study was conducted to investigate behaviours in intersections and roundabouts. The field study is available in the Swedish language in its whole length (Björklund, 2003), but a short summary is provided here.

Informal rules in intersections and roundabouts – a field study

Earlier investigations have indicated that drivers use informal rules in intersections instead of, for example, the right-hand rule (e.g., Helmers & Åberg, 1978; Johannesen, 1984). The formal rules for roundabout driving are quite vague and it can therefore be expected that informal rules will develop in roundabout driving. It is also believed that drivers learn informal rules through interactions with other drivers, whereas driver training is focused on formal traffic rules (Bjørnskau, 1993). Accordingly, it is expected that experienced drivers use informal rules more frequently than novice drivers.

The first aim of the field study was to investigate to what extent informal traffic rules are used by experienced versus novice drivers in intersections and in roundabouts. A second aim was to measure the validity of self-reports by comparing drivers' self-reported behaviour with real driving in roundabouts. The study was largely a replication of the study by Helmers and Åberg (1978). However, the present study was extended to also investigate roundabouts and to compare novice drivers with experienced drivers.

Method and participants

Eight participants, four experienced (two females and two males) and four novice drivers (two females and two males), participated in the study. The experienced drivers had a mean age of 43 years (range 34 to 51 years) and an annual mileage of 15,000 to 30,000 kilometres. The novice drivers were 19 years old, had held a driver's licence for less than one year, and had driven less than 10,000 kilometres during this time.

Each participant drove a 30-minute long test route, with the instruction to drive as he or she normally would do. An observer sat in the passenger seat and kept records of which lane the participant got into and how he or she used the indicators in the roundabouts. Moreover, in selected intersections of

various regulations the participant was asked to verbally express how he or she would drive if crossing road users were approaching. After driving, the participant was asked to indicate on maps how he or she normally drove in the roundabouts along the route. However, the participant was not told that it was the same roundabouts. Finally, each participant viewed a video film of the route, which had been recorded during the driving, and was asked to report which priority rule that was in force at the selected intersections.

Results

Most participants reported that they would yield to others in intersections with “give way” signs. In four-way intersections in which the right-hand rule was in force the drivers reported in 78% of the cases that they yielded to other drivers coming from the right. In three-way intersections they reported in 69% of the cases that they would yield to drivers coming from the right on the connecting road when they themselves drove on the straight road through the intersection. When coming on the connecting road, the most frequent reported behaviour was giving way to other vehicles, indicating an informal rule because crossing drivers from the left actually should give way to the participants.

No differences were observed between novice and experienced drivers in four-way intersections. In three-way intersections there was a non-significant tendency for novice drivers to comply with the formal rule more frequently than the experienced drivers. The novice drivers reported correct behaviour in 13 of 16 cases (81%) when driving on the straight through road, whereas the corresponding number for the experienced drivers was 9 of 16 (56%). When coming on the connecting road the novice drivers reported correct behaviour in 5 of 12 cases (42%) and the experienced drivers in 3 of 12 cases (25%).

Each participant encountered nine roundabouts during the route. There was a non-significant tendency for novice drivers to use the indicator more frequently than the experienced drivers when entering a roundabout at left turns. In the other situations (i.e., when turning right, when leaving roundabouts at left turns, and when driving straight through) there were no differences between novice and experienced drivers. Almost all participants used the right indicator at right turns and when leaving the roundabouts at left turns. When driving straight through, the most frequent behaviour was to not indicate at all.

To measure the validity of self-reports a comparison was made between reported and observed behaviour in the roundabouts. The results showed a great concordance between reported and actual behaviour for the novice drivers. Only in one of 36 situations the reported behaviour differed from the observed regarding use of indicator or not. The experienced drivers, on the other hand, differed in reported and observed indicator behaviour in 11 of 36 roundabout situations.

Discussion

A comparison between compliance with the right-hand rule was made between the results in this study and the results in Paper I. In the present study the participants reported in 69% of the crossing situations that they would give way to another driver when they were driving on the straight through road in three-way intersections. In four-way intersections the proportion was 78%. In Paper I, 60% of the respondents reported that they would yield the right of way (*always* and *frequently* yielding) in the three-way intersection scenario (where the other driver always slowed down); in the four-way intersections on average 75% of the respondents reported that they would yield to another driver from the right. As shown, these two studies indicated yielding frequencies of about the same proportions.

The results in the study by Helmers and Åberg (1978) showed that in only 3% of the crossing situations that involved driving on a straight through road in three-way intersections the drivers reported that they would give way to another driver. In four-way intersections this proportion increased to 35%. There could be several reasons for differences in results between the present study and Helmers and Åberg's study. First, two decades have passed between the first and the second study; second, the studies were not carried out in the same city; and third, there was a small number of participants. However, the present results were more in agreement with the results presented by Johannesen (1984) in which the frequency of yielding in four-way crossings was 78% and in three-way crossings 56%.

Only minor differences between novice and experienced drivers in reported yielding behaviour could be found. However, there was a tendency that novice drivers more often than the experienced drivers complied with the right-hand rule in three-way intersections. The experienced drivers tended to be more influenced by the road design in deciding which road user should yield.

The results of the comparison between reported and observed behaviour in the roundabouts showed that the novice drivers were more consistent in their behavioural strategies, whereas the behaviour of the experienced drivers varied somewhat with different situations.

It is difficult to draw any conclusions about validity from the present field study. However, there was a great concordance between actual and reported behaviour regarding use of indicator or not, at least for the novice drivers. There is also a small tendency of the results to support the idea that drivers are using informal rules in intersections and roundabouts.

Paper II: Driver irritation and aggressive behaviour

To diminish irritation and aggressive behaviour on the roads it is necessary to learn why some drivers get irritated and to examine the connection between irritation and aggressive behaviour. By means of the UK Driving Anger Scale (UK DAS), which measures the amount of anger felt in different potentially provocative traffic situations, Lajunen et al. (1998) found three sources of anger-provoking situations: “progress impeded”, “reckless driving”, and “direct hostility”.

The first aim of Paper II was to apply a Swedish version of the UK DAS to a sample of Swedish drivers in an attempt to replicate this three-factor structure. A second aim was to investigate to what extent different irritation-provoking situations lead to openly aggressive reactions. A third aim was to test models of drivers’ irritation and aggressive behaviour. It was hypothesised that a high amount of irritation is related to aggressive actions. Driver irritation, on its part, was predicted to be influenced by driver characteristics (i.e., sex, age and driving experience), but also by driving style (i.e., speed). This applies particularly to irritation provoked by progress impeded, because drivers who normally drive fast are more often obstructed by other road users than drivers who drive slower.

One hundred drivers, students and employees at Dalarna University, a small university in the middle of Sweden, participated in the study. Two of the participants had not answered all the items investigated in this paper and were therefore omitted from the analyses, reducing the number of participants to 98. The remaining participants were, on average, 35 years old (range 21-58 years) and had held a driver’s licence for a mean period of 16 years. The median category for mileage driven during the past year was 10,010 to 15,000 kilometres. Of the participants, 48% were women and 52% were men. Each participant received a cinema voucher, worth approximately 75 Swedish Kronor, as reimbursement.

The original UK DAS-scale concerned degree of anger, but in the present questionnaire the participants were asked about degree of irritation. The reason for this was that the Swedish translation of the word anger denotes a quite strong feeling and consequently there was a possibility that the distribution among the questions would be too small and skewed. The items were assessed on a 5-point scale with response alternatives *not at all irritated* (1), *a little irritated* (2), *fairly irritated* (3), *very irritated* (4), and *extremely irritated* (5). To measure expressed irritation in addition to experienced irritation, the reactions of the drivers in each of the potentially provoking situations were measured by using the alternatives *no reaction*; *mutter to myself*; *beep horn and/or flash lights*; *gesture and/or yell at the other road user*; *using the vehicle to tell what I think of the other road user, for example, follow or drive close to the other road user*. Responses to any of the three

latter alternatives were coded as aggressive reactions. The behaviour *mutter to myself* was not defined as an aggressive behaviour because it does not have any influence on another driver.

The results showed that the item provoking most irritation was “someone is driving very close to your rear bumper”. The distributional data indicated that only one person reported that this would not make him or her irritated at all, whereas 58% reported that they would get very irritated or extremely irritated. Next, most irritation was generated by having someone cutting in and taking the parking spot you have been waiting for. The first behaviour elicited aggressive reactions in 38% of the drivers (the most common reaction was flashing the braking lights) and the second behaviour elicited reactions in 36% of the drivers. To drive close to another car’s rear bumper could be very dangerous, whereas taking the parking spot someone else has been waiting for is more impolite. The two behaviours that elicited the largest amount of aggressive reactions were when someone coming towards you does not dim his or her headlights at night (90% reacting) and when someone backs out right in front of you without looking (71% reacting). In both these situations it is quite easy to express irritation by means of flashing lights or beeping the horn.

An exploratory principal component factor analysis of the 21 items yielded four factors with eigenvalues exceeding 1.00, together explaining 61.4% of the variance. However, the four-factor solution was difficult to interpret and therefore a three-factor solution was preferred, accounting for 55.7% of the variance. The factor structure in the study by Lajunen et al. (1998), with the factors progress impeded, reckless driving, and direct hostility, was largely replicated. However, three of the items in the factor progress impeded in the present study loaded onto the factor reckless driving in the British study.

The three items with highest factor loadings in every factor were used as indicator variables for that factor in subsequent analyses. By using LISREL 8.54 (Jöreskog & Sörbom, 1993) – a computer program for structural equation modelling – factor scores for each latent irritation variable were obtained. Scales for aggressive actions were also constructed for each source of irritation. Only the reactions to the three indicator variables for each latent variable were used and therefore the number of aggressive actions could vary between zero and three. In Figure 2 the number of aggressive actions for each of the three sources of irritation is shown.

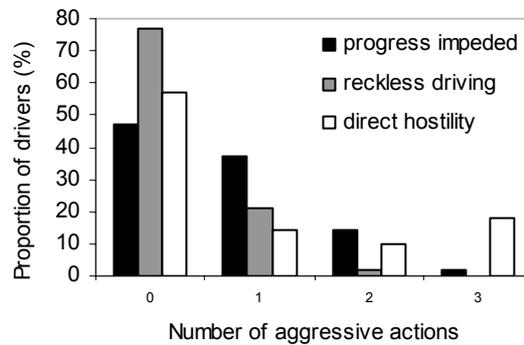


Figure 2. Proportion of drivers who reported that they would react aggressively to the three sources of irritation.

As shown in Figure 2, about half of the drivers (53%) reported that they would react, at least in one of the situations, when their progress was impeded. When the drivers were watching others' reckless driving, 23% of them reported that they would react aggressively. The corresponding proportion in the case of the direct hostility of other drivers was 43%. Eighteen drivers reported that they would behave aggressively in all three situations where other drivers showed their hostility. Of these drivers, 14 were men and 4 were women. There were no differences between these "high reacting" drivers and the other drivers regarding age or mileage driven during the previous year. However, the "high reacting" drivers reported a much higher irritation for others' direct hostility as compared with the "low reacting" drivers, $t(33.49) = -5.08, p < .001$.

For each source of irritation, a model was constructed that included irritation and speed as latent variables and sex, age, mileage, and aggressive actions as manifest variables. The models were based on the following assumptions: (a) the degree of irritation determines the frequency of aggressive actions; (b) sex, age, and mileage may have a direct effect on aggressive actions or may be fully or partly mediated by speed and irritation; and (c) speed may have a direct effect on aggressive actions or may be mediated by irritation. However, speed was not included in the model of direct hostility because there is no reason to believe that the driving speed has any influence on experienced irritation in this case. In the model of progress impeded it was assumed that drivers who drive faster than other drivers become more irritated because they are impeded more often. Because speeding is a part of the concept of reckless driving, drivers' own speed may have an impact on the degree of irritation also in this case. The final models are shown in Figure 3. Only paths with significant coefficients ($p < .05$) are included.

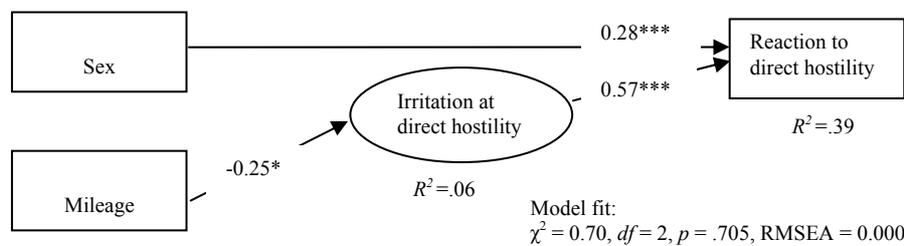
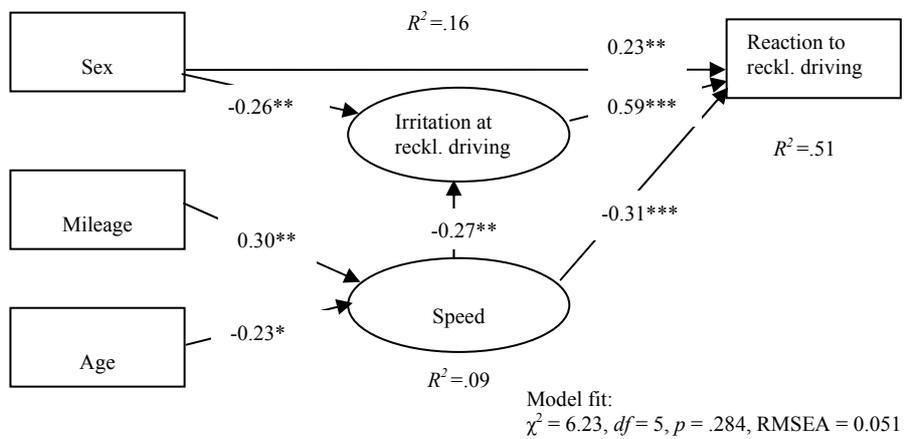
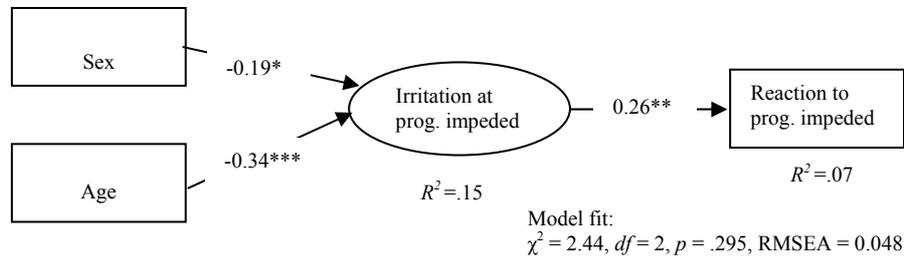


Figure 3. Models of relationships regarding sex, mileage, age, speed, driver irritation and aggressive actions in relation to progress impeded, reckless driving, and direct hostility. Numbers on arrows are standardised path coefficients (* $p < .05$, ** $p < .01$, *** $p < .001$). Latent variables are depicted as ovals. Correlation coefficients between sex and mileage and between age and mileage were 0.22 ($p < .05$) and 0.36 ($p < .001$), respectively. The correlation coefficient between sex and age was non-significant. Female drivers were coded as “1” and male drivers as “2”.

The fit statistics show that all three models fit the data quite well, with non-significant p-values and low Root Mean Square Error of Approximation (RMSEA). In all the models drivers who reported that they became irritated to a high degree also reported that they reacted in an aggressive way more often than drivers who reported a lower degree of irritation, although the path coefficient in the progress impeded model was much smaller than in the other models.

In the progress impeded model it is shown that women reported more irritation than men, and that younger drivers reported more irritation than older drivers. It was assumed that drivers who enjoyed a faster speed than other drivers would become more irritated if their progress was impeded. However, this relationship was non-significant.

The model of reckless driving shows that women reported more irritation than men, but that men reported aggressive behaviour more frequently than women. It is also shown that drivers who enjoyed a higher speed than other drivers reported both a lower irritation and a lower frequency of aggressive reactions to the reckless driving of others. This means that drivers who drive fast themselves do not become irritated and do not behave aggressively when they see other drivers drive fast, run a red light or a stop sign, or weave in and out of traffic to pass quicker. The connection between excessive speed and road traffic accidents is well known (e.g., Cooper, 1997; Kloeden, McLean, Moore, & Ponte, 1997; Nilsson, 1982), and it is worrying if many drivers view this behaviour as normal and not especially negative (i.e., dangerous). Drivers reporting a high speed were younger and had a higher annual mileage as compared with drivers reporting a lower speed.

In the model of direct hostility it is shown that men reported that they reacted more frequently than women, although sex did not influence degree of irritation. Furthermore, drivers with a low annual mileage reported a higher degree of irritation in comparison with drivers with a high annual mileage.

The results of Paper II indicate that irritability and aggressive behaviour on the roads depend on drivers' interactions. Some aggressive behaviour both provokes irritation and is an expression of irritation. This means that feelings of irritation could take the form of some kind of chain reaction and spread from driver to driver. However, a driver's irritation might not depend on situational characteristics only, but also on his or her interpretation of the situation. Therefore, in Paper III, it was investigated which attributional biases drivers might be subject to when judging the behaviour of other road users in irritation-provoking situations.

Paper III: Driver attribution and irritation

Driver irritation and aggression are probably often the results of misunderstandings and misinterpretations among road users. Two examples of biases drivers might be subject to when judging and interpreting the behaviour of other road users are the *actor-observer effect* and the *false consensus bias*. The first bias reflects the tendency of people to attribute their own actions to situational factors whereas the behaviours of others are attributed to dispositional factors. The second bias, false consensus bias, refers to people's tendencies to see their own behaviours as more common than they actually are.

The main aim of Paper III was to investigate cognitive biases of drivers when judging behaviour of other road users in potential irritation-provoking situations. More specifically, the aims of the study were:

- To examine if there is any difference between the degree of irritation drivers report when they are obstructed and the degree of irritation other, obstructive, drivers attribute to these drivers.
- To determine if there is any difference between the amount of botheration drivers report when they are obstructive and the amount of botheration other, obstructed, drivers attribute to these drivers.
- To investigate the false consensus effect, that is, if highly irritated (bothered) drivers regard other drivers as more irritated (bothered) than what less irritated (bothered) drivers do.
- To study to what extent drivers attribute their own and other drivers' behaviour according to the actor-observer effect, that is, make situational attributions to their own behaviour and dispositional attributions to the behaviour of other drivers.
- To examine if drivers report varying degrees of irritation depending on their attributions of the behaviours of other drivers.

The participants, the same drivers as in Paper II (with no drivers omitted from the analyses), were presented six traffic scenarios describing relatively common and obstructive events during driving. Two versions of the questionnaire were constructed, each describing three scenarios where the participants were told that they were obstructed by another driver and three scenarios where they themselves acted obstructively. In the first version the participants were obstructed in the first three scenarios and in the second version the participants were obstructed in the last three scenarios. Half of the participants were given the first version and the other half the second version. The participants were asked to indicate degree of irritation when obstructed, amount of botheration when obstructive, and attributions of their own and other drivers' obstructive behaviour. Eight persons, not involved in the main study, were subsequently asked to code the open-ended questions about the reasons for the behaviour of the participants and the other drivers.

Every explanation given by the participants was placed into one of three categories: “dispositional, that is, a steady quality of the person concerned” (e.g., an old person, inexperienced, scared, too cautious, unhelpful, stubborn), “a temporary behaviour of the person concerned” (e.g., does not know the way, is talking on a mobile telephone, has not seen the traffic sign, has not looked in the rear mirror, does not know the car, has made a misjudgement), and “situational, that is, something in the actual traffic situation” (e.g., something is wrong with the car he or she is driving, poor visibility, obstructions, heavy traffic, bad road conditions).

In Table 2 the mean irritation reported by the participants is shown for each scenario.

Table 2: *A comparison of obstructed drivers’ mean irritation (SD) as estimated by other drivers and reported by the obstructed drivers themselves.*

Scenario	Obstructed drivers’ irritation ^a		t-value
	Estimated by obstructive drivers	Reported by the obstructed drivers themselves	
1. A car is driving at 70 km/h on a 90-road. There is only a narrow shoulder.	3.70 (0.91)	2.76 (1.12)	4.62***
2. A car is driving at 70 km/h on a 90-road. There is a broad shoulder.	4.28 (0.94)	3.50 (1.17)	3.64***
3. A driver is going to turn right in an intersection but does not drive aside on the shoulder.	3.39 (1.22)	2.68 (1.06)	3.08**
4. A driver is waiting to enter a main road. A small gap in the traffic appears but the driver does not use it.	2.90 (0.87)	2.38 (1.03)	2.70**
5. A driver, that should give right of way, cuts right in front of another car, but uses the broad shoulder as an acceleration lane.	2.60 (1.11)	2.48 (1.18)	0.54
6. A driver, that should give right of way, cuts right in front of another car.	4.51 (0.68)	4.16 (0.96)	2.10*

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

^a Response scale 1 – 5

The highest degree of irritation was elicited in scenario 6, where a driver cut right in front of another car. This is considered a behaviour that is obstructive, dangerous, and in violation of a formal traffic rule. The behaviour described in scenario 5 is also a formal violation. However, this situation elicited less irritation than most of the other scenarios. Thus, a broad shoulder is accepted and expected by drivers to be used as an acceleration lane. A possible explanation for the result is that this behaviour complies with an informal rule and the fact that the behaviour violates a formal rule is not irritating to other drivers.

Obstructed drivers’ irritation that was reported by the obstructed drivers themselves was lower than irritation that was estimated by the obstructive drivers. The largest differences in obstructed drivers’ degree of irritation

estimated by the obstructive drivers and by the obstructed drivers themselves were found in scenarios 1 and 2. These situations may be more obstructive than the other scenarios because drivers could have been caught behind the slow driving driver for a long time. The behaviour in scenario 3 (not driving on the shoulder when turning right) is in one way obstructive because the drivers who are behind have to slow down. On the other hand, to drive on the shoulder could create a dangerous situation if there are drivers waiting to enter the main road because an overtaking car might be hidden by the turning car. Some of the respondents reported this possibility as an explanation as to why they did not drive aside when turning.

In five of the six scenarios (although not statistically significant regarding scenario 1) the obstructed drivers thought that obstructive drivers would be less bothered than the obstructive drivers expected themselves to be. The situation in which the participants expected themselves to be most bothered was when cutting right in front of another car (scenario 6), whereas the obstructed drivers expected most botheration to occur in scenario 4. A possible explanation why the participants did not think that other drivers would experience any high degree of botheration is that they did not think that obstructive drivers look in the rear mirror. If drivers do not look in the rear mirror, they are probably not aware that there are other drivers behind them and therefore they probably do not feel bothered.

The false consensus bias, which previously has been found in connection with speeding and other aberrant driving behaviour (Åberg et al., 1997; Haglund & Åberg, 2000; Manstead et al., 1992), was also found regarding driver irritation. This implies that drivers who became more irritated also perceived other drivers as more irritated than drivers who became less irritated. Such a bias was not found regarding driver botheration. A negative point with the false consensus bias in connection with driving is that if drivers who possess an aberrant driving style perceive themselves as “normal” regarding driving, they do not see any reason to change their destructive behaviour (Manstead et al., 1992).

Although disparate results were obtained for the different scenarios (see Figure 4), the results nevertheless provide clear evidence of an actor-observer effect. For instance, in the first three scenarios most attributions were made only to dispositional or situational factors. In the other three scenarios many attributions were made to temporary factors. In the last scenario, describing a behaviour that was both dangerous and a violation of a formal traffic rule, few situational explanations were reported. Instead, a common statement on the behaviour was that the driver had a temporary blackout.

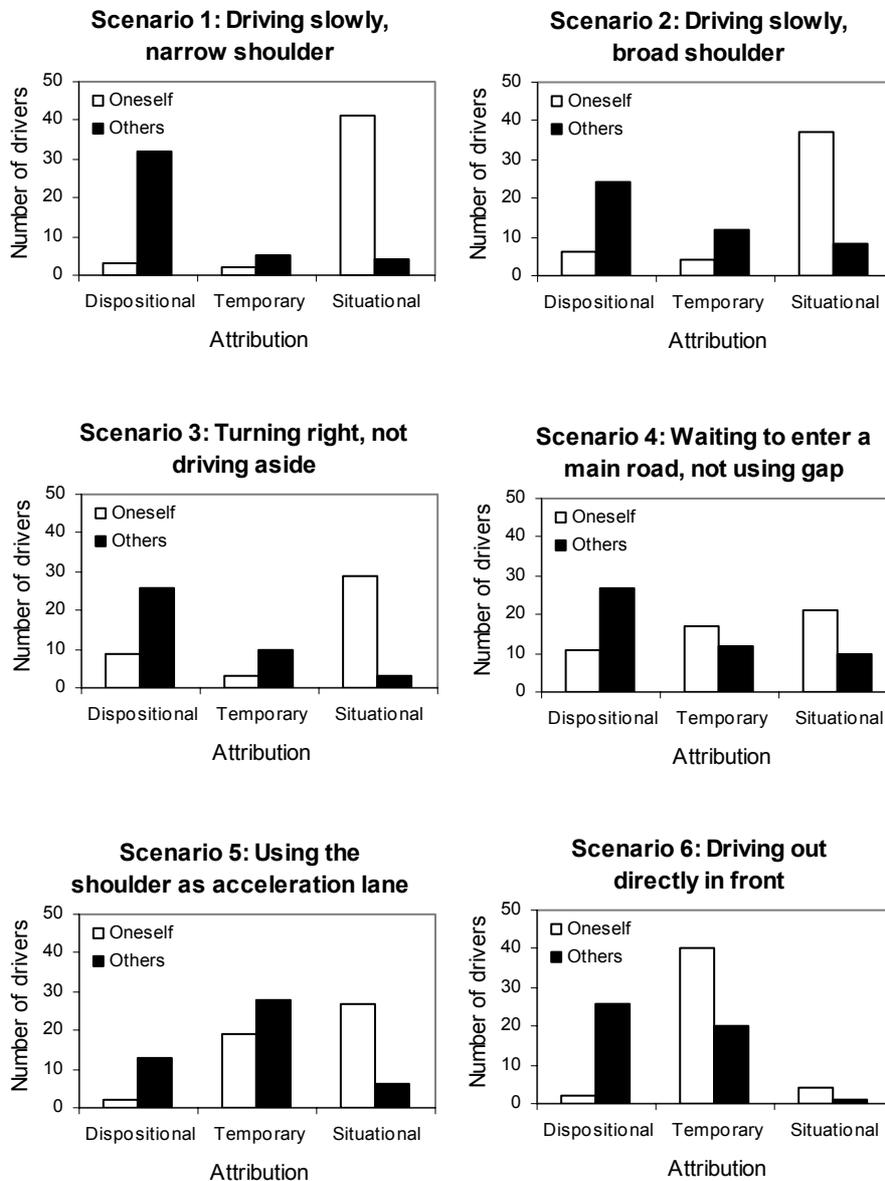


Figure 4. Number of participants who attributed the behaviour in each scenario to dispositional, temporary, or situational factors. In the left panels (white) the participants themselves were obstructive, whereas in the right panels (black) it was the other drivers who were obstructive. Note that persons who made attributions to their own behaviour in the first three situations made attributions to other drivers' behaviour in the last three situations, and vice versa.

In order to measure differences between attributions of participants' own and others' behaviour a comparison was made between dispositional factors and situational factors (with temporary factors included in the situational factors category, which is in accordance with Baxter et al., 1990). The results of the chi-square tests, with one degree of freedom, showed that participants' own behaviour was largely attributed to situational factors, whereas others' behaviour was attributed to dispositional factors: Scenario 1: χ^2 (n = 87) = 46.12, $p < .001$; Scenario 2: χ^2 (n = 92) = 19.00, $p < .001$; Scenario 3: χ^2 (n = 80) = 16.24, $p < .001$; Scenario 4: χ^2 (n = 98) = 11.00, $p < .001$; Scenario 5: χ^2 (n = 95) = 9.86, $p < .01$, and Scenario 6: χ^2 (n = 93) = 28.70, $p < .001$.

It was hypothesised that degree of irritation, when obstructed, depends on how the behaviour is attributed. In fact, it was shown that in all scenarios the mean irritation score was greater for drivers who attributed others' behaviour to dispositional factors than for drivers who attributed others' behaviour to situational factors. This difference, however, was only significant in scenarios 3 and 4, $t(37) = 2.17$, $p < .05$, and $t(47) = 3.05$, $p < .01$, respectively.

From the present results it becomes clear that cognitive biases found in other areas of life also are present in traffic. In summary, the results indicate that drivers who are caught behind another driver become irritated, but to a less extent, and tend to attribute the behaviour of the obstructive driver to dispositional factors. In contrast, drivers who are obstructive, think that drivers behind them are more irritated than they actually are, attributing their own behaviour to factors in the environment. Obstructed drivers also tend to think that obstructive drivers are not that bothered, whereas the obstructive drivers themselves are more bothered than what other drivers think they are.

General discussion

Traffic psychology research has focused for a long time on the road user as a more or less isolated individual. However, most of the time a driver is influenced by the social environment consisting of other road users, general social norms, and formal traffic rules (Zaidel, 1992). This implies that road users, in their own actions, have to take the intentions and behaviours of other road users into account. In other words, road users have to interact with each other. The aim of this thesis was to increase the knowledge about the components in the interaction between road users, that is, factors that regulate and influence the interaction.

To regulate and facilitate the interaction among road users there are formal traffic rules that prescribe the proper way to behave and that indicate the intentions and behaviours of other road users. However, sometimes behaviours that supplement or contradict formal traffic rules become common in a specific situation or place. This event is an indication that an *informal traffic rule* has been developed and put in practice. One place where behaviours often contradict the formal traffic rule is in intersections in which the right-hand rule is in effect. The right-hand rule is probably considered by many drivers as inappropriate or not adjusted to the traffic environment, because rule compliance in these types of intersection is relatively low (Helmers & Åberg, 1978; Janssen et al., 1988; Johannessen, 1984; Kulmala, 1991). In the field study conducted, there was a tendency of drivers to use informal rules in intersections and also in roundabouts.

The results of Paper I indicate that, in addition to the formal rule, drivers rely on informal rules based on road design (a driver from a narrower road yields to a driver from a broader road) and on other drivers' behaviour (a driver yields if a crossing driver does not slow down). Moreover, the results indicated that different drivers relied on different yielding strategies. Some drivers reported behaviours that were in compliance with traffic regulations (the right-hand rule). Some cautious drivers reported that they mostly yielded the right of way to other drivers, regardless of obligation to yield or not, some drivers reported that they rarely yielded, and some drivers reported behaviours that were more dependent on road design than on formal rules. If drivers in a specific situation comply with different rules, conflicts can occur because the possibility to correctly predict another road user's behaviour is decreased (Wilde, 1976). It might be possible that some incongruence between road users' behaviours could be diminished if the road traffic regula-

tions were adjusted to the road design and natural behaviour patterns of humans. However, there would still exist extremely cautious drivers whose behaviour in some situations would lead to a conflict or even an accident (Wilde, 1976), as well as drivers who, deliberately or not, violate formal rules.

If a driver violates a rule, whether it is formal or informal, irritation in other road users might be evoked. Sometimes the irritated driver might even feel an urge to “teach the other driver a lesson”. In Sweden, an informal rule has come about demanding slow drivers to use the shoulder when other drivers are overtaking. A driver refusing to facilitate might be seen as obstructive and induces irritation among others. Shinar (1998) has claimed that it is when other people’s behaviour is perceived as unfair, against the norms, or against the expected behaviour that frustration might develop into aggression directed towards these people. In Paper III, it was actually found that self-reported irritation was greater in a situation in which the obstructive driver in front had a possibility to facilitate than in a situation where this possibility did not exist. It was also found in Paper III that a high amount of irritation was evoked in the scenario in which a crossing driver cut right in front of another car, a behaviour that is obstructive, dangerous, and violates a formal traffic rule. However, a scenario describing a similar situation, except that this time there was a broad shoulder that could be used as an acceleration lane, induced only a small amount of irritation. Strictly, this behaviour is also a violation, but not that obstructive and therefore accepted by most drivers. It is possible that this behaviour mirrors an informal rule.

In Paper II, situations that evoke irritation in drivers were investigated. A Swedish version of the UK DAS (Lajunen et al., 1998) was used to measure the degree of irritation felt in different potentially provocative traffic situations. Lajunen and his colleagues found that the UK DAS measured three sources of anger-provoking situations: progress impeded, reckless driving, and direct hostility. The three-factor structure was replicated in the present sample of Swedish drivers. Irritation evoked in all three sources of situations was positively associated with aggressive behaviours, a finding in accordance with the results of Lajunen and Parker (2001). This association indicates that irritated drivers might try to educate the road user who has provoked the irritation. In this way, specific behaviours (for instance, to comply with informal traffic rules) can be learned by, for example, novice drivers. This was the case in the study by Bjørnskau (1993), in which experienced drivers taught novice drivers to dip their headlights when meeting in the dark. The results of the field study showed that the novice drivers, who recently had obtained their driver’s licence, were more consistent in their behavioural strategies, whereas the behaviour of the experienced drivers varied with different situations. This finding indicates that novice drivers, as long as they are beginners, rely on the formal rules and behavioural strategies they have learned in driving school.

However, the connection between irritation and aggressive actions regarding progress impeded was much smaller than for the other two sources of situations. This result contradicts the ideas that the most important reason for irritation and aggression in traffic is other road users being obstructive (e.g., Bjørnskau, 1993, 1996; Shinar, 1998). However, it should be noted that the latent variables, which measured irritation and aggressive reactions, were based on only three items each. The models should therefore be verified in a study with a larger sample size, in which more items can be included in the variables.

Another finding in Paper II was that the female drivers reported more irritation than male drivers when they were impeded or witnessed reckless driving of other drivers. On the other hand, concerning reckless driving and direct hostility, male drivers more often reported than female drivers that they would react aggressively, even when they were less irritated. This implies that male drivers do not need a high degree of irritation to behave aggressively. Instead, they use aggressive behaviours as a means to achieve other goals. This view is consistent with earlier findings (e.g., Archer & Haigh, 1999), which have shown that women endorse expressive beliefs about aggression, whereas men endorse instrumental beliefs.

It was assumed that drivers who enjoyed a faster speed than other drivers would become more irritated than other drivers when obstructed. Surprisingly, no such association could be found. In a study of congestion and aggressive driving, Shinar and Compton (2004) found that the frequency of aggressive behaviour is higher when the value of time is high (as in rush hours) than when the value of time is low (as in non-rush hour weekdays or at weekends). This finding could perhaps explain why drivers reporting that they drive faster than other drivers did not report any higher irritation when impeded on the road. It might be so that irritation is only provoked when the drivers are in a hurry, and not when fast driving is a part of their everyday behaviour.

In Paper III an indication of false consensus among the drivers concerning irritation but not concerning botheration was obtained. Another finding of Paper III was that drivers in general believed that obstructed drivers were more irritated than these obstructed drivers actually were. A possible consequence of the false consensus bias in relation with driving is that if drivers with an aberrant driving style perceive themselves as “normal” regarding driving, they do not see any reason to change their destructive behaviour (Manstead et al., 1992). Another consequence of the false consensus bias is the result observed in Paper II, namely that drivers who enjoyed a higher speed than other drivers reported both a lower irritation and a lower frequency of aggressive reactions to others’ reckless driving. In other words, drivers who behave reckless do not pay attention to the reckless behaviour of other drivers, suggesting that they view these behaviours as normal. In a study of biased perceptions concerning speed, Walton and McKeown (2001)

noted that drivers who believed that they drove slower than the average driver ignored advertising campaigns encouraging people not to speed. The authors concluded that informing drivers that they exaggerate the speed of others would increase the effectiveness of safety campaigns. Some studies have actually found that feedback on the percentage of drivers *not* speeding, produced a reduction in driver speed (Van Houten et al., 1985; Van Houten & Nau, 1983). It might therefore be possible that by informing drivers that other road users actually are less irritated than what is common thought will have a positive impact on driver irritation.

Another result from Paper III is that mean irritation was greater for drivers who attributed others' behaviour to dispositional factors than for drivers who attributed others' behaviour to situational factors. Clear evidence of the actor-observer effect was also found. Together, these two results suggest that some irritation in traffic might be the result of road users' tendency to attribute others' negative behaviour to dispositional factors. Few studies have investigated the actor-observer effect in traffic, but Baxter et al. (1990) found similar tendencies for drivers when explaining close following and running traffic lights.

According to the original actor-observer hypothesis (Jones & Nisbett, 1972), attributions are either situational or dispositional. In the present study three categories of attributions were used. The reason for this was that explanations such as "the person is stressed" or "the person is talking on a mobile telephone" were considered neither to be a dispositional nor a situational factor. Therefore, a third category ("temporary" attributions) was created. However, for some of the analyses, the temporary category was, for practical reasons, regarded as a sub-category of the situational factors.

In the first three scenarios most attributions were made to either wholly dispositional or situational factors. In these scenarios a driver was being obstructive by driving slower than other drivers or by not driving aside to facilitate for others. These situations may be more obstructive than the other scenarios because, at least in the two first scenarios, drivers could have been caught behind the slow driving driver for a long time. In the other three scenarios many attributions were made to temporary factors. The last scenario was probably so hard to imagine for the participants – at least the participants who were told that they themselves performed the behaviour – that the only reason they could think of was that they had had a temporary blackout.

In this thesis it has been suggested that drivers, in addition to the formal traffic rules, use informal rules in their interaction with each other. Based on the results of Paper I, the informal rules vary with different road designs and with the behaviour of other road users. However, road users also vary in their use of informal rules, something that might lead to misunderstandings and irritation, which, in turn, may lead to attempts by individuals to educate their fellow road users. The results of Paper II indicate that when drivers become impeded, watch others drive reckless, or are subject to direct hostile-

ity from others, they will become irritated. Irritation often results in aggressive actions, which might evoke irritation in other road users, and so on. This possibility means that irritation and aggressive behaviours could take the form of some kind of chain reaction and spread from driver to driver. Another phenomenon that might be a problem in road users' interaction is cognitive biases (Paper III), which distort perceptions of the behaviours of others. For instance, there is a general tendency to believe that when other drivers become obstructed they feel more irritated than they actually do. Furthermore, obstructive drivers are perceived as behaving the way they do because of personal rather than situational factors.

In conclusion, this thesis provides further knowledge about driver interactions, particular informal rules in intersections, irritation and aggression, and cognitive biases. To change the road design in an attempt to reduce irritation in traffic, might be relevant in some situations. However, in most situations the only possible remedy is to change the attitudes and behaviour of the road users. If it is possible to give drivers insight in cognitive biases they are subject to when judging other road users' behaviour, both driver irritation and aggressive behaviours on the roads probably would decrease.

Acknowledgements

As the social being I am, I would not have managed these past years working on my thesis without all the many important people around me. First of all, I would like to thank my supervisor, Professor Lars Åberg, for bringing wise comments to my work, for always being patient with my finicalness and for letting me take my time and do things in roundabout ways, although I usually ended up having the same conclusions as he had reached at a much earlier time.

I would also like to thank the other members of the small, and sometimes endangered, psychology group at Dalarna University: Lena Linde, Sören Nordlund, and Henriette Wallén Warner. Special thanks to Henriette, who has become a good friend during the years, for always taking her time whenever I need to discuss something and for always being encouraging.

I am also grateful to my other colleagues and friends at Dalarna University for administrative and scientific support and for much appreciated chats and nice lunches. Special thanks to the people at the coffee table at Teknikdalen, also including members from VTI and TFK, with whom I have discussed many problems during the years. Special thanks are also due to the library personnel for excellent service.

My colleagues in the traffic research group at Uppsala University, Mats Haglund, Rickard Nilsson, and Per-Arne Rimmö, took good care of me when I started my postgraduate studies. For this, I am very grateful. Special thanks to Per-Arne, who unfortunately is no longer with us, for taking his role as my mentor very seriously.

I would like to thank all my other friends for putting up with me during these years and for still inviting me to various social occasions, although I numerous times chose to work on my thesis instead of spending my time with them.

I am also greatly thankful to Thomas Tydén for introducing me to scientific research and for supporting me in my choice of career.

Finally, I wish to thank my family for taking part in some of my studies as walkers-on, although I think they thought it sometimes was both dangerous and embarrassing. Thank you all!

Borlänge, August 2005

Gunilla

For financial support, I am indebted to the Swedish National Road Administration.

References

- Åberg, L., Larsen, L., Glad, A., & Beilinson, L. (1997). Observed vehicle speed and drivers' perceived speed of others. *Applied Psychology: An International Review*, *46*, 287-302.
- Archer, J., & Haigh, A. (1999). Sex differences in beliefs about aggression: Opponent's sex and the form of aggression. *British Journal of Social Psychology*, *38*, 71-84.
- Baxter, J. S., MacRae, C. N., Manstead, A. S. R., Stradling, S. G., & Parker, D. (1990). Attributional biases and driver behaviour. *Social Behaviour*, *5*, 185-192.
- Björklund, G. (2003). *Informella regler i korsningar och cirkulationsplatser – en pilotstudie* [Informal rules in intersections and roundabouts – a pilot study] (Working Papers in Transport, Tourism, and Information Technology No. 2002:4). Borlänge, Sweden: Dalarna University.
- Bjørnskau, T. (1993). *Spillteori, trafikk og ulykker: En teori om interaksjon i trafikken* [Game theory, road traffic, and accidents: A theory of road user interaction]. Doctoral dissertation, University of Oslo, Norway.
- Bjørnskau, T. (1996). Why are the “safest” norms, attitudes and types of behaviour not typical for the safest drivers? *Transport Reviews*, *16*, 169-181.
- Cialdini, R. B., & Trost, M. R. (1998). Social influence: social norms, conformity, and compliance. In D. T. Gilbert, S. T. Fiske, & G. Lindzey (Eds.), *The handbook of social psychology* (4th ed., Vol. 2, pp. 151-192). Boston, MA: McGraw-Hill.
- Cooper, P. J. (1997). The relationship between speeding behaviour (as measured by violation convictions) and crash involvement. *Journal of Safety Research*, *28*, 83-95.
- Dahlen, E. R., Martin, R. C., Ragan, K., & Kuhlman, M. M. (2005). Driving anger, sensation seeking, impulsiveness, and boredom proneness in the prediction of unsafe driving. *Accident Analysis and Prevention*, *37*, 341-348.
- Dannefer, W. D. (1977). Driving and symbolic interaction. *Sociological Inquiry*, *47*, 33-38.
- Deffenbacher, J. L., Deffenbacher, D. M., Lynch, R. S., & Richards, T. L. (2003). Anger, aggression, and risky behavior: a comparison of high and low anger drivers. *Behaviour Research and Therapy*, *41*, 701-718.
- Deffenbacher, J. L., Oetting, E. R., & Lynch, R. S. (1994). Development of a driving anger scale. *Psychological Reports*, *74*, 83-91.
- Deehy, P. T. (1968). *Sociology and road safety*. Paper presented at a seminar of the Engineering Institute of Canada Committee on Road Safety Research, Kingston, Canada, 1968.
- Dollard, J., Doob, L. W., Miller, N. E., Mowrer, O. H., & Sears, R. R. (1939). *Frustration and aggression*. New Haven, CN: Yale University Press.
- Englund, A., Gregersen, N. P., Hydén, C., Lövsund, P., & Åberg, L. (1998). *Trafiksäkerhet. En kunskapsöversikt*. [Traffic safety. An overview]. Lund, Sweden: Studentlitteratur.

- Haglund, M., & Åberg, L. (2000). Speed choice in relation to speed limit and influences from other drivers. *Transportation Research Part F*, 3, 39-51.
- Helmets, G., & Åberg, L. (1978). *Förarbeteende i gatukorsningar i relation till företrädesregler och vägutformning. En explorativ studie*. [Driver behaviour in intersections as related to priority rules and road design. An exploratory study] (Rapport nr 167). Linköping, Sweden: Statens Väg- och trafikinstitut (VTI).
- Hennessy, D. A., & Wiesenthal, D. L. (1999). Traffic congestion, driver stress, and driver aggression. *Aggressive behavior*, 25, 409-423.
- Hjorthol, R., Assum, T., & Solheim, T. (1984). *Sosiologi i transportforskning*. [Sociology in transport research] (TØI-notat 720). Oslo, Norway: Transportøkonomisk institutt.
- Janssen, W., van der Horst, R., Bakker, P., & ten Broeke, W. (1988). Auto-auto and auto-bicycle interactions in priority situations. In T. Rothengatter & R. de Bruin (Eds.), *Road user behaviour: theory and research* (pp. 639-644). Assen/Maastricht: van Gorcum.
- Johannessen, S. (1984). *Kjøreatferd i uregulerte T-kryss. Høyregel eller vikeplik-tregulering?* [Driving behaviour in unregulated T-junctions. The right-hand rule or duty to give way?] (Rapport Nr. STF63 A84009). Trondheim, Norway: Stiftelsen for industriell og teknisk forskning ved Norges tekniske høyskole (SINTEF).
- Jones, E. E., & Nisbett, R. E. (1972). The actor and the observer: divergent perceptions of the causes of behavior. In E. E. Jones, D. E. Kanouse, H. H. Kelley, R. E. Nisbett, S. Valins, & B. Weiner (Eds.), *Attribution: perceiving the causes of behavior*, New Jersey: General Learning Press.
- Jöreskog, K. G., & Sörbom, D. (1993). *LISREL 8: Structural equation modeling with the SIMPLIS command language*. Chicago, US: Scientific Software International.
- Kloeden, C. N., McLean, A. J., Moore, V. M., & Ponte, G. (1997). *Travelling speed and the risk of crash involvement. Volume 1: Findings*. (Report no. CR 172). Canberra, Australia: Department of Transport and Regional Development, Federal Office of Road Safety.
- Knapper, C. K., & Cropley, A. J. (1978). Towards a social psychology of the traffic environment. In D. F. Burkhardt, & W. H. Ittelson (Eds.), *Environmental Assessment of Socioeconomic Systems*, New York: Plenum.
- Kulmala, R. (1991). Driver behaviour at urban junctions with the right-hand rule. In M. Draskóczy (Ed.), *International cooperation on theories and concepts in traffic safety (ICTCT), Proceedings of the third workshop of ICTCT in Cracow, November 1990* (pp. 137-147). University of Lund, Department of traffic planning and engineering, Sweden.
- Lajunen, T., & Parker, D. (2001). Are aggressive people aggressive drivers? A study of the relationship between self-reported general aggressiveness, driver anger and aggressive driving. *Accident Analysis and Prevention*, 33, 243-255.
- Lajunen, T., Parker, D., & Stradling, S. G. (1998). Dimensions of driver anger, aggressive and highway code violations and their mediation by safety orientation in UK drivers. *Transportation Research Part F*, 1, 107-121.
- Lajunen, T., Parker, D., & Summala, H. (1999). Does traffic congestion increase driver aggression? *Transportation Research Part F*, 2, 225-236.
- Lazarus, R. S. (1991). *Emotion and adaptation*. New York: Oxford University Press.
- Lurie, L. H. (1968). *Sociology and road safety. A review and discussion of available literature*. Paper presented at a seminar of the Engineering Institute of Canada Committee on Road Safety Research, Kingston, Canada, 1968.

- Manstead, A. S. R. (1997). *Agressie op de weg*. Unpublished paper presented at the SWOV Institute for Road Safety Research, Leidschendam, The Netherlands.
- Manstead, A. S. R., Parker, D., Stradling, S. G., Reason, J. T., & Baxter, J. S. (1992). Perceived consensus in estimates of the prevalence of driving errors and violations. *Journal of Applied Social Psychology, 22*, 509-530.
- McKenna, F. P. & Crick, J. L. (1994). *Hazard perception in drivers: a methodology for testing and training*. TRL Contractor Report 313, Transport Research Laboratory, Crowthorne, Berkshire.
- Mesken, J. (2003). *Personal versus situational factors in the elicitation of anger*. Paper presented at the Young Researchers' Seminar, organised by the European Conference of Transport Research Institutes, December 16-18, 2003, Bron, France.
- Nilsson, G. (1982). *The effects of speed limits on traffic accidents in Sweden*. (Report no. 68). Linköping, Sweden: National Road and Traffic Research Institute (VTI).
- Parker, D., Manstead, A. S. R., Stradling, S. G., Reason, J. T., & Baxter, J. S. (1992). Intention to commit driving violations: An application of the Theory of planned behavior. *Journal of Applied Psychology, 77*, 94-101.
- Parker, D., West, R., Stradling, S., & Manstead, A. S. R. (1995). Behavioural characteristics and involvement in different types of traffic accidents. *Accident Analysis and Prevention, 27*, 571-581.
- Ross, L. (1977). The intuitive psychologist and his shortcomings: distortions in the attribution process. In L. Berkowitz (Ed.), *Advances in experimental social psychology*, New York: Academic Press.
- Ross, L., Greene, D., & House, P. (1977). The "false consensus effect": An egocentric bias in social perception and attribution processes. *Journal of Experimental Social Psychology, 13*, 279-301.
- Rothengatter, T. (1991). Normative behaviour is unattractive if it is abnormal: Relationships between norms, attitudes and traffic law. In M. J. Koornstra & J. Christensen (Eds.), *Enforcement and rewarding: Strategies and effects*. Leidschendam, The Netherlands: SWOV Institute for Road Safety Research.
- Rumar, K. (1990). The basic driver error: late detection. *Ergonomics, 33*, 1281-1290.
- Shinar, D. (1998). Aggressive driving: the contribution of the drivers and the situation. *Transportation Research Part F, 1*, 137-160.
- Shinar, D., & Compton, R. (2004). Aggressive driving: an observational study of driver, vehicle, and situational variables. *Accident Analysis and Prevention, 36*, 429-437.
- Shor, R. E. (1964). Shared patterns of nonverbal normative expectations in automobile driving. *The Journal of Social Psychology, 62*, 155-163.
- Smith, C. A., & Lazarus, R. S. (1993). Appraisal components, core relational themes, and the emotions. *Cognition and Emotion, 7*, 233-269.
- Summala, H., Pasanen, E., Räsänen, M., & Sievänen, J. (1996). Bicycle accidents and drivers' visual search at left and right turns. *Accident Analysis and Prevention, 28*, 147-153.
- Ulleberg, P. (2004). *Aggressiv kjøring – en litteraturstudie* [Aggressive driving – a literature review] (TØI-rapport 709). Oslo, Norway: Transportøkonomisk institutt.
- Vaa, T. (2000). *Some comments on the definition of aggression and aggressive driving behaviour*. Paper presented at 11th International Congress: Traffic Safety on Three Continents, September 20-22, 2000, Pretoria.

- Van Houten, R. & Nau, P. A. (1983). Feedback interventions and driving speed: A parametric and comparative analysis. *Journal of Applied Behavior Analysis, 16*, 253-281.
- Van Houten, R., Rolider, A., Nau, P. A., Friedman, R., Becker, M., Chalodovsky, I., & Scherer, M. (1985). Large-scale reductions in speeding and accidents in Canada and Israel: A behavioral ecological perspective. *Journal of Applied Behavior Analysis, 18*, 87-93.
- Walton, D., & McKeown, P. C. (2001). Drivers' biased perceptions of speed and safety campaign messages. *Accident Analysis and Prevention, 33*, 629-640.
- Wilde, G. J. S. (1976). Social interaction patterns in driver behavior: an introductory review. *Human Factors, 18*, 477-492.
- Wilde, G. J. S. (1978). Sozialverhalten von Verkehrsteilnehmern und Theorien der Unfallverursachung. *Gruppendynamik, 4*, 263-282.
- Yinon, Y. & Levian, E. (1995). Presence of other drivers as a determinant of traffic violations. *The Journal of Social Psychology, 135*(3), 299-304.
- Zaidel, D. M. (1992). A modeling perspective on the culture of driving. *Accident Analysis and Prevention, 24*, 6, 585-597.

Acta Universitatis Upsaliensis

*Digital Comprehensive Summaries of Uppsala Dissertations
from the Faculty of Social Sciences 8*

Editor: The Dean of the Faculty of Social Sciences

A doctoral dissertation from the Faculty of Social Sciences, Uppsala University, is usually a summary of a number of papers. A few copies of the complete dissertation are kept at major Swedish research libraries, while the summary alone is distributed internationally through the series Digital Comprehensive Summaries of Uppsala Dissertations from the Faculty of Social Sciences. (Prior to January, 2005, the series was published under the title "Comprehensive Summaries of Uppsala Dissertations from the Faculty of Social Sciences".)

Distribution: publications.uu.se
urn:nbn:se:uu:diva-5948



ACTA
UNIVERSITATIS
UPSALIENSIS
UPPSALA
2005