6. Conclusions and discussion

The research presented in the current thesis focussed on the role of emotion in driving behaviour. Two general subjects were central in the studies: the elicitation of emotions during driving, and the consequences of emotions on driving-related performance. The combination of these subjects presented a challenge, because they addressed research questions derived from three different research areas. Siemer (2001) already noted that in the area of emotions and moods, the research developed along two largely separated research lines. One focussed on the process of the elicitation of emotion and was primarily concerned with appraisal: the way we evaluate events according to our personal concerns and goals. The other focussed on moods and their effects on cognition and behaviour. The third research line can be found in the area of traffic psychology: it deals with event-steered reactions of individuals to the demands of the task environment. Driving anger, stress and aggression are the typical subjects addressed in this field of interest.

Different research traditions imply the use of different research methods, and different theories. The knowledge about the process of emotion elicitation is largely based on studies using the vignette or scenario method: subjects are presented with a hypothetical scenario in which important aspects (appraisal components) are varied, and subjects’ emotional responses are registered. The results found from appraisal studies are mainly based on questionnaires. Studies on emotion effects require the experimental induction of affective states in subjects and the comparison of these subjects with controls. Experiments are often carried out within a laboratory, in which separated areas of task performance are investigated. As car driving implies the use of a range of aspects of task performance, most of the traffic psychological studies were not carried out in the laboratory. Rather, popular methods in traffic psychology are questionnaires, driving simulators or instrumented cars. In the current research, all of these different methods were used. The elicitation of emotions was studied using a questionnaire; the effect of emotion on cognition was studied using emotion manipulation in a driving simulator and in the laboratory, and effects of emotion on behaviour were studied using an instrumented car.

To gain a better understanding of the role of emotions while driving, influential theories from all three research traditions should be tied together. An attempt to do this was made in Chapter 1: the process of emotion elicitation (appraisal theory) was connected to the process of emotion effects
(appraisal tendency approach). Also, the emotion process was placed within Groeger’s four-facet model of driving behaviour, in order to specify at which stage in the driving process emotions may be elicited, and how they may affect the selection and implementation of action. Although the current research did not aim to test the relations in this model, the data presented in Chapters 3 and 4 give indicates that the framework is useful. In Chapter 4, it was suggested that angry respondents reported different behaviour intentions regarding following distance than non-angry respondents. This indicates a relation with action planning: angry respondents seem to choose other courses of action than non-angry respondents. Chapter 3, on the other hand, showed that respondents who reported negative emotions to events, in some cases reported to drive with decreased concentration, which might be related to the facet of implementation. The intention to carry out the driving task is still there, but emotions require attention and thus the capacity to direct attention to the driving task is reduced. Connecting the emotion process to a general framework of driving behaviour thus showed to be useful to specify differential relations between emotions and driving.

A systematic review of empirical studies on emotions and driving behaviour was described in Chapter 2. By comparing the outcomes of these studies to the theoretical framework that was developed, the missing links could be established. This resulted in specific research questions that formed the basis of the empirical studies described in Chapters 3, 4 and 5. It was examined whether the elicitation of emotions in traffic could be explained by appraisal theory. Specifically, the role of two appraisal components, personal interaction and goal congruence, was examined. Furthermore, it was explored whether emotions, once present, have an effect on two cognitive processes: optimism bias and illusion of control. And finally, it was investigated whether emotions are related to driving behaviour.

6.1. Emotion elicitation: personal versus situational factors

The question what determines the elicitation of emotion during driving was addressed in Chapter 3 and Chapter 5. In Chapter 3, appraisal theory was used as a framework to examine the role of two aspects: goal congruence and personal interaction, on the occurrence of emotions. Results showed that the role of these aspects differed for the different emotions that were investigated. As expected, goal congruent events were associated with positive emotions, and goal incongruent events with negative emotions. Furthermore, whereas subjects reported higher levels of anger when being presented with a goal incongruent personal event than with a goal
incongruent situational event, for happiness it was the other way around. Reported happiness was higher when subjects were presented with a goal congruent situational event than with a goal congruent personal event. Individual differences also played a significant role: the association between the appraisal components and reported emotions became weaker when Trait Anger and Trait Anxiety were included in the model, although most associations remained significant.

The findings presented in Chapter 3 may not be new in the eyes of appraisal theorists; similar findings have been shown in other areas, for example in the area of close relationships (Fitness & Fletcher, 1993) and computer games (Van Reekum, Johnstone, & Banse, 2004). However, the research presented here applied the principles of appraisal theory to a task-oriented context. Task involvement might have consequences for experienced emotions, because a conflict might occur between responses required for the task and responses required for the emotion (response competition hypothesis, Frijda, 1986). As driving is a complex and risky task, most of the time, the task requirements will take precedence and thus emotions will be regulated. Still, also in the task-oriented context that traffic is, the principles of appraisal theory could be demonstrated. Whereas the results presented in Chapter 3 were based on a questionnaire study, in Chapter 5 similar findings were shown in a naturalistic, on-road environment. Analysis of video pictures of emotion-eliciting traffic events showed that anger was mostly associated with goal incongruent, personal events, whereas anxiety was mostly associated with goal incongruent, situational events. Happiness did not occur very often spontaneously on the road. Chapter 5 thus confirmed our findings from Chapter 3: goal congruence and personal interaction are important for the elicitation of emotion, and on-road emotions can be differentiated by their association with these aspects.

The results from Chapter 5 furthermore showed that the type of goal blocked is important for the elicitation of on-road emotion. There are two main goals in car driving: maintaining safety and arriving at your destination in time (Cnossen, 1999). As these goals are restricted to the area of traffic, appraisal theory makes no assumptions about their associations with different emotions. Traffic studies, however, show that types of events are relevant for different emotions: congestion may be associated with anger and aggression, and complicated traffic situations may be associated with anxiety (Carbonell Vaya, Banuls, Chisvert, Monteagudo, & Pastor, 1997). In Chapter 5 it was shown that the blocking of these goals is associated with different emotions: progress-related events are mainly associated with anger, whereas safety-related events are related to anxiety. This is also in line with a recent study
by Stephens and Groeger (2006) who showed that decreased speed due to interrupting traffic events is associated with ratings of anger and frustration.

For appraisal theory, it would therefore be good to specify the type of goal blocked, in line with the (task) environment in which emotions are elicited. In sports psychology, for example, a relevant specification of the type of goal blocked might not be progress versus safety, but individual success versus success of the team (Rejeski & Brawley, 1983). In sum, the findings presented in Chapter 3 and Chapter 5 show that appraisal theory is useful to explain emotion elicitation during car driving, and that for car driving specifically, goal congruence, type of goal blocked (progress versus safety), and responsible agent (person versus situation) are key aspects. The combination of these aspects determines which emotion will occur in traffic.

6.2. Emotion and cognitive bias

As was noted before, the effects of emotion on cognition has received little attention. Most of the research on affective influences on cognition was carried out in the area of moods. According to Clore and Gasper (2000) this is because moods in general do not have an object, whereas emotions do. Therefore, when an affective state has no object, the information that is provided by the affective state can easily be attributed to other objects. This misattribution hypothesis was discussed in Chapter 2. However, in recent years, some articles and books appeared on the effects of emotions on cognition. The monograph of Frijda, Manstead and Bem (2000) is one of these, and so is the research carried out by Jennifer Lerner and colleagues (Lerner & Keltner, 2000, 2001) about the appraisal tendency approach. This approach states that emotion triggers people to evaluate upcoming events in line with the appraisal components relevant for the emotion that is experienced. In a series of studies, empirical support was found for this approach. Thus, these research efforts show that the presence of a clear object, as is the case in emotion, does not prevent emotions from having an effect on cognition.

Several cognitive processes are relevant for car driving, such as risk perception, optimism bias and illusion of control. Some of these have been shown to be related to affective states (e.g. Alloy, Abramson, & Viscusi, 1981; see Section 4.1.). In the two studies reported in Chapter 4, the effects of emotions on these processes was investigated. The studies were designed as “true experiments” in the sense that the variable of interest (emotion) was manipulated directly, respondents were randomly assigned to groups and possible effects of third variables were excluded by use of a control group
(Neale & Liebert, 1986). The experimental design was however abandoned when results indicated that the emotion manipulation was unsuccessful: Study 1 showed no effects of the emotion manipulation; study 2, showed only limited effects. As in study 2 the emotion manipulation was effective in some subjects but not in others, those who had become angry during the experiment were compared with those who had not become angry. Their scores on risk perception, optimism bias, illusion of control and behaviour intention in pre-test and post-test were compared. Both study 1 and study 2 showed that regardless of experimental group, subjects were more risk-averse in the post-test than in the pre-test. The video fragments that subjects were asked to evaluate, were judged more risky and less controllable in the post-test than in the pre-test. Subjects rated their chance to be involve in a (near) accident, compared to an average driver, as higher in the post-test than in the pre-test. And finally, subjects were less likely to drive like the driver in the video in the post-test than in the pre-test. Study 2 showed that this general measurement effect did not occur in subjects who had become angry during the experiment. They were not more risk-averse in the post-test than in the pre-test.

The difference between pre-test and post-test in both study 1 and study 2, regardless of experimental group, was an unexpected finding. It was assumed beforehand that those in the control condition would evaluate the video fragments the same in the post-test as in the pre-test. In fact, for the other scales included in the study, there were no differences between pre-test and post-test. Therefore, some kind of learning effect must have occurred that was specific for the task of evaluating following distances on video. Obviously, subjects in the post-test had a better idea of the range of following distances and were therefore better able to make accurate evaluations than subjects in the pre-test. This was however not the case for subjects who had become angry during the experiment: their ratings of the video fragments in pre-test and post-test were similar. Two explanations are possible. First, it could be that the angry state prevented subjects to adjust their evaluation in a more risk-averse direction. However, due to the failed emotion manipulation, the effect of a third variable cannot be ruled out. As subjects who had become angry differed from subjects who had not become angry in their levels of Sensation Seeking, it might be that not anger, but Sensation Seeking was responsible for the differences found. Still, while no causal effects of emotion on cognitive bias could be established, results of the studies did suggest a difference between angry and non-angry persons in their evaluation of traffic events; which is possibly partly affected by their levels of Sensation Seeking.
6.3. Emotion and driving behaviour

Whereas Chapters 3 and 4 presented questionnaire and laboratory research, the study presented in Chapter 5 was conducted on the road. The first aim of this study was to establish the frequency and strength of emotions experienced while actually driving. Although the public opinion is that traffic is becoming more and more aggressive, and drivers are angered more often nowadays than before, previous studies provided mixed results about how often emotions occur during driving. A second aim was to confirm the findings from Chapter 3 in an actual on-road environment. And finally, the aim of the study was to establish the consequences of emotions for driving related performance.

The results showed that anger and anxiety occur more often than could be expected based on questionnaire and driving log studies (Underwood, Chapman, Wright, & Crundall, 1999; Levelt, 2003b). Most of the reported emotions were not very strong (between 1 and 2 on a scale from 1 to 5). Also, most of the emotions did not last long: emotion scores were asked every 3 minutes, and it almost never occurred that an emotion remained until the next moment of measurement. This suggests that during driving, people experience many emotions, most of them mild and short-lasting, which may well be forgotten when people arrive at their destination. Questionnaire studies and driving log methods are therefore not sensitive enough to capture all emotions: they lead to an under-registration of mild emotions. Multiple methods to measure emotions were used (Mesken, 2002): self-reports, observational data (facial expression) and physiology (heart rate). Although the analysis of facial expressions did not provide any differentiation between emotions, the physiological measures did. Periods during which subjects reported anxiety, were associated with a higher heart rate than subjects during control periods in which respondents did not report anxiety. No difference was shown between anger periods and control periods. These results are in line with those found by Lerner, Gonzales, Dahl, Hariri, and Taylor (2005) who showed differential physiological correlates of anger and fear. They explained these findings by appraisals of control: fear is associated with a high perception of risk and a lack of control, leading to more stress and consequently stronger physiological responses than anger, which is associated with a low perception of risk and a high level of control. In fact, the findings from Chapter 5 also showed that anxiety, but not anger, was associated with higher levels of perceived risk. Thus, anger and anxiety are experienced frequently during driving, and they show differential relations with physiological activity and risk perception.
The results of the study presented in Chapter 5 furthermore confirmed the hypothesis that general appraisal components, such as goal congruence and personal interaction, but also task-specific appraisal components, determine the elicitation of emotions (see also Section 6.1). The effects of emotions on actual driving behaviour were investigated by measuring speed during the drive. Subjects who had become angry during the drive were compared with subjects who had not become angry during the drive, on two road sections: one inside the urban area, with a speed limit of 50 km/h, and one on a highway with a speed limit of 100 km/h. Results showed that respondents who had reported anger, drover significantly faster on the 100 km/h road section than respondents who had not reported anger. No differences were shown on the 50 km/h road section. These results are in line with findings from other studies (Arnett, Offer, & Fine, 1997; Deffenbacher, Deffenbacher, Lynch, & Richards, 2003) suggesting that anger is related to speed. However, in these studies, anger and speed were not measured during the actual driving task. McGarva and Steiner (2000) in a study on drivers’ aggression, did measure speed while actually driving. Although he did not measure actual state anger, his results suggest that drivers are inclined to accelerate immediately after a provoking event. This tendency of approach and attack is conform the theoretical notions of the action tendencies of anger (Lazarus, 1991). Thus, Chapter 5 confirms the theoretical notions of the action tendency of anger in a naturalistic environment, with important implications for road safety. In Section 6.6 this issue will be explored further.

6.4. Implications for theory and research

The results of the studies presented in this thesis have several implications for theory and research on emotions and driving behaviour. First, existing literature on the elicitation of emotions while driving have focussed either on general attributes of the traffic context (e.g. congestion), or on characteristics of the driver (e.g. trait driving anger). Appraisal theory predicts that emotions occur as an interaction between specific events and the way they are evaluated according to a person’s personal goals. Specific aspects of traffic events, such as personal interaction, have not received much attention in traffic psychology literature, probably because several studies on emotional aspects of driving behaviour are lacking a theoretical framework. The relation between specific attributes of traffic events and their evaluation by the driver is therefore an area that needs to be explored further. In this

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9 Actually, also studies on other aspects of driving behaviour often lack a theoretical framework (Gärling, 2006).
thesis, the role of goal congruence and personal interaction in emotion elicitation while driving was investigated. Other, more task-specific aspects of traffic events were also shown to be important, such as the difference between progress-related and safety-related events. These are, however, only a selection of appraisal components; there might be more appraisal components that are important to explain the occurrence of emotions in traffic. To capture all relevant aspects, it is necessary to consider not only the theoretical field of appraisal and emotion, but also task-specific fields. For example, appraisal theory states that ego-involvement is an important appraisal component for the emotions of anger and pride (Lazarus, 1991). The concept of ego-involvement has not been studied in the area of emotions and traffic. Also, anonymity and lack of communication are important task-specific aspects, as studies on aggressive driving (e.g. Ellison-Potter, Bell, & Deffenbacher, 2001) has made clear. These aspects have as yet not been studied in relation to emotion. For a full understanding of how and why emotions occur in traffic, these aspects need to be included in future research.

Second, the results from Chapter 4 suggest a relation between affective state and cognitive bias. Although causal links could not be made in the present research, previous studies do show effects of mood on various cognitive processes (see Section 4.1). Recent discussions also address the potential effects of specific emotions on cognition (Clore & Gasper, 2000; Lerner & Keltner, 2001). Considering the fact that emotions do occur rather frequently while driving, as was demonstrated in Chapter 5, and considering the impact of emotions on driving-related cognitive processes, the relation between emotion and cognitive bias in traffic needs to be explored further. The appraisal tendency approach offers a useful framework to study these effects. In other contexts, studies using this approach have demonstrated the differential effects of anger and fear on risk perception. In the area of traffic, these effects have as yet not been established. Furthermore, more knowledge on the effects of emotions on cognitive processes might explain other findings, such as the relations between anger and violations. Chapter 5 showed that anger is related to speed. Also, previous research shows that driving anger is related to violations (Lajunen, Parker, & Stradling, 1998; Lajunen & Parker, 2001). The relation between anger and violations may be mediated by the effects of emotion on cognitive processes such as risk perception and judgement. Likewise, a cognitive bias caused by emotion might be related to driving errors. Westerman and Haigney (2000) reported associations between driver stress and errors and violations, but they did not offer a clear explanation for this. It is important to clarify these relations, given the differential relations between driving errors and violations on the
one hand, and accident involvement on the other (Parker et al., 1995). Also, further research may be directed at the effects of anger on specific violations: not only speed, but also, for example, close following.

Third, the current thesis made clear in the area of emotions while driving, special attention should be directed to the use of theoretical concepts and research methodology. The literature presented in Chapters 1 and 2 showed that many different affective concepts are used interchangeably: stress, anxiety, aggression, emotion, these concepts are all frequently used and it is often not clear what they mean in the context of the study, and how they are different from other affective concepts. Another source of confusion is the use of concepts like state and trait anger. The series of studies by Deffenbacher and colleagues showed that Driving Anger is related to a general aggressive and risky driving style. Driving Anger was conceptualised by the tendency to experience anger while driving, and thus should be considered to be a trait. However, studies referring to Driving Anger are not always specific about this, which might lead to confusion about state or trait driving anger. It should be noted that the concepts mentioned here are all mental states and thus it is not an easy task to distinguish them. Still, the concepts used can and should be defined in such a way that they can be considered separate phenomena. (Frijda et al., 2000).

Several research methods were used in the current thesis: a questionnaire study, laboratory experiments, and an on-road study with an instrumented car. Whereas the studies reported in Chapter 4 were designed according to the requirements of a true experiment, the experimental design could not be maintained. Therefore the results were more difficult to interpret than the results of Chapter 3 and Chapter 5. The main methodological problem in Chapter 4 was the manipulation of emotion. Two attempts were made to experimentally induce emotions, and both were not sufficiently successful. The methods were chosen based on several studies showing the effectiveness of these methods (e.g. Levine & Burgess, 1997; see also Nummenmaa & Niemi, 2004, for a review). Two explanations are possible for the difference in findings between the studies reported in Chapter 4, and other studies in which emotions were experimentally induced. One is that the effects reported in other studies are in fact not as strong as reported. It is difficult to accurately compare the findings, because most studies did not report information about a control group, about effect size or about duration of the emotional state. Another explanation is that the methods used in other studies are suitable for controlled laboratory task environment, but not for a naturalistic task-environment. Future research needs to clarify these issues before choosing an emotion induction procedure.
The measurement of emotion is another methodological issue relevant for future research. In the current thesis, the reported studies made use of different emotion measures: self-reports, physiology and observed behaviour. Previous studies on emotions while driving typically used only self-reports, although one study (Malta, Blanchard, Freidenberg, Galovski, Karl, et al., 2001) reported the use of physiological measures as well. This thesis showed that anger and happiness reported in the questionnaire were stronger than anger and happiness reported on the road. Anxiety, on the other hand, was hardly reported in the questionnaire, but was elicited rather frequently during actual driving. Obviously there are differences between self-reported emotions in questionnaires and self-reported emotions during the actual driving task. Furthermore, physiological measures showed differential relations with anger and anxiety. This leads us to conclude that the mere use of questionnaires does not suffice when the topic of emotions is concerned. Future research should focus on the measurement of emotions while actually driving and preferably use methods other than self-reports, such as physiology or facial expressions. In the present studies the analysis of facial expressions did not provide useful results; possibly the use of computer programs specifically designed for the analysis of facial expressions will provide more useful results.

6.5. Implications for traffic policy

The relevance of emotions for driving performance is more and more acknowledged, not only by traffic researchers but also by policy makers (Ministerie van Verkeer en Waterstaat, 2004). Especially the area of drivers aggression received attention, and several initiatives have already been developed in the Netherlands to reduce aggressive driving. The present research also indicated that it is more useful to develop actions to prevent anger, than to prevent anxiety. Anger is associated mostly with actions of other road users, whereas anxiety occurs when drivers are confronted with a difficult driving situation. When road safety is concerned, anger then seems to be more relevant than anxiety, because anger is associated with a lowered risk perception and with risky and aggressive behaviour tendencies. Anxiety is related to a higher perception of risk, which implies a more careful driving style. In fact, the study reported in Chapter 3 showed that negative events related to the traffic situation are associated with a more careful driving style, whereas negative events related to another driver are associated with negative expressions and behaviour. Thus, measures should be directed to prevent the elicitation of anger rather than anxiety. In this last section, three
areas of policy are discussed: Training and education, infrastructure and enforcement.

6.5.1. Training and education

In the introduction, it was argued that car driving is a social activity, requiring social skills. The emphasis in driver training, however, is on motor skills (handling the vehicle) and, in recent years, on cognitive skills (hazard perception). The anticipation of the behaviour of others, and the interpretation of this behaviour, is not a major issue. This thesis showed that the evaluation of other road users’ behaviour in terms with one’s personal goals and concerns is the main determinant of driving anger. Therefore, social and communicative skills should be as much a part of driver training as motoric and cognitive skills. A way to teach student drivers these skills is to let them drive in stressful situations which include many interactions with other road users: for example in the city centre at rush hour. Communication during car driving is actually quite difficult because one cannot see or hear the other driver as well as one would while, for example walking or cycling. The difficulties in communication during car driving is an issue that deserves more attention in, for example, public information campaigns.

Another issue for training and education is the estimation of following distances. The results described in Chapter 4 showed that respondents made different safety evaluations of following distances when they had seen the range of distances before, than when they saw the video fragments for the first time. This suggests that drivers need some kind of reference to be able to decide whether a following distance is safe or not. Following distances and their safety implications can easily be taught during theoretical as well as practical training. Also, information campaigns can use video fragments and photographs to communicate safe and risky following distances. Difficulties remain however with the estimation of the actual risk of following distances. Even when respondents had evaluated the video fragments before, they considered short following distances as rather safe. The 2-seconds rule which is advised by the Dutch Traffic Ministry is also evaluated as rather long by many drivers. Still, the findings presented in Chapter 4 demonstrate that learning effects do occur. Possibly they will be stronger when actual safety consequences of short following distances are communicated.

Obligatory driver improvement courses are often considered promising to handle aggressive driving. Experiments have been carried out in Belgium and Germany, but several reviews (Masten & Peck, 2003; Ker, Roberts, Collier, Beyer, Bunn, et al., 2005) showed limited effects of such courses. Two
aspects might be included in these training programs to increase their effectiveness. First, the current thesis showed a learning effect when evaluating following distances. Driver improvement courses could benefit from such learning effects by teaching participants how to evaluate following distances or other risky situations. Second, the current research indicates the importance of specific traffic events in the elicitation of emotion. Instead of trying to increase the general safety perception of drivers, driver improvement courses should therefore try to improve the interpretation of specific traffic events.

6.5.2. Infrastructure

This thesis showed that anger was mostly associated with impeded progress. Although this offers support for the hypothesis that congestion is related to anger and aggression, it should be noted that anger was also mostly associated with the actions of other road users. Thus, the mere presence of congestion is not enough to elicit anger; for anger, it is necessary that another person is to blame. In congestion, this is not so clear. Therefore, infrastructural measures directed at decreasing congestion as such, are not believed to be successful in preventing angry responses. Rather, the roads should be designed in such a way that they minimize the number of interactions between road users. When interactions are inevitable, as in urban dwelling areas, the behaviour of all road participants should be predictable and ambiguity should be decreased. This implies that in order to decrease ambiguity, it is better to regulate than to deregulate the priority system at intersections, e.g. by traffic lights. Other ambiguous situations such as specific lanes for rush hour traffic should also be avoided. In fact, the viewpoint that roads and the behaviour of road users should be predictable, is part of the vision of Sustainable Safety, that was developed in the Netherlands (Wegman & Aarts, in press). The aim of a sustainable safe traffic system is to prevent accidents or to minimise the risk of serious injury by taking a user centred instead of a system centred approach. Roads should thus be designed consistently in order to support the expectations of road users.

A specific recommendation to prevent anger by making the traffic system more predictable and to minimise interactions, is a system of “keep your lane”. Two behaviours that have been listed in top-10 lists of annoying behaviours, are close following and driving on the left lane of the highway for too long. Obviously, these behaviours are related to each other. When the driver on the left lane perceives the close following behaviour of the driver behind him as intentional, he will be more likely to be annoyed than when he
does not perceive the behaviour as such. Possibly, he will decrease speed to retaliate. The driver who is close following, on the other hand, will most likely be annoyed when he evaluates the behaviour of the other driver as intentional, that is, he believes that the driver is staying in the left lane on purpose. A system of “keep your lane”, in which lane change is minimised and overtaking on both sides is permitted, could decrease the number of interactions and thus reduce the likelihood of angry responses.

6.5.3. Enforcement

Enforcement has been shown effective for a range of behaviours involving the state of the driver. The effects of police enforcement on driving under the influence of alcohol have been demonstrated already some while ago. In this area, police enforcement became especially effective when it became possible to test drivers’ blood alcohol levels by roadside surveys. Also, laws on resting times for truck drivers have been effective in reducing the number of fatigue-related accidents. Emotion is obviously impossible to enforce, because there is no single measure, except self-reports, that indicates the presence or absence of an emotion. Attention should therefore be directed towards behaviours that are known to increase risk. The Dutch campaign “I love verkeersregels” may not have been effective because its approach was evaluated as too soft. However, the ideas behind the campaign are promising, because the campaign addresses specific behaviours rather than a general driving style. This should be the approach of police enforcement as well: not to consider aggressive driving as one phenomenon, as it represents a range of behaviours that may or may not be a result of anger. Enforcement should rather focus on specific behaviours, like speeding and close following.

The experiment described in Chapter 5 resulted in the observation that speed limits might induce anger in two specific situations. One is the situation in which the reason of the speed limit is not clear, as was the case in a situation were the speed limit on the highway was temporarily decreased from 100 km/h to 80 km/h. Another is a situation in which the safety benefits of a speed limit are not clear, as was the case on a 50 km/h urban road with two lanes for each direction, without side streets and with a separated bicycle lane. Several respondents reported anger in these situations. This touches on the issue of credible speed limits (Van Schagen, Wegman, & Roszbach, 2005): Speed limits are more likely to be observed if the perceived legitimacy is high. Speed awareness courses might change the perceived legitimacy of police action (McKenna, 2005).
6.6. Conclusion

In sum, this thesis showed that emotions occur rather frequently in traffic, and although they are often relatively mild, they can be differentiated in terms of determinants and consequences, but also in terms of physiological responses. Both questionnaire and on road studies showed the relevance of appraisal for the elicitation of emotion: emotions are elicited by the evaluation of specific aspects of traffic events and it depends on the person’s individual characteristics whether and to what extent emotions are experienced. Emotions, especially anger, are related to cognitive bias, although in the present studies, causal inferences could not be made. Finally, emotions were shown to be related to evaluations of risk and to behaviour tendencies and actual driving behaviour.