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Velocity versus safety: Impact of goal conflict and task difficulty on drivers' behaviour, feelings of anxiety, and electrodermal responses

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ABSTRACT

This paper proposes a goal conflict model that links drivers' conflicting motivations for fast and safe driving with an emotional state of anxiety. It is proposed that this linkage is mediated by a behavioural inhibition system (Gray & McNaughton, 2000) affecting drivers' mood, physiological responses and choice of speed. The model was tested with 24 male participants, each of whom undertook 18 runs of a simple driving simulation. On each run, the goal conflict was induced by time pressure and the advance warning of a possible encounter with a deer. The conflict's intensity varied depending on the magnitude of the equally-sized gain and loss assigned to early arrival and collision respectively. Results show that the larger the conflict, the more slowly the participants drove. In addition, they rated themselves as being more anxious, attentive, and aroused. An increase in task difficulty induced by low visibility resulted in an additional speed reduction and increase in self-reported anxiety but did not lead to a further increase in self-assessed attention and arousal. Overall, the number of electrodermal responses depended neither on conflict nor on task difficulty, but increased linearly with conflict during low visibility. Implications for the incorporation of goal conflict into theories on driving behaviour and conclusions for traffic safety policies are discussed.

1. Introduction

In the literature there is broad consensus on the key role of motivational factors in explaining risky driving behaviour (e.g., Forward, 2009; Näätänen & Summala, 1974; Rothengatter, 1988). Motives like keeping an appointment, enjoying speed or impressing others can cause excessive speed, bold overtaking manoeuvres or disregard of traffic signs. However, there are also motives that counteract risky driving either by inhibiting or mitigating its occurrence. Probably the most important motives are accident prevention and penalty avoidance. Given the ubiquity of reasons for both kinds of motives, goal conflicts can be regarded as a common implication of driving; particularly the conflict between velocity and safety. Thus, accidents caused by risky driving can be ascribed to a goal conflict that was not resolved in favour of safety, which is typically achieved by speed reduction. The potential role of goal conflicts in the cause and prevention of accidents qualifies them as a promising area of research in the field of traffic safety.

There has been substantial work on models describing speed selection as a function of the combined effects of drivers' multiple action goals or motives (e.g., O'Neill, 1977; Tarko, 2009). However, beyond the descriptive level, it might be important to understand the underlying mechanisms. The aim of the present paper is to contribute to this understanding. This will

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be carried out by applying the neuropsychological theory of anxiety put forward by Gray and McNaughton (2000) to the field of driving behaviour.

1.1. Behavioural inhibition system

Gray and McNaughton (2000) define a goal as a conflation of an aim of action and a tendency or motivation to reach that aim. Accordingly, a *goal conflict* arises if different goals emerge at the same time that cannot be pursued simultaneously. A typical goal conflict is the approach–avoidance conflict, which arises if the pursuit of a goal is discovered to be risky. The neuropsychological theory of anxiety (Gray & McNaughton, 2000) relates such conflicts to anxiety. The theory proposes a behavioural inhibition system that serves as a detector and dissolver of goal conflicts. If the behavioural inhibition system detects that more than one goal is highly activated simultaneously, it starts executing control over the activity of other systems, especially those that gave rise to the conflict in the first place. In this way the behavioural inhibition system produces three kinds of output: first, the system inhibits ongoing behaviour which is noticeable either because it is accomplished more slowly or because it is omitted completely (passive avoidance). Second, it increases vigilance and general attention which favours detection of threatening signals. And third, arousal is increased so that behaviour can be executed faster and more vigorously as soon as it is no longer inhibited. All these changes in behaviour, attention, and arousal during conflict solution can be summarised as symptoms of anxiety.

With respect to the neuroanatomical and neurochemical level, the theory mainly draws on animal studies, and in particular, the congruent behavioural effects (reduction of passive avoidance in an approach-avoidance conflict) of so-called anti-anxiety drugs (e.g., alcohol, tranquilisers, or barbiturates) and defined brain lesions. Based on these findings, Gray and McNaughton (2000) ascribe the functioning of the behavioural inhibition system to an interaction of various brain areas of which the so called septo-hippocampal system is the key element. The septo-hippocampal system comprises selected structures at the inner surface of the frontal and temporal lobe and is connected to brain areas related to goal-directed behaviour, attention, and arousal. If the septo-hippocampal system detects a goal conflict, it uses these connections in order to increase the valence of affectively negative stimuli and associations. As a consequence of this affective negative bias, the tendency to execute behaviour associated with more negative stimuli is weakened in favour of the competing behaviour. Thus, the septo-hippocampal system resolves the conflict by supporting the pursuit of safe goals at the expense of risky goals.

Although the affective negative bias favours the avoidance goal by increasing the significance and detection of punishment signals, the behavioural inhibition system does not control flight behaviour. If an individual in a goal conflict does decide to flee, the behaviour is controlled by a system that – in the terminology of Gray and McNaughton (2000) – mediates fear. The behavioural inhibition system instead controls approach under dangerous conditions. In order to differentiate from the concept of fear, Gray and McNaughton use the term *anxiety* to describe the emotional correlate of an activated behavioural inhibition system.

1.2. Anxiety during driving

By applying the neuropsychological theory of anxiety (Gray & McNaughton, 2000) to the field of driving behaviour, emphasis is given to the fact that driving behaviour is managed by the brain, a neuronal structure shaped by evolution. This allows methods for measuring brain function and the associated findings to be integrated into research on this particular kind of human–machine interaction: an approach Parasuraman (2003) termed *Neuroergonomics*. As a first step, this paper focuses on whether the neuropsychological theory of anxiety offers distinct and verifiable predictions about driving under risk that go beyond the currently proposed models. From this point on, the driving-related assumptions derived from Gray and McNaughton's theory are referred to as the goal conflict (GC) model which is illustrated in Fig. 1.

According to the GC model, a driver caught between the concurrent goals of velocity and safety is in an approach-avoidance conflict. This conflict is assumed to be stronger the more both goals are activated. Depending on the severity of the conflict, the driver's behavioural inhibition system is activated, whereas its central neuronal correlate, the septo-hippocampal system, causes an affective negative bias. With respect to the driver's conflicting action goals, the affectively negative stimuli and associations whose valence is increased might refer, for instance, to signs and thoughts anticipating delayed arrival on the one hand and accidents on the other hand. This negative bias underpins the three outputs of the behavioural inhibition system which characterise the state of anxiety that is induced by the conflict: behavioural inhibition, increase of attention and increase of arousal. Although the neuropsychological theory of anxiety mainly draws on behavioural experiments with animals, it is claimed to be applicable to humans as well. Therefore transferring the theory to the field of driving suggests incorporating the driver's subjective experience and physiological activation. In particular, the GC model predicts that the following anxiety-related changes characterise a driver in an approach-avoidance conflict:

1. Behavioural inhibition slows down the execution of actions related to the driving task.
2. Due to the anxiety-related increase in vigilance, the driver pays more attention to the street.
3. As long as the conflict is unresolved, the driver feels afraid.
4. Increased arousal results in heightened activity of the sympathetic part of the autonomic nervous system and feelings of excitement and tension.

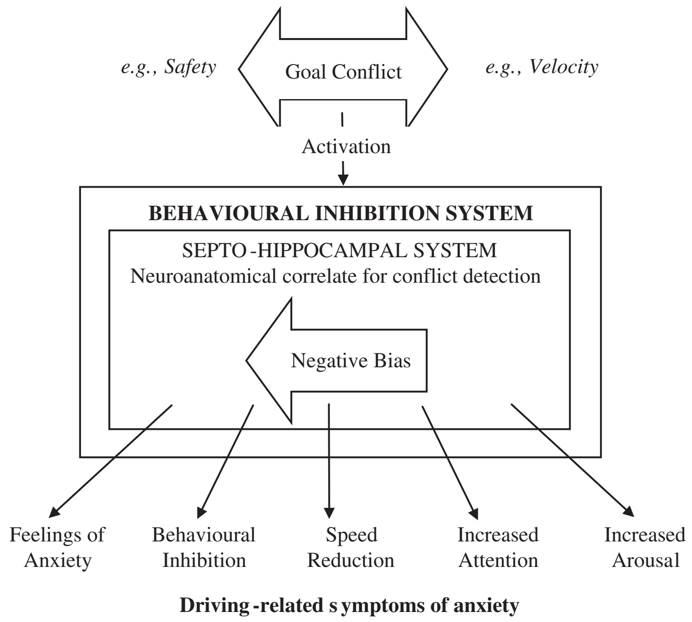

Fig. 1. Illustration of the goal conflict model as an adoption and extension of the neuropsychological theory of anxiety (Gray & McNaughton, 2000) to the field of driving behaviour.

5. Provided that, during driving, there are more signals associated with negative consequences of fast driving (e.g., an accident) than signals associated with negative consequences of slow driving (e.g., belated arrival) the affective negative bias favours speed reduction.

Behavioural inhibition, increased attention, and increased arousal can be considered to be universal symptoms of anxiety and thus are directly adopted from the neuropsychological theory of anxiety. Feelings of anxiety and speed reduction are, however, more specific symptoms resulting from the theory's adoption to human driving.

A conceptualisation of driving as an approach-avoidance conflict has already been anticipated in Fuller's (1984) threat-avoidance model of driving behaviour. Fuller assumed that conditioned aversive stimuli (discriminative stimuli) signalling possible accident hazards trigger avoidance responses, heightened arousal, and feelings of risk. This model resembles previous versions of the neuropsychological theory of anxiety (Gray, 1982) that assumed that the behavioural inhibition system is particularly activated by conditioned aversive stimuli. In the theory's latest version, however, it is not the aversive stimulus itself that activates the behavioural inhibition system, but the goal conflict it implicates. Accordingly, the GC model emphasises the essential role of driver's motivation in respect to the emotional effects of external risk cues. Thereby, the extent to which a danger signal elicits anxiety does not depend on the signalled danger alone but on the equally important current motivation of the driver to accept that danger.

1.3. Amendment to current motivational models on driving behaviour

There are many motivational models on driver behaviour that assign risk-related cognitions or emotions a central role in speed selection (e.g., Fuller, 1984; Gibson & Crooks, 1938; Koornstra, 2009; Näätänen & Summala, 1974; Taylor, 1964; Vaa, 2007; Wilde, 1982). The GC model proposed here shares many common elements with these models. For instance, most models incorporate concepts such as signals of aversive outcome (e.g., perceived accident risk), threat related emotional feelings (e.g., sensations of fear or anxiety) and bodily changes (e.g., arousal, skin conductance). However, current motivational models usually declare one or two of these elements to be the key variable for speed selection. In general, they propose that the respective variable provides a target level (e.g., Wilde, 1982), an optimal range (e.g., Koornstra, 2009), or a threshold value (e.g., Näätänen & Summala, 1974) which the driver seeks to maintain. The GC model instead does not deal with direct causal interdependence of threat-related attention, anxious feelings, physiological arousal, and speed selection but considers all of them as coordinated symptoms of an activated behavioural inhibition system.

Most motivational models on driving behaviour agree that in dangerous driving situations a substantial increase in subjective accident risk induces drivers to reduce their speed although the models disagree whether this subjective risk is mediated by cognitive estimation or perception (e.g., Gibson & Crooks, 1938), by feelings of fear or discomfort (e.g., Summala, 2007) or by body responses (e.g., Vaa, 2007). Likewise, in the GC model, speed reduction depends on threat perception. However, in this model, threat is not unconditionally linked to objective or subjective accident probabilities. Instead, threat is defined as the amount by which current driving conditions challenge the pursuit of the driver's prevailing action goal. Thus, in the GC model, threat is related to the driver's motivations rather than to objective demands of the driving task.

Current models incorporate, to some extent, the idea that the target level, optimal range, or threshold value, which determines the driving speed, depends on the driver's motivations. This means that if incentives for high velocity increase (e.g., an urgent business meeting), drivers are willing to accept a higher value and thus drive faster, whereas they drive slower if incentives for safety (e.g., a child on board) increase. Hence, although there is disagreement about which kind of information drivers use to select their speed (e.g., electrodermal activity, a target feeling, estimation of risk), there is consensus that speed selection is a trade-off between conflicting motivations. The GC model complements this assumption by proposing that the goal conflict itself has an effect on speed selection. Therefore not only the balance of the conflict (i.e. the relative weighting of motives for approach and avoidance) but also the intensity of the conflict (absolute strength of both motives) is important. In particular, the GC model predicts that the tendency to reduce speed increases with the intensity of the goal conflict.

1.4. Task difficulty

Fuller (2005) proposed a theory of homeostasis where the role of risk, as the central concept in many motivational models, is replaced by task difficulty. In his task-capability interface (TCI) model, speed selection is regarded as dependent on a comparison between the perceived demands of the driving task and the driver's estimation of his or her own capabilities. Fuller originally conceives driving as requiring cognitive estimations rather than emotional judgments. However, more recently he reported results indicating that task difficulty and feelings of risk are highly correlated (Fuller, McHugh, & Pender, 2008). Accordingly, Fuller (2007) proposes that feelings of risk provide a motivational dimension that supplies the driver with continuous information about task difficulty – in particular the danger of losing control.

Fuller's concept of feelings of risk differs from the concept of anxiety detailed here. In contrast to Fuller's concept, anxiety related to the behavioural inhibition system is assumed not to depend on task difficulty unless task difficulty is a substantial factor within the goal conflict giving rise to the anxiety. This difference between the TCI model and the GC model can be typified by a driver who enters a difficult road section. According to Fuller the driver will experience heightened feelings of risks and thus will reduce speed. The GC model, however, states that anxiety – as indicated by distinct changes in behaviour, feelings, and physiological responses – only occurs if the driver simultaneously has a strong motive for fast driving.

1.5. Objectives

The main objective of the present study was to test key predictions of the GC model. In particular, the study examined whether an approach-avoidance conflict during driving induces anxiety-related changes in driver's behaviour, feelings, and physiological responses and whether these changes increase with strength of conflict. Additionally, it explored the extent to which these changes depend on task difficulty.

2. Method

2.1. Participants

Twenty-six healthy male volunteers participated in the study. All of them were right-handed, had normal or corrected-to-normal vision and German as their first language. Two participants' data had to be excluded from analysis due to missing data caused by technical failure or improper task processing. Thus, 24 participants, aged between 21 and 36 years, (M = 27.46, SD = 4.42), were included in further data analysis. Habitual anxiety, assessed with the trait scale of the State-Trait-Anxiety Inventory (STAI-X1, German version, Laux, Glanzmann, Schaffner, & Spielberger, 1981), was within the normal range. The same was ensured for Extraversion and Neuroticism, measured with the 50 item short version of the revised Eysenck Personality Questionnaire (EPQ-RK, German version, Ruch, 1999). The experiment was undertaken with the understanding and consent of each participant. As a reward for their participation they received a 1 GB USB memory stick.

2.2. Design

The study followed a (3×2) design with *goal conflict* (low, medium, high) and *visibility* (high, low) as within-participant factors. Both factors were implemented in a simple driving simulation. The combinations of factor levels corresponded to separate runs. The factor *conflict* referred to an approach-avoidance conflict which was induced by time pressure and a warning of deer on the road. The magnitude of an incentive for fast driving and of an equivalent incentive for slow driving altered between runs so that the intensity of conflict varied between low, medium, and high. The factor *visibility* was chosen to modulate task difficulty (e.g., Baldwin, Freeman, & Coyne, 2004) by altering the task demands. Runs with easy driving conditions were characterised by high visibility of the road, and runs with difficult conditions by low visibility due to fog.

The driving simulation was a computer controlled task that provided sparse visual feedback for a manual speed choice. The task was not designed to be as realistic as possible with respect to the road environment and handling of a car. Instead the design aimed to simulate motivational conditions for a driver's speed choice within the laboratory (which is a key challenge for studying motivational models on driving behaviour, Ranney, 1994). The implementation of speed control and visual feedback was subordinated to that aim. It was adapted to the assessment of behavioural, self-report, and physiological measures and was kept simple in order to support inferences from these measures mainly about the emotional concomitants of drivers' speed choice.

2.3. Stimuli

Driving was simulated with the rapid (100 Hz) presentation of a repeating sequence of 640 × 480 pixel images displaying white lines representing the two edge lines and the centre line of a straight road against a grey background. Between consecutive images, the gaps in the centre line moved slightly downwards in order to create the illusion of driving. By altering which images in the sequence were presented (every 2nd picture, every 3rd picture, etc.), the illusion of travelling at different speeds was created. Under high visibility the lines marking the street converged at the horizon. Under low visibility these lines dissolved into an opaque white bar, simulating a wall of fog. Stimulus examples are shown in Fig. 2.

At the end of some runs the black silhouette of a deer occurred. This silhouette increased in size at a rate which depended on the velocity until it covered half of the screen. Under high visibility conditions the deer first appeared at the horizon. Under low visibility its dark silhouette emerged from the fog at about half the distance of the horizon.

2.4. Procedure

Each participant completed 18 separate runs of the driving simulation. During each run he could choose between four different speed levels. Furthermore, he was asked to brake immediately upon sight of a deer. Participants controlled speed and braking with their right index finger by pressing five keys (v, b, n, m, and SPACE) of a standard keyboard (SAITEK) labelled with the corresponding function (40, 60, 80, 100, and brake). The speed labels roughly conformed to the perceived velocity in km/h which was confirmed by 12 students in advance. In order to maintain their selected speed, participants had to press the corresponding key at least once every 1500 ms. If the delay between key presses exceeded 1500 ms the simulated car movement stopped until a speed key was pressed again. Participants were allowed to change the speed without restrictions.

The driving task was embedded into a fictional scenario in which participants were employees in an agency, which had the task of delivering cars as safely and as quickly as possible to a destination. They were informed that during some of the runs, a deer would appear on the road. Thus, participants were brought into a conflict between safe and fast driving. In order to vary the intensity of the conflict, different amounts of money were assigned to every run: either 1 euro, 300 euros or 1000 euros. These amounts defined the size of the reward for early arrival or the size of the fine if the participant hit a deer during the run. In order to bestow the fictitious money with personal value, participants were told that the driving task would be used to measure their emotional and practical intelligence. Thus, the more fictitious money they earn the higher their estimated intelligence would be. Accordingly, we expected that the more money was at stake, the higher the conflict would be that is experienced by the participants during the driving run.

Before each run the amount of money that could be won or lost was displayed on the screen. Nine runs with high visibility and nine runs with low visibility were completed in alternating blocks of three runs per visibility condition. Within these blocks, each conflict condition was presented once in a pseudorandom order. The order of the blocks was balanced across participants. For every combination of conflict and visibility there was one run in which a deer appeared and two runs without a deer. A deer occurred during runs 3, 4, 8, 10, 11, and 14, either 20, 30, or 40 s after the start of the run. Runs without a deer lasted for either 50 or 70 s. In order to conceal the fixed run durations, participants were told that a variable distance had to be covered in each run.

Participants completed three training runs to become familiar with the different velocities, visibility conditions, and the appearance of a deer. Then the driving task was introduced as a measure of emotional and practical intelligence. Its completion required about 40 min. Afterwards participants were fully informed about the task and its aims. Because circadian

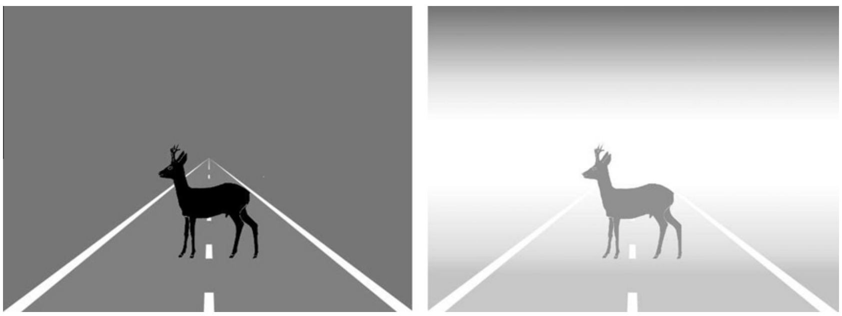

Fig. 2. Appearance of the road in the high (left picture) and low (right picture) visibility condition and a deer positioned two thirds of the way into its approach path.

rhythm affects performance, testing was restricted to the morning hours either from 8:00 am to 9:30 am or from 10:00 am to 11:30 am.

The driving simulation was controlled by the experimental software Presentation (Neurobehavioral Systems, version 12) running on an Intel Celeron PC (Medion 1024 MB RAM, 3.08 GHz) and was presented via a 19 in. monitor (Samsung SyncMaster 950p). Participants were seated in a comfortable chair in a dimly lit room. They were monitored by the experimenter through a window from a neighbouring room.

2.5. Data recording and analysis

During driving, measures indicating behaviour, subjective experience and physiological activity were recorded. Analyses of these measures were restricted to runs in which no deer appeared. Thus, the retrospectively reported mood was not contaminated by the deer encounter. Only those behavioural and physiological data were analysed that had been recorded between second 10 and second 50 of each run. In this way, potential adaptation and cross-over effects at the beginning of a run were skipped and an identical temporal basis for the comparison of the different driving conditions was selected.

2.5.1. Behavioural data

The manually chosen speed (speed choice) and the rate at which the speed was confirmed (tap latency) were recorded. Whereas speed choice served as a measure for the anxiety-related bias to reduce speed, tap latency served as an indicator for the behavioural inhibition. Speed choice was calculated by averaging the speed values of all key presses within the assessment phase. Tap latency was defined as the average time between consecutive key presses excluding those linked with speed change. Durations exceeding the maximal latency necessary to keep the driving simulation in motion, were included with a value of 1500 ms.

2.5.2. Self-report data

After each run participants completed a paper-based custom-made rating scale containing six 7-point scales ranging from "0/not at all" to "6/very much". In order to assess anxiety-related subjective experience, participants rated how anxious/worried, attentive/concentrated and aroused/tense they felt during the preceding run. Unintended emotional changes were controlled by three interspersed items: happy/amused, angry/irritable, and sad/depressed.

2.5.3. Physiological data

On the physiological level, electrodermal activity (EDA) and heart rate (HR) were measured during driving. In accordance with Fowles (1980), increases in EDA were regarded as reflecting the arousal output of the behavioural inhibition system whereas HR served as a control variable which is more related to effort and behavioural activation.

EDA was continuously registered with two electrodes (8 mm Ag/AgCl) attached to the thenar and hypothenar of the left hand. The signal was acquired by an EDA-Coupler (PAR) operating with a time constant of 10 s. To assess the HR, an electrocardiogram (ECG) was recorded with three electrodes (8 mm Ag/AgCl), attached on the upper breastbone, the left leg, and a ground on the right leg. The signal was amplified by 10,000 and band-pass filtered (13–150 Hz) using a Coulbourne Isolated Direct Coupled Bioamplifier (V75-06). Physiological data were A/D converted with a sample rate of 1000 Hz per channel using a DI 400 (DATAQ).

EDA was analysed by counting the number of electrodermal responses with amplitudes exceeding 0.01 μS. HR was determined by the number of *R*-peaks in the EKG. Both frequencies were determined with computer assistance by applying the software EDA (event detection analysis for physiological signals, Trosiener & Kayser, 1992). Data were then converted to common per minute frequency values.

Table 1
Means, standard errors of the mean (in brackets) and ANOVA effect size of conflict and visibility.

Measure	High visibility			Low visibility (fog)			Effect size *f*	
	Weak conflict	Medium conflict	Strong conflict	Weak conflict	Medium conflict	Strong conflict	Conflict	Visibility
Speed choice	93.52 (1.88)	88.79 (2.26)	83.46 (2.66)	68.19 (2.8)	62.10 (2.76)	59.11 (2.96)	0.99****	2.50****
Tap latency	394.44 (36.43)	411.15 (40.38)	434.83 (43.88)	424.05 (43.81)	453.15 (43.57)	485.84 (56.47)	0.38*	0.52**
Subjective anxiety	0.90 (0.18)	1.23 (0.27)	1.29 (0.25)	0.92 (0.25)	1.48 (0.29)	1.67 (0.33)	0.67****	0.44**
Subjective attention	3.77 (0.23)	4.23 (0.21)	4.40 (0.18)	3.85 (0.21)	3.98 (0.23)	4.23 (0.23)	0.70****	0.21
Subjective arousal	2.31 (0.28)	2.65 (0.26)	2.88 (0.29)	2.31 (0.29)	2.56 (0.27)	2.75 (0.29)	0.60****	0.13
EDA	7.00 (0.92)	7.59 (0.92)	7.19 (0.98)	6.44 (0.85)	6.88 (0.82)	7.78 (0.87)	0.23	0.14

* $p < .100$.
** $p < .050$.
**** $p < .001$.

2.5.4. Statistical analysis

3×2 repeated measures analyses of variance (ANOVA) were performed for each measure. To confirm that the predicted conflict-induced anxiety increase is not confined to driving under a certain level of task difficulty, two separated tests of within-participants' contrasts proved a linear trend of conflict strength in the high visibility and low visibility condition respectively. If necessary, violations of assumed sphericity were corrected by the Greenhouse–Geisser correction.

3. Results

None of the analysed measures revealed an interaction of conflict and visibility. Thus only main effects are reported. Results are summarised in Table 1 and illustrated in Fig. 3.

3.1. Behavioural data

As expected, participants drove more slowly the more money they could win or lose (Fig. 3a). This effect of stronger conflict (larger potential gains and losses) on speed choice was significant, $F(1.31, 30.03) = 22.59$, $p < .001$, $f = 0.99$. A linear trend was evident during runs with high visibility, $F(1,23) = 27.63$, $p < .001$, $f = 1.1$, as well as during runs with low visibility, $F(1,23) = 12.53$, $p = .002$, $f = 0.74$. In addition, participants chose a slower speed during fog compared to runs without fog, reflected by a high significant effect of visibility, $F(1,23) = 144.17$, $p < .001$, $f = 2.5$.

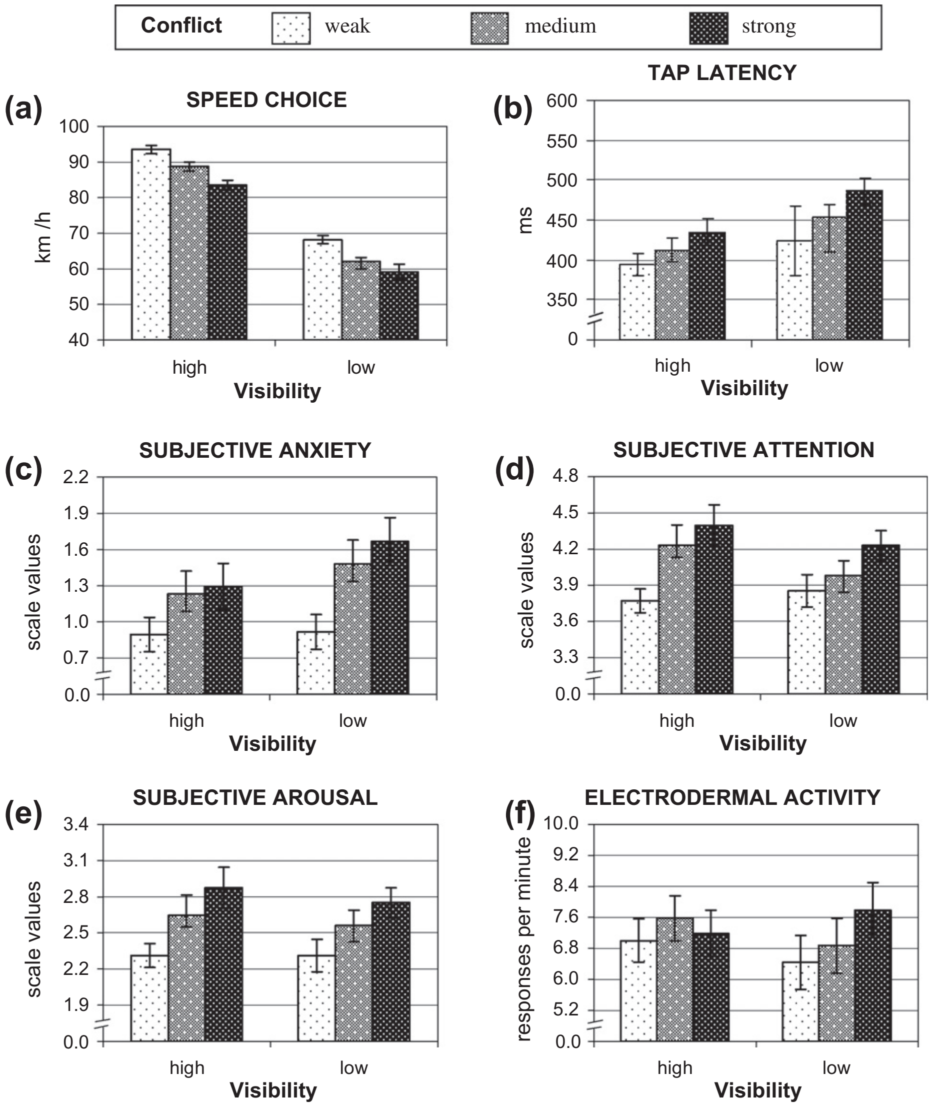

Fig. 3. Average speed choice (a), tap latency (b), self-reported anxiety (c), self-reported attention (d), self-reported arousal (e), and electrodermal activity (f) in relation to conflict intensity and visibility of the road. Standard errors refer to differences between driving conditions depicted adjacent to each other.

Conflict exerted only a marginally significant effect on tap latency (Fig. 3b), $F(1.45,33.28) = 3.35$, $p = .061$, $f = 0.38$. Descriptively, an increase in conflict was associated with a more hesitant speed confirmation in both visibility conditions. But a linear trend regarding behavioural inhibition was only significant in the high visibility condition, $F(1,23) = 5.42$, $p = .029$, $f = 0.49$, and not in the fog condition, $F(1,23) = 1.83$, $p = .190$, $f = 0.28$. There was a significant effect of visibility, $F(1,23) = 6.27$, $p = .020$, $f = 0.52$, indicating that tap latency was longer in the low visibility condition compared to the high visibility condition.

3.2. Self-report data

Participants rated themselves retrospectively as more anxious/worried the higher the conflict (Fig. 3c). This expected effect of conflict was significant, $F(1.59,36.66) = 10.26$, $p = .001$, $f = 0.67$. A conflict-dependent linear increase in self-reported anxiety was evident in both visibility conditions, $F(1,23) = 4.44$, $p = .046$, $f = 0.44$ (high visibility), $F(1,23) = 20.03$, $p < .001$, $f = 0.93$ (low visibility). There was also a main effect of visibility, $F(1, 23) = 4.49$, $p = .045$, $f = 0.44$. During fog participants rated their anxiety level as higher than during high visibility. Analyses of self-reported anger, sadness, and happiness revealed no significant main effects and no interactions, which backed up the emotional selectivity of the experimental manipulations.

In accordance with predictions, participants judged themselves as being more attentive/concentrated during runs with higher conflict, $F(2,46) = 11.27$, $p < .001$, $f = 0.7$ (Fig. 3d). Again, this was based on a linear trend in both visibility conditions, $F(1,23) = 17.08$, $p < .001$, $f = 0.86$ (high visibility), $F(1,23) = 8.06$, $p = .009$, $f = 0.59$ (low visibility). Thus, this subjective measure confirmed the expected increase in attention as a cognitive concomitant of the conflict-induced anxiety. There was no significant influence of visibility, $F(1,46) = 1.03$, $p = .322$, $f = 0.21$, indicating that participants allocated a similar amount of attention to runs with high and low visibility conditions.

Analyses of self-report data also confirmed the rise in subjective arousal/tension, expected to accompany conflict induced anxiety. There was a significant effect of conflict, $F(2,46) = 8.26$, $p < .001$, $f = 0.6$, based on a linear increase in self-reported arousal during high visibility, $F(1,23) = 7.23$, $p = .013$, $f = 0.56$, and low visibility, $F(1,23) = 5.52$, $p = .028$, $f = 0.49$. Visibility had no significant effect on the self-assessed arousal, $F(2,46) < 1$.

3.3. Physiological data

Contrary to predictions, the analysis of the EDA showed no significant main effect of conflict (Fig. 3e), $F(2,46) = 1.2$, $p = .310$, $f = 0.23$. The separate analysis for each visibility condition revealed that in particular during high visibility this indicator of sympathetic arousal did not differ between runs linked to 1 euro, 300 euros, and 1000 euros, $F(1,23) < 1$. However, the expected trend was evident in the low visibility condition, $F(1,23) = 4.32$, $p = .049$, $f = 0.43$, confirming that the number of electrodermal reactions increased with conflict. Analysis revealed no effect of visibility, $F(1,46) < 1$. Thus, there was no indication that driving during fog was associated with a change in arousal.

As expected, analysis of the heart rate gave no hints that the participants' behavioural activation and effort changed depending on the conflict strength, $F(2,46) < 1$. A linear trend was neither evident in the high visibility condition nor in the low visibility condition, $F(1,23) < 1$ (both). Visibility itself also exerted no significant effect on HR, $F(1,46) < 1$.

4. Discussion

It was predicted that a goal conflict while driving causes anxiety that manifests itself in drivers' behaviour, experience, and physiological responses. Overall, the results of the experiment confirmed these predictions. If a substantial conflict between the goal of safety and velocity was introduced, participants drove slower and reported being more anxious, attentive, and aroused. In the low visibility condition, a higher conflict was also associated with more hesitant behaviour and a higher number of electrodermal responses. In accordance with the predicted quantitative relationship between goal conflict and anxiety these changes increased linearly with the gains and losses constituting the conflict. Altogether, results are in line with the goal conflict (GC) model derived from the neuropsychological theory of anxiety (Gray & McNaughton, 2000). According to this model the observed anxiety was caused by the activation of a behavioural inhibition system that exerts control on ongoing behaviour, attention, and arousal and increasingly favours the execution of the safer action goal.

The present study extracted indicators of anxiety from three different types of data: behaviour, self report and physiological responses. This multi-level assessment approach compensates the shortcoming of every single level of observation. For instance, subjective ratings promise emotion-specific information but are susceptible to mere cognitive appraisals of the emotional situation. In contrast, physiological measures lack emotional specificity but provide a more implicit assessment. In addition, the multi-level approach helps to distinguish between different outputs of the behavioural inhibition system that might be confounded within a single measure. In particular, electrodermal activity does not only indicate arousal but is closely related to attention. However, combined with the self-report data, results suggest that both attention and arousal increased.

Neither heart rate nor self-reported happiness, anger, or sadness changed depending on the strength of the conflict. This finding supports the assumption that the amount of money at stake did not cause a substantial change in effort, behavioural activation or mood states that, according to Gray and McNaughton (2000), would not have been mediated by the behavioural inhibition system.

4.1. Speed choice and driving related symptoms of anxiety

Speed choice is closely related to accident risk (Aarts & Van Schagen, 2006). Thus, predicting speed choice is a key ambition of theories on driving behaviour. In the present study participants drove more slowly the higher the goal conflict. It is important to note that participants decided to change their speed despite the fact that wins and losses increased in equal measure. This effect requires an amendment of theories on driving behaviour. Although speed selection is commonly conceived as a trade off between conflicting motivations, the intensity of the goal conflict has received little attention so far.

Results are consistent with the reliably demonstrated phenomenon in research on decision making, namely loss aversion (e.g., Tversky & Kahneman, 1981). Individuals weigh losses more heavily than gains. This supposed difference in subjectively attributed values increases with the objective size of the wins and losses and thus corresponds with the observed speed reduction in the present study. However, the difference does not increase linearly with the size of the objective reference values. Instead, the gain in subjective difference between equivalent wins and losses decreases the higher they are. This might have contributed to the finding that speed reduction followed a linear trend although the increase in money constituting the goal conflict did not (1, 300, and 1000 euro).

In terms of decision making, loss aversion might be an appropriate description of the speed reduction observed in the present study. However, the GC model goes beyond that descriptive level. By referring to the neuropsychological theory of anxiety, it offers a psychological and neuronal frame for the explanation of this loss aversion. Thereby, the GC model classifies the observed speed reduction as a result of increased anxiety and thus integrates it into a comprehensive view on drivers' behaviour, feelings, and physiological arousal during goal conflicts.

In the present study, hesitancy regarding speed choice was expected to indicate anxiety-related behavioural inhibition. However, evidence that tap latency increased with goal conflict was small. It might be that the tapping speed was also susceptible to the accompanying increase in arousal which could have diminished the expected hesitancy. Moreover, it cannot be excluded that lower speed triggers lower tapping frequency. This would explain the significant increase in tap latency during the low visibility condition, in which participants drove considerably slower. Thus, the marginal increase in tap latency during higher conflict might not be directly mediated by the behavioural inhibition system.

To summarise, results suggest that tap latency was not an appropriate indicator of behavioural inhibition. Despite methodological objections, anxiety-related inhibition might express itself in human driving behaviour on the level of decision making rather than on the level of motoric execution. If this applies, the chosen speed should be considered as the adequate measure. This conclusion is plausible with regards to the neuropsychological theory of anxiety. According to Gray and McNaughton (2000), anxiety related behavioural inhibition aids cautious approach by increasing the available time for threat detection and adequate responses. In the present study this function exactly corresponds with the utility of speed reduction.

It is reasonable to discuss driving speed as a confounding variable not only for tap latency but also for the physiological and self-report measures of anxiety. However, in contrast to tap latency, one would expect that electrodermal activity and self-reported anxiety, attention, and arousal decrease if drivers reduce their speed. Thus, if at all, the conflict-dependent speed reduction should have impeded the observation of anxiety related increases in these measures. Predominantly however, this was not the case, although it might explain why the tonic EDA only significantly rose with conflict during fog. Due to the reduced visibility of the centre line there were fewer cues that could evoke speed-specific electrodermal responses (for the distinction between specific and unspecific responses, see Boucsein, 1993).

4.2. Contribution to risk-oriented views on driving behaviour

With respect to progress in motivational theory on driving behaviour, there is little sense in proposing a new model without reference to the existing ones. Drivers' feelings of anxiety and physiological arousal play a key role in many models. Therefore, the following section discusses the extent to which the GC models complements or exceeds the capability of other models to explain the present results.

Regardless of whether the goal conflict increased or the visibility decreased, participants reported higher levels of anxiety despite reducing their speed. This contradicts the assumption that drivers adapt their speed in order to maintain their risk-related emotional feeling (e.g., experienced risk, feelings of fear, feelings of anxiety) at a constant level or beneath a certain threshold. However, other motivational models on driving behaviour might account for the goal conflict results if they are extended by assumptions derived from the GC model. In terms of zero risk theory (Näätänen & Summala, 1974) it could be assumed that goal conflicts activate a proposed risk monitor which would lead to both speed reduction and an increase in subjective risk. The theory of risk homeostasis (Wilde, 1982) could explain the present results with a twofold effect of goal conflict: an increase in perceived risk, which would explain the speed reduction, and a smaller increase in target level of risk, which would explain why anxiety increased despite speed reduction. Similarly, the risk adaptation model (Koornstra, 2009) would attribute the conflict-related findings to a substantial increase in risk sensation. Due to risk adaptation this increase would only partially be compensated by speed reduction. Thus, drivers subjected to goal conflict would drive more slowly but with a higher level of risk sensation which is associated with an increase in sensations of fear and arousal. To sum up, other motivational models can account for the goal conflict results, if they are amended by the central assumption of the GC model: a negative bias favouring risk perception that increases with strength of conflict.

The present results do not support the assumption that drivers keep their experienced anxiety constant by choosing a speed that leads to a homogeneous distribution of EDR over time (Taylor, 1964). On the contrary, tonic EDA increased with conflict – at least during low visibility – and this increase occurred although participants reduced their speed. Moreover, the tonic EDA did not change significantly with visibility although participants reported heightened anxiety and showed a pronounced speed reduction. These findings also challenge the monitor model (Vaa, 2007) which is based on the somatic marker hypothesis of Damasio (1994). In this model a somatic marker is a body signal – predominantly acquired by previous experience – that informs the driver about the emotional valence of an option for action. Accordingly, the EDA, assessed in the present study, might indicate that the emotional valence of the somatically marked speed options increased with the money at stake but was not altered by visibility. However, given that a specification of the somatic marker mechanism is still in need of research (Dunn, Dalgleish, & Lawrence, 2006), it is unclear whether the monitor model would have predicted these results in advance. Thus, in the present state, results support the GC model which conceptualise EDA and speed reduction as independent variables that co-vary if the strength of a goal conflict increases.

Compared with other motivational models, the GC model offers a succinct explanation for the goal conflict effects on participants' behaviour, experience and physiological responses. The model ascribes all these effects to a single mechanism, namely the activation of a behavioural inhibition system that causes an affective negative bias. Admittedly, the goal conflict that was varied in the present study addressed the key concept of the GC model. However, to scrutinise the validity of the GC model, it is also important to consider the effects of high versus low visibility – the factor that was proposed to vary the task difficulty. Task difficulty is not central to the GC model but it is the key concept of the TCI model.

4.3. Contribution to the task difficulty-oriented view on driving behaviour

By proposing a task-capability interface (TCI) model, Fuller (2005) emphasised that driving behaviour depends on an interaction of the driver's estimations of task demands and of his or her own capabilities which constitutes the experienced task difficulty. The driver's experience of task difficulty is not only conceived as a cognitive process. Instead, Fuller proposed that feelings of risk inform the driver about the actual level of task difficulty. According to the model, drivers use these feelings in order to choose a behaviour that aligns the actual task difficulty with a target level of task difficulty. This target level is assumed to be determined by the driver's motivations.

Under certain assumptions the TCI model can account for the results observed in the present study. According to these assumptions, low visibility increased the task demands whereas the goal conflict had a disruptive effect on participants' capabilities. Thus both factors were, independently of each other, capable of increasing the difficulty of the driving task. Furthermore, a TCI interpretation of the increases in self-reported anxiety suggests that both low visibility and stronger conflict induced participants to accept a higher target level of task difficulty. Provided that the increase in experienced task difficulty exceeded the accepted increase in target level, the TCI model predicts a compensatory speed reduction, but only until the decreasing actual task difficulty equals the higher target level. This would explain why self-reported anxiety increased during low visibility and during stronger conflict despite the observed speed reduction.

However, some findings do not fit into this interpretation. First of all, heart rate did not confirm a substantial increase in mental workload (Wilson, 2002) – neither for stronger conflicts nor for low visibility. Thus, the assumption that participants drove on higher levels of accepted task difficulty is not supported by the heart rate data (note, however, that heart rate might not be unconditionally sensitive for increasing mental workload, Backs, Lenneman, Wetzel, & Green, 2003). Second, the present study found no significant interactions between goal conflict and visibility. According to the TCI interpretation, this suggests that during degraded visibility, participants increased their target level of task difficulty independent of the goal conflict. On the contrary, however, one should expect that rising task demands (low visibility) induce drivers to accept a higher level of task difficulty only to the extent to which they are motivated to overcome these difficulties. In other words, the impact of rising task demands should depend on their relevance for the achievement of the predominant action goals. This leads directly towards a goal conflict interpretation of the visibility results.

The GC model suggests that the effects of money and visibility observed in the present study were both mediated by their impact on the drivers' conflicting motivations. According to this interpretation, the amount of money at risk determined the intensity of the conflict whereas the visibility of the road modulated the balancing of the conflict. Both factors shifted the balance point between the motives for approach and avoidance into the direction of more cautious driving. This explains why speed was reduced during both stronger conflict and low visibility. Nevertheless, the GC model suggests that the shifting of the conflict's balance point is caused by different mechanisms and thus accounts for the lack of interaction between goal conflict and visibility.

In the case of the increasing goal conflict, the shift towards more cautious driving is due to an internal process, namely the affective negative bias. Thus, the higher the goal conflict the stronger the affective negative bias and the more cautious the driving behaviour. However, this speed reduction did not reduce the intensity of the conflict. Instead, the decreasing risk of losing money due to an accident was counterbalanced by an increasing risk of not receiving the same amount of money paid for fast arrival. Therefore, it can be assumed that – in the case of goal conflict intensity – the shifting of the balance point towards cautious behaviour did not reduce the activation of the behavioural inhibition system. This explains why attention and arousal increased with the goal conflict despite the accompanying speed reduction.

In the case of low visibility, the shift towards cautious driving was mediated by external information which signals a higher risk of not achieving the accident avoidance goal. By reducing their speed, participants counteracted this perceived increase in accident risk and thus readjusted their behaviour to a point at which their approach and avoidance goals are in balance. In common with the conflict-dependent speed reduction, it can be assumed that this readjustment neither increased nor decreased the intensity of the conflict. However, unlike the low speed caused by the intensity of the conflict, the visibility-dependent speed reduction compensated its causes by reconstituting the balance of the conflict. This might explain why, in contrast to the money at stake, the visibility of the road had no effect on the participants' attention and arousal.

Interestingly, the self-reported anxiety increased during fog. The GC model would not consider this result as an indication of anxiety because this increase cannot be explained by an increase in conflict. In terms of the neuropsychological theory of anxiety (Gray & McNaughton, 2000) this threat-related emotional feeling would be referred to rather as fear.

The terms fear and anxiety are often used as synonyms. A distinction, which is common in neuropsychological theory and research, might help to advance the discourse about drivers' emotions. Fear can be considered as a stimulus-driven emotional response to signals of aversive outcome (Schmidt-Daffy, 2008). With respect to driving, it is reasonable to assume that such responses are closely related to the estimation of risk (e.g., Koornstra, 2009; Taylor, 1964) or task difficulty (Fuller et al., 2008). Thus, it seems that most driving behaviour models that incorporate the concept of threat-related emotional feelings actually refer to fear.

In contrast to fear, the GC model claims to account for anxiety. Thereby, within the context of the GC model, the term anxiety refers to emotional responses that are top-down mediated by the detection of conflicts between simultaneously activated action goals. Results of the present study support the distinction between fear and anxiety. This distinction is suggested by the lack of interaction between goal conflict and visibility as well as by their different response patterns regarding attention and arousal. Future research is needed to incorporate both aspects into a unified theory on drivers' emotions and behaviour.

5. Applicability to real driving

The present study varied motivational incentives for fast and safe driving on the one hand and visibility of the road on the other hand to investigate the impact of drivers' conflicting motivations and perceived task difficulty on speed choice and accompanying feelings and physiological responses. During real driving these responses depend on the net-effect of many additional variables, including, for example, drivers' skills and motoric activities, changing road conditions, vehicle properties, and behaviour of other road users. The more variables involved, the more difficult it is to discover basic principles. Therefore a driving simulation was used that provided only a sparse visual velocity feedback and reduced the driver's task to a simple speed choice. This allowed an isolated examination of the selected variables' interplay (Carsten & Jamson, 2011). The highly standardised approach gives the advantage that a relatively small sample size is sufficient to test hypotheses with adequate statistical power. However, the approach is only justified if results promise to be relevant for real driving as well. In the present study the question of applicability refers to drivers' motivations on the one hand and to the cognitive demands of the driving task on the other hand.

5.1. Real drivers' motivations

It is reasonable to assume that drivers usually do not experience a strong goal conflict. Instead, most drivers might align the speed to their attitudes, subjective norms, and perceived behavioural control (Ajzen, 1991; Elliott, Armitage, & Baughan, 2003) without much internal discord. In particular this should apply to drivers who start their trip on time and to whom receiving a penalty or the risk of having an accident isn't a major concern. However, speeding is one of the most frequent reasons for fatal road accidents (Peden et al., 2004). Because speeding is often due to strong speed-related goals (e.g., hurry, Fuller et al., 2006) this indicates that there are incidences in real driving in which motivations gain more importance for speed choice and in which safety-related motivations do not unconditionally prevail. The goal conflict results of the present study might particularly apply to such situations. They suggest that these high conflict situations usually lead to a negative bias that prevents risky driving. However, it appears that the proposed mechanism does not work for all situations and all drivers. The GC model offers a framework for investigating why the mechanism sometimes fails (e.g., alcohol) and how it might be supported by traffic safety measures.

5.2. Cognitive demands of real driving

Vehicle handling in real driving implicates perceptual and behavioural demands that were not reproduced in the present study. However, experienced drivers accomplish many components of the driving task in an automatic processing mode (Ranney, 1994). In particular, this applies to common situations in which drivers steer their own cars on familiar roads. Thus, a driving simulator with simplified handling might be more adequate to reproduce the interplay of real driver's motivations and perceived task difficulty, than a complex simulator whose handling was not extensively trained. However, there are situations in real traffic where the mental workload of drivers increases; for example, if a second task has to be accomplished simultaneously. According to the TCI model (Fuller, 2005), a decrease in drivers' information processing capacities should lead to similar effects as an increase in demands of the driving task. In the present study, effects of visibility (task demands) did not interact with the strength of drivers' goal conflict. Therefore, it can be tentatively assumed that the goal conflict results also hold for real driving situations with higher cognitive demands. However, further research is needed to test this assumption.

6. Research implications

The goal conflict model that is proposed in the present paper does not claim to represent a unified theory of driving behaviour. However, it might serve to complete and amend current research and theories about the role of motivation and emotion in speed choice. The main implications of the model can be summarised as follows:

1. The GC model emphasises that motivations act as a mediator between features of the driving task and the driver's emotional experiences and behaviour. For instance, the model contradicts theories which suggest that the perception of collision risk is equal to anxiety. Instead, the model predicts that only drivers who are motivated to take a perceived risk will actually experience anxiety. Given this conflict, threat-related feelings that vary with task demands should be characterised as fear, whereas feelings that vary with the intensity of the conflict should be characterised as anxiety.
2. The GC model draws attention to the interplay of the driver's various action goals. In particular, it proposes a common rule underlying this interplay – the affectively negative bias. This rule is assumed to be valid for a broad spectrum of different motivations. In the present study, the conflict between the goals for safety and velocity was induced by the participants' seeking to achieve a high emotional and practical intelligence score. However, the model predicts the same effects for aims that are more characteristic of drivers outside the laboratory (e.g., money, social relations). This assumption needs to be validated by future research. In addition, future studies ought to systematically compare the effects of varied intensity and balancing of goal conflicts.
3. The GC model's emphasis on the key role of the driver's motivations suggests testing assumptions about risk perception and emotional experience within self-paced driving tasks. Otherwise, studies might rather account for the estimations and feelings of co-drivers than drivers. However, a self-paced task involves speed as a confounding factor. This problem needs further attention.
4. The GC model refers to a comprehensive theory about the neuroanatomical and neurochemical basis of anxiety (Gray & McNaughton, 2000). Thus, it offers a biological explanation for the disinhibiting effects of alcohol on driving behaviour and the amplification of these effects in a goal conflict (Fillmore, Blackburn, & Harrison, 2008). In summary, the model predicts that substances inhibiting the behavioural inhibition system facilitate risky driving. Thus, the present simulation might be developed further into a paradigm for testing the effect of substances and their dosage on traffic safety. Hence, it could complement current models that are more aimed at the perceptual, cognitive, and motor impairments (Owens & Ramaekers, 2009).
5. The GC model offers a bridge towards research on the role of driver's traits and habits (e.g., Sumer, 2003). In the field of personality and individual differences the neuropsychological theory of anxiety (Gray, 1982; Gray & McNaughton, 2000) is referred to as reinforcement sensitivity theory (RST, Corr, 2008). According to the RST, drivers having a behavioural inhibition system that is less sensitive for signals of punishment or non-reward are more prone to accidents caused by excessive speed or disregarding of traffic signs (Castella & Perez, 2004).
6. The GC model predicts a reliably demonstrated phenomenon in research on decision making; that is loss aversion. Therefore the model is compatible with theories conceiving speed selection as a problem of decision making under the assumption of bounded rationality (e.g., Tarko, 2009). This could serve a greater alignment of theory formation within two related fields of research: drivers' decision making and risk related judgment and choice in general (Tversky & Kahneman, 1981).
7. The GC model considers anxiety as a multi-component emotional state that – amongst others – comprises cognitive and behavioural changes. Instead of the current focus on self-report or physiological data only, this argues for a multilevel assessment of driving-related anxiety. This kind of assessment should be further developed through future research. For instance, evidence for increased attention and arousal should not only rely on self-report and physiological data but also on behavioural observations.
8. The GC model conceives speed reduction, feelings of anxiety, and accompanying physiological responses as parallel symptoms of drivers' anxiety which originate in the activation of the behavioural inhibition system. This disagrees with the assumption that feelings of anxiety or the amount of EDA play an essential causal role in speed reduction, accomplished, for instance, by informing the driver about the subjective risk. The GC model does not exclude mutual dependencies of the outputs of the behavioural inhibition system, which, of course, are worth studying (e.g., Vaa, 2007). However, this requires methodical approaches that go beyond the description of correlations between speed on the one hand and drivers' subjective estimations and physiological responses on the other hand.

7. Policy implications

Results of the present study suggest that augmenting a goal conflict between safety and velocity induces drivers to choose a lower speed and to be more attentive. This gives rise to the question whether the consideration of such goal conflicts promises a distinct contribution to the field of traffic safety. In sum, the GC model gives reasons for traffic safety measures that are capable of inducing and augmenting conflicts in drivers' action goals. This strategy might often be synonymous with increasing drivers' awareness of the ambiguity of risky behaviour in relation to their predominant action goals. However, it departs from measures aimed at increasing the motivation for safe driving only (e.g., accident warnings, intensification of penalty). Instead, the goal conflict approach emphasises the need to incorporate drivers' motivation for velocity as well. In other words, according to the goal conflict approach, an effective measure for traffic safety does not only induce the driver to recognise a risk. It inspires the driver to ask himself: am I willing to take that risk?

The GC model corresponds to Rothengatter's (1988) claim that an efficient model for road safety must also account for those motivations of drivers that are not related to risk perception. There are hints that the efficiency of traffic safety measures, targeting motivations for safe driving only, might have some limitations. For instance, some field studies questioned whether increasing statutory penalties foster cautious driving behaviour (Bjornskau & Elvik, 1992; Briscoe, 2004; Von Hirsch, Bottoms, Burney, & Wikstrom, 1999). Likewise, findings regarding the effectiveness of fear appeals in road safety advertising are equivocal (Lewis, Watson, Tay, & White, 2007). Basically, there are three reasons why the goal conflict view might be a promising approach to overcome these limitations.

1. Motives and attitudes relevant to traffic safety vary between different drivers (e.g., depending on age and gender, Iversen & Rundmo, 2004). They might not be stable even for a single person on different occasions (Forward, 2009). Thus, only a proportion of drivers are reached by measures targeting a particular motivation. For example, heightened penalties probably will not impress drivers who currently care less about money or do not expect to be caught (Briscoe, 2004). However, these drivers might change their behaviour if they recognise not only the potential negative consequences of speeding for their safety-related goals (e.g. an accident) but also that these consequences threaten the achievement of their velocity-related goals, such as fast arrival. Thus, targeting goal conflicts in general instead of targeting a particular motivation might be an approach that accounts for drivers' diverse and often unknown motives and attitudes.
2. Increasing drivers' motivation for safe driving and augmenting drivers' goal conflicts seem to result in different effects regarding the readiness to cope with traffic hazards. In the present study, participants reduced their speed regardless whether task difficulty or goal conflict increased. But they only reported heightened attention and arousal if the goal conflict increased. Provided that this finding indicates a reliable difference that goes beyond self-attributions, this suggests a differential adequacy of the two strategies. If, for instance, a traffic safety measure (e.g., a warning signal) is just aimed at bringing drivers to reduce their speed (e.g., at winding road sections), referring to the task difficulty alone might be sufficient. However, if drivers' attention and vigilance is also needed (e.g., near schools or deer crossings), addressing drivers' goal conflict might be essential.
3. Measures that are intended to increase drivers' motivation for safe driving only (e.g., accident warnings, intensification of penalty) suffer from provoking attitudes of denial or defiance. In contrast, a measure that equally accounts for the drivers' motivation for safety and velocity acts as the advice of a friend rather than as a sanction made by an opponent. Therefore, a strategy addressing drivers' goal conflicts might achieve more compliance than a pure strategy of deterrence.

It is important to note, though, that the symptoms of anxiety, predicted by the GC model, might not unconditionally foster safe driving. For instance, it could turn out that, under certain circumstances, behavioural inhibition slows down the execution of accident-avoiding actions. In addition, increased attention to threat signals might be disadvantageous if this distracts attention from the driving task. In fact, unfavourable effects of an oversensitive behavioural inhibition system might contribute to the high number of car crashes reported by habitually anxious drivers (Dula, Adams, Miesner, & Leonard, 2010). Future research might show to which extent the general appeal regarding the consideration of goal conflicts can be translated into concrete measures for the improvement of traffic safety.

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