



Emotional states of drivers and the impact on speed, acceleration and traffic violations—A simulator study



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ABSTRACT

Maladjusted driving, such as aggressive driving and delayed reactions, is seen as one cause of traffic accidents. Such behavioural patterns could be influenced by strong emotions in the driver. The causes of emotions in traffic are divided into two distinct classes: personal factors and properties of the specific driving situation. In traffic situations, various appraisal factors are responsible for the nature and intensity of experienced emotions. These include whether another driver was accountable, whether goals were blocked and whether progress and safety were affected. In a simulator study, seventy-nine participants took part in four traffic situations which each elicited a different emotion. Each situation had critical elements (e.g. slow car, obstacle on the street) based on combinations of the appraisal factors. Driving parameters such as velocity, acceleration, and speeding, together with the experienced emotions, were recorded. Results indicate that anger leads to stronger acceleration and higher speeds even for 2 km beyond the emotion-eliciting event. Anxiety and contempt yielded similar but weaker effects, yet showed the same negative and dangerous driving pattern as anger. Fright correlated with stronger braking momentum and lower speeds directly after the critical event.

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1. Introduction

In 2011, round about 400,000 people were injured in traffic accidents in Germany. Almost 4000 died in those situations (Destatis, 2012). One important cause is the presence of strong emotions in the traffic participant and the resulting maladaptive driving behaviours (Nesbit et al., 2007; Dula and Ballard, 2003). Emotions create a motivational tendency (and therefore an increased probability) to perform a set of driving behaviours. This could be devastating for all traffic participants when, for example, aggressive driving occurs in situations like dense city traffic or sharp curves on a country road. Several studies in the past examined the connection between the frequency of elicited emotions and their potential negative consequences such as high speeds (Deffenbacher et al., 2003) aggressive behaviours towards other drivers (Shinar and Compton, 2004) and accidents (Underwood et al., 1999). Those studies focused on the personal characteristics of the driver including trait driving anger, the propensity to display anger in various traffic situations (Deffenbacher et al., 2003). They found evidence for the maladaptive power of emotions, but most of them failed

to generalize causes for emotions based on the attributes of traffic situations. Normally, the focus lies on salient and observable behavioural classes, such as aggressive gestures, honking and driving too fast as elements of driving anger and aggressive driving. However, that does not account for the context in which the situation has happened, nor does it describe the implications for possible appraisal. Both are vital to explain the cause of an experienced emotion precisely (Ekman and Davidson, 1994; Kuppens et al., 2003). Only one study conducted by Mesken et al. (2007) examined specific situational attributes and shed some light on their impact on emotions elicited (anger and anxiety) as well as the traffic related consequences (velocity and speeding behaviour).

According to the appraisal theory of emotions, the subjective assessment (appraisal) of a given situation determines whether an emotion is elicited or not, as well as the quality and the intensity of the emotion (Lazarus, 1991; Frijda, 1993; Scherer et al., 2001). This happens in a two-step process (Scherer et al., 2001). During the primary appraisal stage, the individual assesses the relevance and goal-blocking (low goal congruence) or goal-promoting (high goal congruence) potential of the situation and this determines if an emotion (positive or negative) will occur. In the second stage, the type of emotion is determined based on the evaluation of the coping potential and the anticipated consequences. Combinations of different secondary appraisal components are therefore the cognitive determinants and responsible for the evocation of specific

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emotions, their quality and intensity (Scherer et al., 2001; Smith and Lazarus, 1993).

The present study examines the factors goal congruency, goal relevance and other-accountability and their impact on experienced emotions (Scherer et al., 2001; Kuppens et al., 2007). Goal congruency labels the development of a situation with high or low accordance with one's personal goals. An example of low goal congruency could be when progress on the road is impeded due to a slow car in front. High goal congruence could be associated with perfect road conditions, which promote safe driving. Goal relevance focuses on the two most important traffic-related goals: timely and safe arrival at the destination (Cnossen, 2001). Other-accountability relates to different agents causing changes in a given situation (Kuppens et al., 2003). On the one hand, these can be other drivers interacting directly with others in a traffic situation. Examples are specific negative driving patterns (speeding and tailgating) or gestures (honking and verbal aggression). On the other hand a generic situational context (heavy rain or fog) can force a driver to reassess the traffic event and change the driving behaviour.

This factorial structure has been discussed by many studies looking at driving anger but mostly in an intuitive, general way. The frustration–aggression hypothesis (Dollard et al., 1939) was employed to cover all those traffic situations with various goal blocking characteristics (and very often direct personal agency, too) (Björklund, 2008; Lajunen and Parker, 2001; Lawton and Nutter, 2002; Lajunen et al., 2004). For example, the UK Driving Anger Scale (Lajunen et al., 1998) identified several clusters of anger provoking situations, which shared similarities on the level of goal congruency and goal relevance: either the progress of the participant was impeded or reckless driving reduced the safety. However, the focus lays on the anger, caused by another driver's blame. Furthermore, only two items from the original DAS (Deffenbacher et al., 1994) deal with a potential anger-provoking event with no specific personal agency (traffic jam and construction site). This picture changes however when looking at driving anxiety (or driving related fear, DRF). Building on the assumption that a lack of control in a situation with no specific identifiable agent can induce anxiety (Berkowitz, 1993; Lazarus, 1991), new sets of traffic situations were studied. Dangerous road conditions and own maladjusted driving behaviour became important and completed the catalogue of emotion eliciting events (Ehlers et al., 1994; Taylor et al., 2000).

In addition to situational attributes, personal characteristics are responsible for the occurrence of emotions in traffic. Persons scoring high on trait (driving) anger tend to experience more emotions in that specific domain than others and, as a result, drive faster and generate more traffic violations (Deffenbacher et al., 1994; Mesken et al., 2005). High state anxiety is associated with more self-inflicted errors while driving (Fairclough et al., 2006). Furthermore age, gender, driving experience or how important driving is to the driver and how much they enjoy it (driving motivation) have an effect on emotional episodes on the road: younger drivers tend to experience more anger than older traffic participants (Lajunen and Parker, 2001; Parker et al., 2002); men report more anger when they are impeded by other drivers (Deffenbacher et al., 1994); woman are more angered when they are confronted with direct hostility, illegal actions or traffic obstructions (Parker et al., 2002). Driving experience is generally negatively correlated with anger feelings and experienced drivers feel less irritated in various traffic situations. It is assumed that their anger-threshold is heightened due to a frequent exposure to critical situations (Lajunen and Parker, 2001). When traffic participants internalize driving in their identity, this obsessive passion starts to control their actions and leads to greater desire and more intense will to drive. These highly motivated drivers are prone to negative emotions in goal-blocking situations (e.g. impeded progress on the road or erratic driving of others), which could, in turn, lead to

maladaptive driving behaviours (e.g. aggressive driving) (Philippe et al., 2009).

The implications of those emotions (anger and anxiety) in traffic are two-fold. Firstly, cognitive processes are influenced due to emotional experiences (Lazarus, 1991; Lerner and Keltner, 2001) and, as a result, effectively influence driving behaviours. The appraisal tendency approach implies that experienced emotions and its associated appraisal components trigger an aligned evaluation of subsequent events. Negative moods, such as feelings of anxiety, appear to lead to pessimistic risk perceptions, as opposed to positive mood, which makes people more confident in situation where they do not have any control over the events (Johnson and Tversky, 1983). However, anger could lead to more perceived control and therefore to more optimistic risk appraisals (Lerner and Keltner, 2001); This translates into the traffic context, that angry drivers are prone to underestimate risky situations and therefore change their behaviour in a maladaptive way (Mesken et al., 2007). They tend to show aggressive behaviours in traffic (e.g.; Lajunen and Parker, 2001; Björklund, 2008; Dahlen and White, 2006; Stephens and Groeger, 2009; Britt and Garrity, 2006) such as increased speed (Deffenbacher et al., 2003; Matthews et al., 1997), traffic violations (Mesken et al., 2007; Maxwell et al., 2005; Sümer, 2003), (hostile) gestures (Philippe et al., 2009) and honking (Shinar, 1998; Philippe et al., 2009). Ultimately, these forms of behaviour increase the risk of crashes and endanger other road participants (Deffenbacher et al., 2003; Chliaoutakis et al., 2005; Underwood et al., 1999).

According to the appraisal tendency approach high levels of anxiety should lead to reduced speed and more cautious driving behaviour. But the literature shows different results: anxious drivers tend to perform even more risky and dangerous behaviours (Fairclough et al., 2006; Dula et al., 2010). One interpretation might be, that anxiety works as restricting factor on overall working memory, which limits cognitive capacity that could otherwise be used for driving tasks (Shahar, 2009; Dula et al., 2010). This could trigger lapses, errors and violations while driving (Shahar, 2009; Taylor et al., 2007).

The present study has pursued two different goals: first, the emotion-eliciting potential of various situational factors as well as personal characteristics were tested. According to the appraisal theory framework, different combinations of situational factors should elicit different emotions. In this experiment, the focus was laid on anger, when the driver's arrival or safety goal was blocked due to another driver (Parkinson, 2001; Mesken et al., 2007) and anxiety, when the driver's security in traffic was at stake (Ehlers et al., 1994; Taylor et al., 2000). Furthermore, characteristics of the driver could influence experienced emotions in various ways: males (in specific situations), less experienced drivers with high trait anger and driving motivation might report higher levels of anger. Women or drivers with high trait anxiety scores might experience more anxiety. A second aim was to evaluate the impact of emotions of anger and anxiety on driving behaviour in the simulator. Velocity, acceleration, lateral acceleration and speeding were focused in this study due to their relevance in the literature of emotional driving (Stephens and Groeger, 2009; Cai and Lin, 2011; Deffenbacher et al., 2003). Furthermore, driving accidents (with no other traffic participants involved) due to maladaptive speeds contribute to 35% of all accidents and to 45% of the traffic fatalities on rural roads and highways in Germany (Destatis, 2012). Additionally, driving parameters such as high velocities and strong acceleration can increase the negative impact of more complex behaviours such as tailgating or risky overtaking (which are also endangering other traffic participants) even more. However, to elicit emotions in a controlled experiment in the laboratory is a difficult task, which requires a thorough design and reliable measures (Mesken et al., 2005). Simulator based studies promise a high standardization of the emotion eliciting events and the

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