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Are happy drivers safer drivers? Evidence from hazard response times and eye tracking data

Tatjana Zimasa [a,*], Samantha Jamson [a], Brian Henson [b]

[a] University of Leeds, Institute for Transport Studies, United Kingdom
[b] University of Leeds, Faculty of Engineering, United Kingdom

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ABSTRACT

Previous research shows that negative emotions have a detrimental effect on cognitive processes in general and on driving safety in particular. However to date, there has been no empirical investigation of the impact that positive emotions might have on driving safety. This research examined the influence of mood on driving safety using hazard perception videos and an eye tracker. Participants' mood was manipulated (Sad, Neutral, Happy) after which they observed videos containing a number of potential hazards. Hazard response times and eye fixations were measured. The Sad mood affected drivers the most, with the longest response times and fixation durations. The effects of the Happy mood were less clear, suggesting that apart from emotional valence, emotional arousal should be considered. In addition, hazard response times differed as a function of hazard onset (i.e. unexpected or developing hazard) and type of hazard (i.e. human, car). The results are interpreted in terms of theories of positive emotions and psychological arousal.

1. Introduction

Road accidents are still the most common cause of accidental death in developed countries, claiming over 40,000 lives every year (Plainis, Murray, & Pallikaris, 2006). Research suggests that attention, or rather lack of it, is an underlying cause of road accidents (Klauer, Dingus, Neale, Sudweeks, & Ramsey, 2006). Attention can vary as a function of experience whereby an experienced driver's ability to divide their attention between car controls and the environment is enhanced (Crundall et al., 2012; Underwood, 2007; Underwood, Chapman, Berger, & Crundall, 2003). Poor road conditions or visibility, as well as various distractors which require additional attention, can result in attentional overload and a failure to react safely and promptly (Konstantopoulos, 2009; Plainis et al., 2006). Thus, numerous factors can influence drivers' attention, but one of the most neglected factors is related to a driver's emotional state and the interaction between emotion and attention.

Stress, worry, anger and excitement can have as much negative impact on attention as other factors, such as talking on a mobile phone or driving under the influence of alcohol or drugs (Dahlen, Martin, Ragan, & Kuhlman, 2005; Underwood, Chapman, Wright, & Crundall, 1999). For example, Underwood et al. (1999) found that drivers who reported anger while driving, also reported near accidents in the same journeys. Deffenbacher, Lynch, Oetting, and Yingling (2001) found that drivers with high anger trait characteristics also showed greater situational anger and adopted more aggressive and risky driv-

* Corresponding author.
E-mail addresses: tstz@leeds.ac.uk (T. Zimasa), S.L.Jamson@its.leeds.ac.uk (S. Jamson), B.Henson@leeds.ac.uk (B. Henson).

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ing styles. Abdu, Shinar, and Meiran (2012) report that angry drivers more often run yellow traffic lights, and Arnett, Offer, and Fine (1997) found a direct relationship between trait anger and exceeding the speed limit.

Although, to date, the vast majority of research has been devoted to the investigation of negative emotions on road safety, the effect that positive emotions may have on driving has also been studied. De Looze, Kuijt-Evers, and Van Dieën (2003) point out the importance of positive emotions gained from seating comfort in connection with drivers' tiredness and loss of attention. Regarding drivers' mood, Cackowski and Nasar (2003) found that scenes with vegetation have a more positive effect on mood than scenes with man-made structures. They also found that roadside vegetation can help to reduce stress and facilitate recovery from attentional fatigue.

Emotion is the primary source of psychological arousal (Thayer 1978). Therefore, it is logical to examine the influence of different emotional states on attentional abilities. Many researchers agree that positive mood has a positive effect on human attention and cognition (Carver, 2003; Fredrickson, 2001; Isen, 2001). Fredrickson (2001) developed the Broaden-and-Build Theory proposing that positive emotions expand the perceptual and attentional scope along with mental representations and actions. Fredrickson and Branigan (2005) further built on this work differentiating between a low-activation state of contentment and a high activation state of amusement. They concluded that attentional scope was enhanced regardless of low or high activation state.

Carver (2003) also investigated the attention-emotion relationship and suggested the existence of a so-called 'regulatory system' which maintains a state without emotions. If negative emotions are experienced, the regulatory system puts in effort to return the emotions back to a neutral level. This action is costly as the regulatory system strives to achieve a result as soon as possible and consequently ignores activities that are not directly related to this particular action. Although the regulatory system prefers neither positive nor negative emotions and it treats any deviation from the neutral state as an 'error', Carver (2003) argues that a positive is not as costly as a negative affect. He suggests that this is because of the different ways in which positive and negative affect are arrived at. People do not put effort into arriving at a negative affect, as this is unnatural and unwanted. Therefore, under negative affect, energy is required to fix the problem. In contrast, to reach a positive affect, people dedicate some effort. When the goal is reached, there is no need for further effort and the available resources could be directed elsewhere. Carver (2003) called this phenomenon the 'effect of coasting'. Consequently, the available energy and attention, since the system is in an idle state, can be used to look for new sources of danger. For example, in the driving context, extra attention could be used to identify imminent hazards in order to be able to deal with them safely and promptly.

One method of measuring attention is to assess how well hazards are spotted during driving. Vlakveld (2014) defines hazard perception as the awareness of dangerous situations in the road and traffic environment. Importantly, hazard perception refers to potential hazards that may or may not materialise. Hazard perception tests are widely used not only for assessment of novice drivers, but also in a broad range of psychological research, and have been found to be a reliable measure of safety behaviour (Chapman, Underwood, & Roberts, 2002; Grayson & Sexton, 2002; Mckenna & Horswill, 1999; Pradhan, Pollatsek, Knodler, & Fisher, 2009; Vlakveld, 2014). Traditionally, hazard perception tests are recorded as short videos taken from the driver's perspective. Participants are required to watch these videos and imagine they are the driver of the car. Each video contains at least one potential hazard, which later develops into a critical situation requiring immediate action. The potential hazards vary and can include pedestrians stepping into the road, cars merging unexpectedly, cars braking suddenly or too rapidly, or road users violating traffic rules. As soon as a participant identifies a hazard, he/she has to press a button. Hazard perception skills are evaluated by computing the hazard response time (HRT) measured from the first indication of the hazard until the button is pressed (Chapman & Underwood, 1998).

The perception of a hazard is reliant on the participant's gaze behaviour. Research employing the measurement of eye-movements generally agrees that viewers mostly fixate on the most informative parts of the scene and these fixations are significantly longer than the less informative parts, such as the background (Chapman & Underwood, 1998; Chapman et al., 2002; Rayner, 1998). Visual fixation is defined as keeping the visual gaze on a particular position while processing visual information (Velichkovsky et al., 2003). Fixation times also change as a function of increased visual scene complexity (i.e. more cars, road signs, road furniture) in terms of shorter fixation durations and increased number of saccades (Chapman & Underwood, 1998; Robinson, Erickson, Thurston, & Clark, 1972). With regards to emotion, research is mostly consistent; content with an emotional connotation attracts visual focus leaving little or no attention left for peripheral stimulus processing (Kensinger, 2009). However, Wadlinger and Isaacowitz (2006) found that positive priming results in more fixations on peripheral stimuli, therefore widening the visual field. Moreover, Kaspar et al. (2013) examined not only the impact of the emotional content on viewing behaviours, but also the effect of participants' particular emotional state. Longer fixations and shorter saccades were observed when primed with negative images. Priming with the positive images resulted in shorter saccades, but not longer fixations. Thus eye movement data can help not only understand general observational patterns and the effect of emotion, but also gives deeper insight into the processes behind it and the resulting behaviours.

Previous research shows that fixation durations are directly related to driving safety. For example, Underwood (2007) states that when a hazard occurs it captures the drivers' attention. This increased focusing is characterised by longer eye fixations at the time of hazard detection. This attentional capture is natural and appropriate, as the driver needs time to assess the situation and decide if there is potential for a collision. The problem here is appropriate timing, as too long an attentional focus can result in missing secondary hazards, due to rapid changes in a traffic situation. On the other hand, shorter attentional capture was related to better attentional refocusing towards possible additional hazards. This evidence was derived by comparing search patterns of learner and experienced drivers. Experienced drivers were less vulnerable to the effect of attentional capture; long fixations, instead, were associated with less experience and, therefore, higher likelihood of involve-