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Safety messages and visibility of vulnerable road users for drivers

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ABSTRACT

Objective: The aim of this study was to evaluate the possibility of enhancing the visibility of motorcycles and pedestrians for motorists via safety messages concerning the vulnerability of these road users.
Background: In several cases of collision between cars and vulnerable road users (VRU), car drivers failed to detect the latter in time to avoid collision because of their low conspicuity.
Method: 2 groups of 17 motorists (23.6 years old) carried out a VRU detection task in 2 sessions in a car-driving simulator after either watching or not watching a film presenting safety messages about the vulnerability of these road users. Participants had to detect pedestrians and motorcyclists standing at the road side or who appeared on different parts of the road.
Results: The group of motorists who watched the film detected these VRUs at a greater distance and drove safely in zones which constitute a high risk of collision for pedestrians (key areas). Only the intensity of anger felt after the film can explain the improvement in VRU visibility distance. Moreover, this improvement was also associated with a modification in speed management in key areas. This last result provides evidence of the importance of top down processes in the detection of VRUs by motorists.
Conclusion: The film enhanced VRU visibility and led to safer driving behaviour for pedestrians.
Application: The practical implications of these results for safety campaigns and future directions of research on the emotional states of motorists and their perception during driving are considered.
Short abstract: We examine motorists' ability to detect motorcycles and pedestrians (VRUs) in a simulated car-driving task after watching a film presenting safety messages about VRU vulnerability. Informed motorists detect VRU sooner and drive in a safer way for pedestrians. We also consider practical implications and futures lines of research related to safety campaigns.

1. Introduction

The World Health Organisation has estimated the number of deaths on the road at 1.24 million by combining the data of 128 countries, and has shown that in 2010, 50% of fatal accidents involved a vulnerable road user (22% pedestrians, 5% cyclists and 23% motorised two or three-wheelers). Data for Europe reveals a similar trend with 43% of fatal accidents involving a pedestrian, a cyclist or a motorcyclist (World Health Organization, 2013). In France, 13.4% of fatal accidents involved a pedestrian, 7% a cyclist and 23.8% a motorcyclist in 2011 (ONISR, 2012).

Passenger cars are the vehicles most frequently involved in collisions with motorcycles (60% of accidents recorded between 1999 and 2001 in France, Germany, Italy, the Netherlands and Spain), and the primary cause of motorcycle collision was human error (MAIDS, 2005). These accidents may be explained, at least in part, by the low conspicuity of motorcycles for car drivers. The concept of conspicuity is made up of two related aspects: sensory conspicuity and cognitive conspicuity.

1.1. Conspicuity of vulnerable road users

Sensory conspicuity refers to the extent to which an object can be distinguished from its environment, due to its physical

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characteristics: angular size, eccentricity in relation to the point of gaze, brightness against the background, colour, etc. (Cole and Hughes, 1988; Engel, 1971, 1974; Hancock et al., 1990; Wulf et al., 1989). In other words, sensory conspicuity reflects an object's ability to attract visual attention and to be located accurately as a result of its physical properties.

According to Theeuwes, the momentary need for information could play a key role in the process of actively directing the observer's attention (Theeuwes, 1991). The observer could engage in active filtering based on knowledge related to the nature of probable stimulus inputs. These top-down processes can be put forward to explain, at least in part, the low conspicuity of vulnerable road users. Some researchers have suggested that failed and/or late detection of a motorcycle on the road is not exclusively related to its sensory conspicuity (Comelli et al., 2008; Hancock et al., 1990; Hole et al., 1996; Langham et al., 2002; Magazzu et al., 2006; Olson, 1989; Wulf et al., 1989). Drivers' decisions in relation to a motorcycle, or the ability to detect a motorcycle could also depend on cognitive conspicuity. This process takes into account elements which are specific to each driver. Cognitive conspicuity is linked to the fact that the focus of attention is strongly influenced by the observer's expectations, objectives and knowledge. Cognitive conspicuity therefore highlights top-down processes.

The importance of cognitive conspicuity in detecting powered two-wheelers was shown in a study investigating the risk of being responsible for motorcycle-car crash occurrence when owning a specific motorcycle licence (Magazzu et al., 2006), and in a study carried out using a car driving simulator (Rogé et al., 2012). In this latter study, car drivers who also hold a motorcycle licence and who ride regularly (motorcyclist-motorists) detected motorcycles more easily than non-motorcyclist-motorists (who had never ridden a motorcycle) depending on the arrival position of the motorcycles (from behind or in front of the car driver). This result could be explained by a better knowledge of motorcycle riding. Another interpretation could also be considered. Motorcyclist-motorists may be more conscious of motorcyclist vulnerability in case of collision. The interviews conducted after this experiment, revealed that 96% of motorcyclist-motorists (compared to 57% of non-motorcyclist-motorists) had at least one close relative and/or a family member who was a motorcyclist, and who had been injured (un-published data). These motorists' awareness of motorcyclists' fragility and of the higher accident risk they incur, could be higher than that of car drivers who have never ridden. This could lead them to detect these vulnerable road users more easily. If this reasoning is correct, acquiring awareness of the vulnerability of certain road users (such as pedestrians, motorcyclists and cyclists) could lead car drivers to modify their driving behaviour in order to improve VRU safety and enable easy detection. One way to improve car drivers' awareness of VRU vulnerability consists of providing safety messages.

However, safety messages, which direct focus on VRU vulnerability, could also awaken negative feelings (such as fear, sadness, or anger), and these could interfere with driving when messages are viewed immediately before the driving task. The projection of film extracts is one research technique commonly used to induce negative emotions of medium intensity (Gilet, 2008; Rottenberg et al., 2007). One major research question worthy of study is therefore the effect of negative emotions on the cognitive abilities of drivers and on their driving.

1.2. Negative emotions and driving

It is assumed that participants whose mood is negative allow their minds to wander, rather than focusing their attention on the task in hand. According to Ellis and Moore (1999), negative moods can lead participants to develop irrelevant thoughts and therefore decrease attentional resources. The lower capacity of attentional resources is due to the impact of irrelevant thoughts common to depression and negative mood (such as sadness) on attentional resources that would normally be used to perform the task. Emotional states therefore regulate attentional capacity. Two studies on the effect of sadness on driving show that this mood state increases irrelevant thoughts, and decreases attentional resources, leading to inattention (Lemercier and Cellier, 2008; Pêcher et al., 2009). Results obtained in a recent study featuring pictures of intersections are consistent with this idea (Jallais et al., 2014). Three mood states (anger, sadness and neutral) were induced by associating music and guided imagery and their effects on the localisation of road elements were studied. Sadness increased the localisation error rate compared to the neutral condition. This can be explained by a decrease in attentional resources and/or the use of detail-oriented information processing.

According to Jeon, studies involving fear can be found in the driving literature in association with anxiety and nervousness, which are both in the same negative and high arousal dimension in the circumplex model (Jeon et al., 2014). An anxious driver is likely to focus only on part of the entire task in driving situations, neglecting the overall process involved in the task. One of the effects of anxiety on attention is a narrowing of attentional focus and difficulty in focusing attention. Janelle et al. (1999) measured anxiety-based attentional narrowing using a car racing simulator. Results showed that participants in the anxiety groups were generally slower to respond to peripheral stimuli in situations that provoked higher levels of anxiety. Briggs et al. (2011) examined anxiety in arachnophobic drivers involved in an emotionally arousing conversation (discussion about spiders) while driving. Anxious drivers concentrated more on the centre of the screen (ocular behaviour characterised by a decline in the range of their visual fixations), showing a pattern of visual tunnelling.

Stephens and Groeger manipulated angry mood in a group of drivers and examined the consequences in a subsequent neutral simulated drive (Stephens and Groeger, 2011). Drivers subjected to anger-provoking impediments during one drive tried to avoid similar situations containing potential impediments by attempting dangerous over-taking manoeuvres during the subsequent drive. Reaction time data in the neutral drive further showed degraded driving performance, with anger-provoked drivers responding more slowly to novel driving events not encountered in the initial drive. These novel events included vehicles pulling out of driveways into the driver's path and pedestrians walking on the road. Although Stephens and Groeger were able to demonstrate anger-congruent behaviours in the driving environment, they were unable to determine whether degraded performance was the result of drivers missing potential traffic hazards or of their failure to identify novel events as risky.

All these studies led us to the following hypothesis. If the presentation of road safety messages modifies the emotional state of car drivers (i.e. increases negative emotions such as anger, anxiety, sadness), these drivers may experience difficulty in detecting vulnerable road users when driving due to a decrease in attentional resources, to the use of detail-oriented information processing, narrowing of attentional focus and/or difficulty in focusing attention. It should be noted that according to this last hypothesis (which we call the 'emotional hypothesis'), results expected from safety messages should be the opposite of those suggested in our previous hypothesis (which we have named the 'VRU vulnerability awareness hypothesis').