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Are experienced drivers more likely than novice drivers to benefit from driving simulations with a wide field of view?

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ABSTRACT

This study aimed to further our understanding of the impact of a restricted field of view on visual search and hazard perception, by comparing novice and experienced driver performance in a driving simulator as a function of the available field of view. Participants encountered a series of virtual hazards during their drive while viewing the world under narrow or wide field of view conditions. The results showed that all drivers were more likely to avoid the hazards when presented with a wide view, even though the hazards only occurred in an area of the screen that was visible in both the wide and narrow view conditions. Experienced drivers also tended to have fewer crashes, and this appeared to be related to a greater speed reduction 10 metres before the hazard. This speed reduction was greatest in the wide field of view condition suggesting that additional information from wider eccentricities was useful in safely navigating the hazardous events. Gaze movement recording revealed that only experienced drivers made overt use of wider eccentricities, and this was typically in advance of any visual cues that might help identify the hazard. This suggests that either early overt attention to wider eccentricities, or continuous covert attention to these extra-foveal regions on approach to the hazard, is responsible for the safer behaviour of experienced drivers when presented with a wide field of view. We speculate about the possible underlying mechanism and discuss possible consequences for HP tests.

1. Introduction

Hazards are dangerous events that require a reaction (e.g., to brake or to swerve) to avoid an accident when driving. Early detection and processing of hazards is related to accident liability and is therefore a substantial component contributing to traffic safety (e.g., Deery, 1999; Elander, West, & French, 1993; Horswill & McKenna, 2004). From a variety of driving skills this ability has been argued to be one of, if not *the*, best predictor of accident involvement (Horswill & Mckenna, 2004). Hazard perception (HP), the ability to detect hazardous situations on the road, is usually assessed by recording button responses to hazardous situations presented in short video-clips taken from a driver's perspective in a moving vehicle.

Using this simple method for testing HP, researchers have successfully shown that drivers who have not had an accident respond more quickly to hazards than drivers who have (e.g., McGowan & Banbury, 2004; McKenna, Horswill, & Alexander,

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2006; Wallis & Horswill, 2007) and in addition, researchers have successfully discriminated between drivers of varying levels of experience, typically demonstrating that experienced drivers detect hazards more quickly than drivers that are less experienced (McKenna & Crick, 1991, 1994; Wallis & Horswill, 2007).

The typical hazard perception test is however designed as much on the basis of pragmatics as theory. Initial hazard perception studies used relatively immersive settings; Watts and Quimby (1979) placed participants in a car shell and had them watch film clips projected onto a large screen. Later research however reduced the apparatus to a standard computer screen display (McKenna & Crick, 1991, 1994), perhaps with an understanding that, if any HP test was to be introduced as part of the national licensing procedure, apparatus would have to be reduced to a minimum while still retaining validity. Many academic studies have since adopted this simple single-screen approach to hazard perception without questioning the impact that it might have on the ability to accurately measure hazard perception skill. Theories of *spatial presence* argue that immersion is key to evoking and training real-world skills in artificial environments (e.g., Wirth et al., 2007), yet such theories are rarely discussed in the hazard perception literature.

Certainly there are reasons to believe that the provision of a more immersive visual environment may have differential effects on drivers of varying levels of experience both at the behavioural and eye-movements level (Di Stasi, Contreras, Cándido, Cañas, & Catena, 2011; Alberti, Gamberini, Spagnolli, Varotto, & Semenzato, 2012). For instance it has been found that novice drivers fail to look at critical elements on the road (Pradhan et al., 2005), that they fail to appropriately scan the mirrors (Underwood, Crundall, & Chapman, 2002b), and they scan the road less widely than experienced drivers (Mourant & Rockwell, 1972; Underwood, Chapman, Bowden, & Crundall, 2002a; Crundall & Underwood, 1998). On this basis one can predict that simply increasing the field of view of a hazard perception test should create a more realistic scanning pattern in experienced drivers, while novices may still restrict themselves to a relatively central area. This could have the result of improving experienced drivers' responses to hazards above that seen in restricted-view HP tests by allowing access to more information that may prime responses. Alternatively, perhaps the restricted field of view in a typical hazard perception test unduly focuses experienced drivers, and thus the provision of a wider field of view may lead them to respond more slowly to centrally appearing hazards simply because they may be less likely to be looking in the appropriate location when the hazard occurs. Novice drivers however may be unaffected by extending the field of view if they maintain the narrow, central search pattern indicative of their driving skill.

Recently Shahar, Alberti, Clarke, and Crundall (2010) have argued that some biases might originate from the restricted field of view (approximating anywhere between 40 and 80 degrees of visual angle) provided by typical HP tests, failing to reflect some aspects of the complexity of HP skills in real driving, which involves detecting and processing occurrences that are external to this limited view.

Using a video-based HP test Shahar, Alberti, et al. (2010) recorded button presses in a wide and narrow field of view condition finding that responses were faster in the wide field of view condition, even though the hazard appeared in the centre of the visual field. They presented a series of reasons why this would be the case including arguments that greater immersion with a wider field of view may evoke greater and more realistic sampling of the visual scene, or that increased arousal due to greater levels of relevant visual information may lower thresholds for detecting and reporting hazards.

Following on from the video-based study of Shahar, Alberti, et al. (2010), the current paper reports a study assessing the impact of the field of view upon hazard detection and avoidance in a simulated drive through a pre-determined route containing a series of hazardous events. If experienced drivers benefit more from an expanded field of view than novice drivers then their responses to hazards in the simulator should reflect safer driving behaviour. For instance, on approach to a hazard, the wide field of view may result in early braking times for experienced drivers, though the effect should be less pronounced for novices as they are less likely to use the additional visual information.

By examining HP in a simulator (e.g., Crundall, Andrews, van Loon, & Chapman, 2010; Shahar, Poulter, Clarke, & Crundall, 2010; Underwood, Crundall, & Chapman, 2011) researchers bridge the gap between laboratory studies and real world driving. While simulators cannot beat video clips in the realism and complexity of their imagery, the interactivity provides an additional level of spatial presence, and a more realistic range of behavioural responses to the perception of hazards (e.g., Horswill & Mckenna, 2004; Sagberg & Bjørnskau, 2006). This will allow us to identify whether the effects noted by Shahar, Poulter, et al. (2010) translate into real differences in driving behaviour.

Specifically we predict that a wider field of view in the simulator will encourage safer driving behaviour in the presence of hazards, and that this safety improvement will be predominantly for experienced drivers. Furthermore we predict that this improvement in behaviour for experienced drivers will be concomitant with a wider spread of search in the wide field of view condition, as they take advantage of the additional visual information. Novices are less likely to display a wider search patter in the wide field of view condition.

2. Method

2.1. Participants

Forty participants took part in the experiment, including 20 experienced drivers of which five were women (Mean age = 28.6; SD = 9.91; Mean license seniority in years = 10.5; SD = 9.99) and 20 novice drivers of which seven were women (Mean age = 22.4; SD = 4.96; Mean license seniority in years = 1.6; SD = 0.82). Participants received an inconvenience