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Are situation awareness and decision-making in driving totally conscious processes? Results of a hazard prediction task

Andrés Gugliotta [a], Petya Ventsislavova [b], Pedro Garcia-Fernandez [a], Elsa Peña-Suarez [a], Eduardo Eisman [a], David Crundall [b], Candida Castro [a,*]

[a] CIMCYC, Mind, Brain and Behavior Research Center, Faculty of Psychology, University of Granada, Spain
[b] Nottingham Trent University, UK

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ABSTRACT

Detecting danger in the driving environment is an indispensable task to guarantee safety which depends on the driver's ability to predict upcoming hazards. But does correct prediction lead to an appropriate response? This study advances hazard perception research by investigating the link between successful prediction and response selection. Three groups of drivers (learners, novices and experienced drivers) were recruited, with novice and experienced drivers further split into offender and non-offender groups. Specifically, this works aims to develop an improved Spanish Hazard Prediction Test and to explore the differences in Situation Awareness, (SA: perception, comprehension and prediction) and Decision-Making (DM) among learners, younger inexperienced and experienced drivers and between driving offenders and non-offenders. The contribution of the current work is not only theoretical; the Hazard Prediction Test is also a valid way to test Hazard Perception. The test, as well as being useful as part of the test for a driving license, could also serve a purpose in the renewal of licenses after a ban or as a way of training drivers. A sample of 121 participants watched a series of driving video clips that ended with a sudden occlusion prior to a hazard. They then answered questions to assess their SA ("What is the hazard?" "Where is it located?" "What happens next?") and DM ("What would you do in this situation?"). This alternative to the Hazard Perception Test demonstrates a satisfactory internal consistency (Alpha = 0.750), with eleven videos achieving discrimination indices above 0.30. Learners performed significantly worse than experienced drivers when required to identify and locate the hazard. Interestingly, drivers were more accurate in answering the DM question than questions regarding SA, suggesting that drivers can choose an appropriate response manoeuvre without a totally conscious knowledge of the exact hazard.

1. Introduction

Situation Awareness (SA) can be a useful term to describe drivers' understanding of the relationship between themselves and other objects within the driving environment, with the ultimate aim of avoiding hazards on the road (e.g. Wetton, Hill, &

* Corresponding author at: CIMCYC, Centro de Investigación Mente, Cerebro y Comportamiento (Mind, Brain and Behaviour Research Centre), Facultad de Psicología, Universidad de Granada, Campus Cartuja, 18011 Granada, Spain. Fax: +34 958 246239.
E-mail address: candida@ugr.es (C. Castro).

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Horswill, 2013). These authors define hazard perception as 'the ability to predict dangerous situations on the road' (p 65), which elegantly encapsulates the final output of the linear, three-stage model of Situation Awareness popularised by Endsley (e.g. Bolstad & Cuevas, 2010; Endsley, 1988, 1995). In this model, *perception* of the environmental elements precedes *comprehension* of their qualities and relevance to oneself, which allows one to project their future status (e.g. predicting their future locations). While good SA is not *sufficient* to guarantee an appropriate response, it could be argued that SA is at least necessary in order to decide upon the most suitable manoeuvre: whether to brake sharply, make a turn to avoid a hazard, or overtake. While the necessity of good SA seems obvious in support of selecting the correct behavioural response, this has not been tested in the field of driving. Furthermore, while there is much evidence to suggest that hazard prediction discriminates between drivers on the basis of experience, there is no research that has followed these predictions through to the response selection. It is a possibility that adding response selection to a hazard prediction test may enhance (or even degrade) the discriminative function of such tests. For this reason, the current study explores the link between SA and Decision-Making (DM) using a hazard prediction methodology.

Pradhan & Crundall (2017) have defined hazard prediction as the extraction of hazard evidence from the potential hazard precursors in the scene, and then prioritising these precursors for iterative monitoring. They argue that this is a vital sub-process in the whole behaviour chain (from hazard searching to response selection) which they term *hazard avoidance*. In contrast they argue that the term *hazard perception* is often imprecisely used to refer to varying collections of sub-processes within the *hazard avoidance* process (including both perceptual and post-perceptual processes).

Despite the inexact terminology of *hazard perception*, the majority of research over the last five decades has focused upon the use of *hazard perception tests*. Traditionally these tests require participants to watch video clips from a driver's perspective and press a button as soon as they spot a developing hazard (though some also include a measure of location-based accuracy; e.g. Wetton, Hill & Horswill, 2011). Evidence suggests that safer and more experienced drivers respond faster to such hazards (e.g. Horswill & McKenna, 2004; McKenna & Crick, 1991; Wetton et al., 2011), and that performance on these tests can be linked to likelihood of collision (e.g. Boufous, Ivers, Senserrick, & Stevenson, 2011; Horswill, Anstey, Wood & Hatherly, 2010). Indeed the introduction of the UK hazard perception test in 2002 has been directly linked to a significant decrease in on-road crashes (Wells, Tong, Sexton, Grayson & Jones, 2008). It should be noted however that not all studies have had success separating safe from less-safe drivers (Borowsky, Shinar & Oron Gilad, 2010; Chapman & Underwood, 1998; Sagberg & Bjørnskau, 2006; Underwood, Ngai & Underwood, 2013).

The Hazard Prediction Task (also known as the "What happens next?" test) is a variant on the traditional Hazard Perception task that assesses the predictive component of situation awareness for on-road hazards, asking participants to answer three questions that probe SA: "*What* is the hazard?" "*Where* is the hazard?" "*What happens next?*" *(WHN)*. Following the methodology of Jackson, Chapman & Crundall (2009), these questions are asked following occlusion of the video clip, which occurs just as the hazard begins to develop. In comparison with a traditional hazard perception methodology, evidence suggests that this hazard prediction test format is also good at discriminating between experienced, safer drivers and inexperienced, less-safe drivers (e.g. Castro et al., 2014, 2016; Crundall, 2016). However, one benefit of the hazard prediction test over the hazard perception test is that it removes post-perceptual biases from the measure, such as response criterion (where participants may delay responding to a perceived hazard because they feel it falls within their skill level to avoid it). Thus this prediction test is a potentially purer measure of one's ability to spot hazards. It is presumed that a correct prediction of the hazard is needed in order to make appropriate decisions about the manoeuvres to be performed (Endsley, 1995; Horswill & McKenna, 2004; Jackson et al., 2009), but to date this has yet to be tested in a hazard prediction paradigm.

1.1. In-time critical Decision-Making processes and Situation Awareness

Individuals' ability to acquire SA has an impact on their decision-making. According to Smith (2013), making the right decision in a short period of time is crucial in driving. The accuracy of the decision made by the driver is based on his/her knowledge of the driving environment applied to the present context. However, the role that SA plays is not constant even in time-critical situations (SA). That is, it seems more crucial in non-standard situations or when anticipating hazards to have good SA, such as a high level of information about traffic, extraneous activity and unforeseeable events. Therefore, the analytical process of quantifying and qualifying SA should involve integrating DM, and equally, SA should be analysed in order to discover in what form it could be used at the critical time, in order to make the right decisions.

Making a decision whether to keep the same speed and trajectory or make an avoiding manoeuvre may be considered a simple aspect of the driving task that could be carried out in a controlled way but also be primed by automatic processing. However, Groeger & Clegg (1998, p 145) stated that they were very doubtful indeed that the performance of any complex aspect of the driving task (e.g. changing gear) was automatic.

1.2. Driving Experience, Offender status and Hazard Prediction

It has been widely documented that differences in Hazard Prediction are found between different groups of drivers on the basis of experience and crash record (see Horswill, 2017, for a review). There is less evidence however regarding the impact of offender status on traditional hazard perception tests. We know that offenders are more likely to be involved in a collision (Laapotti, Keskinen, Hatakka & Katila, 2001; Simon & Corbett, 1996; Yahya & Hammarström, 2011), and repeat offenders are especially dangerous (Lapham, Ring-Kapitula, C' de la Baca & McMillan, 2006). There has been some suggestion that drivers