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Hazard prediction discriminates between novice and experienced drivers

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ABSTRACT

Typical hazard perception tests often confound multiple processes in their responses. The current study tested hazard prediction in isolation to assess whether this component can discriminate between novice and experienced drivers. A variant of the hazard perception test, based on the Situation Awareness Global Assessment Technique, found experienced drivers to outperform novices across three experiments suggesting that the act of predicting an imminent hazard is a crucial part of the hazard-perception process. Furthermore three additional hypotheses were tested in these experiments. First, performance was compared across clips of different length. There was marginal evidence that novice drivers' performance suffered with the longest clips, but experienced drivers' performance did not, suggesting that experienced drivers find hazard prediction less effortful. Secondly, predictive accuracy was found to be dependent on the temporal proximity of visual precursors to the hazard. Thirdly the relationship between the hazard and its precursor was found to be important, with less obvious precursors improving the discrimination between novice and experience drivers. These findings demonstrate that a measure of hazard prediction, which is less confounded by the influence of risk appraisal than simple response time measures, can still discriminate between novice and experienced drivers. Application of this methodology under different conditions can produce insights into the underlying processes that may be at work, whilst also providing an alternative test of driver skill in relation to the detection of hazards.

1. Introduction

Hazard perception (HP) has been defined differently by many researchers (cf. Jackson et al., 2009) though one increasingly common description is 'the ability to predict dangerous situations on the road' (Wetton et al., 2013, p. 65; McKenna and Horswill, 1999; Horswill and McKenna, 2004). This definition fits with attempts by researchers to understand hazard perception within the theoretical framework of Situation Awareness (Horswill and McKenna, 2004). This theory describes a process of generating and updating a mental model of the current environment as it relates to your goals (e.g. Jeannot et al., 2003; Walker et al., 2009). The most popular version of Situation Awareness (SA) refers to a linear process that generates a situation model through three stages or levels: (L1) *perception* of elements in the environment, (L2) *comprehension* of their qualities and relevance to current goals, and (L3) *projection* of their locations in space over a suitable timeframe for the task at hand (Endsley, 1988a, 1995; Bolstad et al., 2010). While the precise stages and processes involved might be debated (cf. Vidulich et al., 1994; Gugerty, 2011; Walker et al., 2009), most agree that the prediction of future event states (L3), such as potential hazards on the road, is an important outcome for any instantiation of SA. It is understandable then that this framework has been linked to driver safety and the ability to detect hazards.

However, while many studies make a discursive link between SA and HP, relatively few have used SA as the basis for a study in hazard perception. As Gugerty (2011) pointed out, "research on expert-novice differences for [the main measures of SA are] not available for driving tasks. . ." p. 19.6. The current paper addresses this gap, at least in part, by describing three studies which use a variant on the hazard perception test, derived from the most accepted SA measure (the Situation Awareness Global Assessment Technique, or SAGAT).

Before presenting the studies this paper will describe the current approach to hazard perception testing and propose how it can benefit from a test derived from the Situation Awareness framework. It should be noted however that it is not the intention of this paper to provide support for the Situation Awareness model per se, or for the application of SA to the field of hazard perception, but merely to adapt SA techniques to allow better isolation of the

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prediction component in hazard perception. While these experiments attempt to find evidence of prediction as a differentiator of driver groups, any positive findings could still be viewed as agnostic towards the Situation Awareness model.

1.1. The traditional approach to hazard perception

The current UK hazard perception test is based upon decades of research dating back to the 1960s and 70s (e.g. Pelz and Krupat, 1974; Watts and Quimby, 1979). This research was based on the simple underlying hypothesis that safer drivers are more likely to spot hazards earlier than unsafe drivers, and therefore respond to them more quickly. Over the last 40 years this hypothesis has been further unpacked. For instance spotting, comprehending, appraising and responding are all separate aspects of interacting with an on-road hazard, which are further influenced by general driving strategies, caution, and sensation seeking (for a review of these and other factors see Horswill and McKenna, 2004). Despite this, there has been relatively little effort to explain hazard perception in a broader theoretical framework. One reason for this may be that the majority of research, at least in the previous century, was funded by sponsors who were interested in generating a diagnostic test of driver ability, rather than developing a theoretical basis for HP. It appears however that some researchers have now begun to notice the theoretical lacuna underlying hazard perception. As noted in a factsheet produced by the Netherlands' Institute of Road Safety Research (SWOV, 2010) "Some people are of the opinion that hazard perception is too limited a concept and they prefer to talk about situation awareness", p. 2. Certainly the 3 levels of *perception*, *comprehension* and *prediction* of future states contained in Endsley's definition of SA (1988a, 1995) appear at first glance to fit well with the different aspects of hazard perception that have been defined by various authors (e.g. Crundall et al., 2008, 2012; Groeger, 2000). This would include the ability to first detect potential targets, to then understand their hazardous potential, to link them together in time and space, and then anticipate the most likely hazardous outcome.

To see how these stages might map onto traditional measures of hazard perception one can look at the official UK hazard perception test (a part of the licensing procedure since 2002). Like many HP tests used by researchers, the official UK test requires participants to watch a series of video clips[1] taken from the driver's perspective, and to make a timed response as soon as they perceive a hazard that they would need to avoid by braking or steering. Each official UK clip has a temporal scoring window that falls immediately prior to the full development of each hazard. Responses outside the hazard window (either before or after the window) fail to score anything. However, a response made during the scoring window represents spotting the hazard 'in time to avoid it' and is awarded between 1 and 5 points, with higher points reflecting earlier responses within the window.

The official guidelines for the UK hazard perception test suggest that participants should respond to 'developing hazards' with the following example: "...consider a parked vehicle on the side of the road. When you first see it, it is not doing anything; it is just a parked vehicle. If you were to respond to the vehicle at this point, you would not score any marks, but you would not lose any marks. However, when you get closer to the vehicle, you notice that the car's right hand indicator [turn signal] starts to flash. The indicator would lead you to believe that the driver of the vehicle has an intention of moving away, therefore the hazard is now developing and a response at this point would score marks. The indicator coming on is a sign that the parked vehicle has changed its status from a potential hazard into a developing hazard. When you get closer to the vehicle you will probably see the vehicle start to move away from the side of the road; another response should be made at this point"[2] (http://www.nidirect.gov.uk/the-hazard-perception-test-hpt-explained).

The above example hazard has very distinct phases of *potential* (the parked car), *developing* (it indicates) and *actual* hazard states (it moves off). While not explicit in the instructions, it is clear that the official UK hazard perception test is attempting to capture something of the predictive nature of hazard perception, akin to the third level of Situation Awareness.

However it is not clear what the simple response-time measure used in the UK test, and in many tests developed by researchers, is actually measuring. Many factors are likely to influence and confound the response, including individual differences in judging the hazardousness of an event (response criterion), the time required to process the actual hazard, and the level of confirmatory evidence that one requires before making a response (e.g. Deery, 1999).

This multi-faceted nature of hazard processing has been noted by other researchers. For instance, Borowsky and Oron-Gilad (2013) used three separate tests (hazard perception, hazard categorisation and hazardousness ratings) to assess different components of hazard processing, concluding that risk perception related to the likelihood of a collision can affect real-time measures of hazard perception, while risk perception regarding the severity of a possible collision only played a role in hazard processing when used in hindsight (in their ratings and categorisation tests). This suggests that some aspects of risk perception (which relate the hazard to one's own driving skills) can impact on the simple response time measure used in typical hazard perception tests.

A further problem for the traditional hazard perception test, as used in the UK, is that the response is not assessed for accuracy. A participant may press the button for a reason unconnected to the hazard, yet, providing the response falls within the scoring window, they could still receive maximum points. While some researchers have created versions of HP tests that include a measure of accuracy using the mouse pointer or a touch screen to allow localisation of a hazard (e.g. Wetton et al., 2010, 2011), these variants may further confound response times by requiring participants to accurately report the location as part of the speeded response (e.g. a mouse click on a location may take longer than a simple button response depending on the size of the target one is trying to click on).

From a diagnostic perspective these problems may not be important. The typical HP test is not concerned with whether differences between safe and unsafe driver groups are due to the prediction of an imminent hazard, the speed of hazard processing, of the level of perceived risk; it simply seeks to differentiate between groups with a gross measure.

For a diagnostic test, this may be all that is required, providing that the test is found to be reliable across time and valid in terms of separating the safe from the unsafe. However research using hazard perception clips remains mixed, with several researchers failing to discriminate between driver groups (Chapman and Underwood, 1998; Sagberg and Bjørnskau, 2006; Borowsky et al., 2010; Underwood et al., 2013).

These equivocal results could be due to the varying stimuli used by different research groups (e.g. some use natural hazards while others use staged hazards, despite there being no evidence

[1] In January 2015 the UK Driver and Vehicle Standards Agency introduced computer-generated clips instead of filmed clips.

[2] The UK hazard perception test takes the first response within the scoring window as the correct response. Therefore pressing a second time for the hazard should have no effect on one's score, unless the first response was *too fast* and fell before the start of the scoring window.