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Consistency between subjectively and objectively measured hazard perception skills among young male drivers

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ABSTRACT

Young male drivers have lower hazard perception skills (HPS) than older and more experienced drivers and a tendency to overestimate their skills in hazardous situations. Both factors contribute to an over-representation in traffic accidents. Based on a sample of 63 drivers aged 18–24, this study compares the consistency of HPS measured by objective and subjective measures and the link between these measures is the key contribution of the study. Both visible and hidden hazards are included. Objective measures of HPS include responsiveness and eye movements while driving in a driving simulator. Subjective measures of HPS include self-reports derived based on the Hazard Perception Questionnaire (HPQ), Driving Skill Questionnaire (DSQ), and Brief Sensation Seeking Scale (BSSS). Results show that drivers who respond to the hazards on time, as compared to drivers who do not respond, have higher scores on subjective measures of HPS and higher driving skills in the visible but not in the hidden condition. Eye movement analysis confirms the difference and shows that response in time to hazards indicate higher HPS and young drivers are poor at detecting hidden hazards. Drivers with a response in time locate the hazard faster, have more fixations, but dwell less on the hazard. At the same time, those who do not respond have a later first fixation and fewer but longer fixations on the hazard. High sensation seeking drivers respond to visible hazards on time, suggesting that sensation seeking does not affect HPS negatively when the hazard is visible. To enhance the HPS among young drivers, the results of this study suggest that specific hazard perception training is relevant, especially for hazards that require more advanced HPS.

1. Introduction

Road traffic injuries remain the leading cause of death among 15–29 year olds worldwide (World Health Organization, 2015). Young, and in particular male drivers are more prone to engagement in high-risk driving behaviours (Constantinou et al., 2011; Halpern-Felsher et al., 2017) and continue to be over-represented in accident statistics despite general improvements in road safety levels and developments in training and testing (ITF, 2017). Studies show that HPS is a key factor in relation to unsafe driving and accident involvement (e.g. McKnight and McKnight, 2003; Fisher et al., 2006; Pollatsek et al., 2006). In line with an established definition (Crundall et al., 2003), we operationalise HPS as a driver's ability to detect and respond in time and appropriately to potentially dangerous events on the road.

HPS are typically measured with direct behaviour methods where participants know that hazards will occur and a quick response to the hazards is requested. Examples of direct measures include response latency assessed by pushing a button (e.g., Borowsky et al., 2010; Underwood et al., 2005), pointing tasks (e.g., Scialfa et al., 2013; 2012;2011) or mouse clicking tasks (e.g., Smith et al., 2009). Indirect behaviour measures, namely, reactions to hazards when driving in a simulator (e.g., Martinussen et al., 2017; Schall et al., 2013; Young et al., 2017) and eye movements (e.g., Borowsky et al., 2010; Crundall et al., 2012; 2003) are also used. In that case, participants do not know that hazardous situations will occur, which brings participants closer to the naturalistic driving situation. It is argued that, due to the complexity of hazard perception skills, reaction time alone is a too simple measure of HPS (e.g., Huestegge et al., 2010; Sagberg and Bjørnskau, 2006). With indirect measures it is possible to detect driver behaviour before and after the actual hazard is presented. By analysing eye movements it is possible to estimate if a driver has searched and detected the hazard, and by analysing driving behaviour, variations in driving speed, braking, and variations in steering indicates drivers' chosen response to it.

Although young drivers generally have lower HPS compared to more experienced drivers, the level of HPS also differs within subgroups of young drivers. Moreover, it is unknown whether non-responsive drivers do not interpret hazards as potentially dangerous and

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therefore do not respond, or if they fail to detect them. Studies have aimed to separate the process of detection and response to the hazards. Young novice and experienced drivers differ in their hazard perception accuracy, when time available for detection is manipulated (Jackson et al., 2009); young drivers still detect fewer hazards when they have more time available. Additionally, novice and experienced drivers have different processing speeds after a hazard is detected, which affects reaction time (Huestegge et al., 2010). Research on eye movements suggests that inexperienced drivers detect fewer hazards (e.g. Fisher et al., 2006; Pradhan et al., 2005), have a narrower horizontal spread of search (Underwoodt et al., 2003), and fewer (Pradhan et al., 2005) but longer fixation durations (Chapman and Underwood, 1998) indicating a longer processing time. It still remains unclear how young drivers with higher and lower HPS differ when detecting and responding to hazards.

In this study, we measure drivers' response to potential hazards based on changes in driving speed. Additionally, with eye movements, we measure hazard detection to validate the response behaviour (changes in driving speed).

According to Crundall et al. (2012), it is relevant to make a distinction between visible and hidden hazards. Visible hazards have behavioural cues directly related to the hazard. Examples include a blinking turning car starting to drive out of the roadside parking, and a pedestrian standing on the pavement ready to enter the street. Hidden hazards have environmental cues not directly related to the hazard. Examples include a possible but not yet visible road user who may arrive on a collision course, such as a pedestrian behind a bus at a bus stop. Another example of a hidden hazard is a driveway or curve with an object restricting the view of possible traffic approaching from it. Hidden hazards require more advanced HPS than visible hazards. HPS increase with driving experience (e.g. Horswill and McKenna, 2004) and therefore understanding HPS of young, less experienced drivers is of particular interest.

In addition to actual HPS, accurate subjective assessment of one's own HPS is important, as this provides the basis for relevant behavioural adjustments in challenging traffic situations and the avoidance of unintended risky driving (Deery, 1999). The extent to which drivers assess their HPS accurately can be examined by comparing subjective and objective measures of HPS.

To the best of our knowledge, only two studies have compared the consistency between objective and subjective measures of HPS among young drivers: Farrand and Mckenna (2001) examined the relationship between self-ratings of risk perception and objective HPS assessed by recording response latencies in a video based HP test, while Martinussen et al. (2017) examined the accuracy of self-reported HPS compared to objectively measured driving skills in a driving simulator. Among other driving related skills (overtaking, maintenance of safe gap to car in front) objective hazard prediction and detection was measured as a reduction in driving speed prior to the hazardous event and as a latency to braking after the start of the hazardous event.

While Farrand and Mckenna (2001) found that self-assessments were not related to the objectively measured HPS, Martinussen et al. (2017) found that young drivers overestimated their HPS. Moreover, Martinussen et al. (2017) concluded that sub-groups of young drivers are at a 'double' risk because, in addition to inaccurate self-assessments and low objectively measured HPS, they also scored higher in sensation seeking, a factor known to be related to risky driving behaviour (Gregersen, 1996; Schwebel et al., 2006). Sensation seekers have a higher threshold for what they consider risky and even seek out risky situations (Zuckerman, 2007, 1978). They accept higher risks and may thus have a higher threshold for reacting to potential hazards. By contrast, low sensation seekers are more inclined to judge incidents as hazardous (e.g. Horswill and McKenna, 2004). Consequently, sensation seeking may influence hazard perception and is therefore relevant to consider when exploring HPS.

With a focus on young drivers, the purpose of this study is to compare the consistency between self-assessed, and objectively measured HPS in visible and hidden hazard situations, and to examine the possible influence of a sensation seeking propensity. Eye movement analysis is included to determine if participants detected the hazards and thus to assess their HPS in combination with behavioural response measures.

Our hypotheses are as follows:

Hypothesis 1. In line with the findings of Martinussen et al. (2017), we expect that objectively and subjectively measured HPS are inconsistent; drivers with lower objective HPS have higher or the same self-assessed skills than drivers with higher objective HPS.

Hypothesis 2. The possible inconsistency between objective and subjective measures of HPS will be more pronounced in relation to hidden hazards, because hidden hazards require more advanced HPS than visible hazards (Crundall et al., 2012).

Hypothesis 3. Participants who detect potential hazards (measured by eye movements)ey5.9.