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Expert drivers are better than non-expert drivers at rejecting unimportant information in static driving scenes

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ABSTRACT

Safe driving is predicated on a driver's ability to prioritise scene information to segregate hazards and potential hazards from other information, and allocate attention accordingly. Previous research has demonstrated that expert drivers are superior at detecting potential hazards when compared with non-expert drivers. However, hazard perception is a multifaceted skill involving at least three components: drivers must look at the hazard, then detect it, and finally appraise it and respond appropriately. In the current study, we explored how expert drivers (paramedics, $n = 151$) and non-expert drivers ($n = 189$) detect hazards of different threat value. To explore this question, we used a static, driving-related inattentional blindness (IB) task, in which an unexpected object in a critical trial varied from high threat (child running onto the road) to medium threat (pedestrian standing by the road) to low threat (garbage bin next to the road). We hypothesised that experts would have heightened awareness of hazards, which could be reflected as either generally higher rates of noticing objects in the driving scene (lower IB overall), or a heightened ability to prioritise the threat value of objects in the scene (lower IB for high threat, but not low threat objects). The results demonstrated that approx. 90% of drivers, irrespective of expertise, detected high threat objects placed on the side of the road. However, experts were more likely than non-experts to detect medium threat objects (55% of expert drivers vs. 40% of non-expert drivers), whereas the opposite pattern occurred for low threat objects (almost 20% of non-expert drivers noticed low-threat objects, compared with none of the expert drivers). We argue that expertise allows drivers to calibrate a hierarchy of attentional filtering to not only direct attentional resources to locations of interest, but also to explicitly prioritise objects of interest when driving. Importantly, this appears to be due to training rather than years of experience. These results point to the importance of not just increasing awareness while driving, but to develop discriminative capacity to filter out what is unimportant to facilitate safe driving.

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1. Introduction

Safe driving is predicated on attending to objects that are important in the environment, but also filtering out what is unimportant. For example, it is essential to process a child standing on the side of the road, but less important to note a garbage bin by the road. Failing to detect critical objects when driving are estimated to constitute approximately 5% of all crashes (Stutts, Reinfurt, Staplin, & Rodgman, 2001), and around 9% of crashes involving serious injury (Beanland, Fitzharris, Young, & Lenné, 2013). Research has investigated which qualities of the visual scene are important for capturing attention (McCarley, Steelman, & Horrey, 2014), and how performance is mediated by experience (Chapman & Underwood, 1998; Crundall et al., 2012; Crundall, Stedmon, Crundall, & Saikayasit, 2014; Underwood, Crundall, & Chapman, 2002). Relatively less research has been devoted to understanding the role of specific expertise – such as that demonstrated by emergency first responders – in managing attentional filtering when driving (Johnston & Scialfa, 2016). Identifying and describing differences in the attentional filtering of expert drivers is likely to be enormously helpful in the development of driver training programs.

The use of hazard detection or hazard perception tests has become ubiquitous in the driving literature to investigate an observer's ability to detect hazards and critical objects in a driving scene. However, hazard perception is a complex and multi-faceted process, which involves several stages. First, drivers must look at the location of a potential hazard, then they must detect it, and finally they must appraise it correctly to formulate an appropriate response (Crundall, Clarke, Ward, & Bartle, 2008). Hazard perception tests provide an overall measure of drivers' ability to appraise the hazard, but if a participant fails to respond correctly, it is unclear which stage of processing was inadequate. For this reason, complementary techniques have been adopted to explore driver's ability to detect expected or unexpected objects in the driving environment, such as change blindness (e.g., Beanland, Filtness, & Jeans, 2017; Galpin, Underwood, & Crundall, 2009; Harms & Brookhuis, 2016) and visual search tasks (e.g., Beanland, Lenné, & Underwood, 2014). These methods all focus on the "detection" stage of hazard perception, by placing potential hazards in full view. One potential issue is that in these paradigms, participants are explicitly instructed to seek out and identify objects or changes. This creates a slightly artificial experience, as participants respond to a greater number of hazardous objects than they would during real driving.

An alternative experimental technique is the inattentional blindness (IB) paradigm (Mack & Rock, 1998), which involves presenting an unexpected object in the participant's field of view. Because the critical stimulus of interest is unexpected, IB paradigms provide a nice complement to other paradigms in which the observer is deliberately searching for something. In a laboratory-based IB tasks, using abstract geometric shapes as stimuli, up to 100% of participants may fail to detect an unexpected stimulus on the screen if they are engaged in another task (Mack & Rock, 1998; Most et al., 2001). The exact rate of participants who experience IB will vary depending on task parameters and other factors such as the participant's age and expertise (Furley, Memmert, & Heller, 2010; Horwood & Beanland, 2016; Memmert, 2006).

In a driving version of IB, participants are presented with photographs of driving scenes and asked to make a driving-related judgement, such as assessing the safety of the driving situation. IB occurs when the participant fails to detect an additional object placed in the scene that has not been present in any of the other scenes (Pammer & Blink, 2013; Pammer, Bairnsfather, & Burns, 2015; Pammer, Sabadas, & Lentern, 2017). The participant is not told to look for an additional hazard; it simply appears as part of the driving scene while the participant is making other driving-related judgements. This could be considered analogous with real driving during which hazards sometimes occur unexpectedly, such as a child running out onto the road, or someone in a parked car suddenly opens a door toward oncoming traffic. The participant's ability to report the presence of an object is a good indicator of whether an object has attracted the participant's attention, and most importantly, IB tasks mimic looked-but-failed-to-see (LBFTS) errors (Pammer & Blink, 2013; Pammer et al., 2015, 2017).

1.1. Looked-but-failed-to-see-crashes and inattentional blindness

LBFTS errors involve a situation experienced by almost all drivers at some point, where they look at oncoming traffic for a clear manoeuver but fail to see an oncoming vehicle that was plainly in their line of sight. Sometimes considered an example of inadequate surveillance, looking but failing to see an oncoming vehicle has been attributed to 21% of crashes at intersections (Brown, 2002), 71% of surveillance errors made by elderly drivers (Cicchino & McCartt, 2015), and have been cited as one cause of crashes at rail level crossings (Rudin-Brown, George, & Stuart, 2014; Salmon, Read, Stanton, & Lenné, 2013). LBFTS crashes are also believed to be a major cause of incidents with bicycles (Herslund & Jørgensen, 2003) and powered two-wheelers such as motorbikes (ACEM, 2009; Clabaux et al., 2012; Pammer et al., 2017). Brown (2002) reports that most LBFTS incidents occur in the daytime under clear conditions, rather than at night-time. This is important as it suggests that LBFTS crashes are less to do with conspicuity and more to do with cognition; if a driver can look directly at a hazard in the driving situation, under clear, daylight conditions, and still fail to see it, then it implies that it is something about the way a driver thinks and approaches a driving situation that makes them more vulnerable to LBFTS crashes. If this is the case, then it stands to reason that a cognitive model offers the best way to understand LBFTS crashes, and subsequently mitigate the risk of them occurring.