



Visual processing in expert drivers: What makes expert drivers expert?

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ABSTRACT

The aim of this study is to measure some visuo-cognitive mechanisms of expert drivers, and compare them to experienced, competent and novice drivers as a way of gaining an understanding of how expert drivers might differ from non-expert drivers. Instead of driving-related stimuli, we used non-driving visual and cognitive tasks that theoretically should underlie good driving skills, such as scanning the environment for targets, tracking multiple objects, identifying unexpected objects and tendency towards intrusive thought patterns. This design should minimise the influence of top-down factors such as familiarity, allowing us to focus more on stimulus-driven influences. We demonstrated that expert drivers performed better than non-expert, novice and young-competent drivers in tasks designed to reflect on-task performance such as continuous performance and task-intrusive-thoughts. However, in visual search, noticing the unexpected object in Inattentional Blindness (IB), and multiple object tracking in IB, expert drivers were the same as the two younger driver groups. The results suggest that – in driving at least – expertise is qualitatively different from experience, and driving expertise may be partially derived from superior skill in underlying core visuo-cognitive constructs. This finding is important for understanding driver training programs, but also in understanding the ‘backward transference’ of expertise to underlying cognitive-perceptual networks.

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1. Introduction

Expert drivers afford road safety researchers a unique opportunity to understand some of the component skills in driving, such as (but not limited to) attentional shifting, filtering visual scenes for important information, visual tracking of dynamic stimuli, and sustained attention. By understanding what trained, expert drivers do differently from non-expert drivers on a range of basic visual tasks, we gain an understanding of the component skills underlying driving that might be most malleable and therefore useful to training novice drivers. Moreover, from the cognitive psychology perspective, demonstrating that visual differences exist between expert and non-expert drivers in tests that are decoupled from actual driving, has important implications for understanding transference of cognitive skill sets. Therefore, understanding how expert drivers differ from non-expert drivers in tasks of basic visual processing, might provide a crucial link in understanding the necessary visuo-perceptual skills required for driving, as well as understanding that all-important transition from novice to skilled driving.

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1.1. Expert driving

Expert drivers such as emergency service workers, tend also to be experienced drivers, in that a high degree of driver training typically co-occurs with a large number of 'hours-behind-the-wheel'. However, experience should not necessarily be used as a surrogate for expertise, in that one can have considerable driving experience, yet not be an expert. It has been suggested that in general, one of the differences between experience and expertise is the quality of feedback, such that expertise won't equate to experience if the feedback over time is poor (Duncan, Williams, & Brown, 1991). For example, Duncan et al., demonstrated that in some cases of driving skill, experienced drivers were worse than expert drivers, with greater skill-similarity between the novice and expert drivers than the experienced and expert drivers. This suggests that in terms of driving skill, the difference between experience and expertise might be the difference between quantitative and qualitative exposure, where experts should be qualitatively different from experienced drivers in terms of both driving skills and the cognitive tasks underlying them. Indeed, Shanteau, Weiss, Thomas, and Pounds (2002) suggest that "although there are undoubtedly instances where a positive relationship exists between experience and performance, there is little reason to expect this to apply universally. At best, experience is an uncertain predictor of expertise. At worst, experience reflects seniority – and little more" (Shanteau et al., 2002, p 254). Expertise is also less time-dependent. Whereas experience – by definition – requires time, expertise can develop through relatively shorter periods. For example, advanced driver training (e.g. one derived from police driver training), focuses on an explicit system of car control which improves different aspects of situational awareness. Walker, Stanton, Kazi, Salmon, and Jenkins (2009) suggest that after training, drivers improve the quantity of information perceived, the links between current and previous knowledge, and the number of driving techniques used, compared with a control group without training. In addition, the meaning and importance of old elements change, such that drivers have a new comprehension for the same information perceived, which may then help them better evaluate the current situation.

Thus, expert drivers may be qualitatively different from non-expert drivers in terms of attentional behaviour when driving. For example, police driving instructors are faster to respond to hazards compared to experienced drivers (McKenna & Crick, 1991), and demonstrate safer driver behaviour compared to non-police trained controls in driving simulator studies (Dorn & Barker, 2005a; Dorn & Barker, 2005b). In comparisons between the visuo-spatial processing of police pursuit drivers vs. novice vs. experienced drivers, expert drivers did not differ on hazard ratings or the number of hazards detected compared to control groups (Crundall, Chapman, Phelps, & Underwood, 2003). However electrophysiological measures indicated a significantly stronger reaction to hazards for police pursuit drivers. Police pursuit drivers also had a wider visual scan path and shorter fixations than young or control drivers, and spent more time fixating on potential hazards such as pedestrians, side roads and parked vehicles (Crundall, Chapman, France, Underwood, & Phelps, 2005). These findings are important because they suggest that emergency response workers drive in a different manner in terms of how they move their eyes around the world and characterise potentially hazardous objects.

The strength of the studies conducted thus far, is that they show differences between expert and non-expert drivers in driving-related environments, and the demonstration of differences between expert and non-expert drivers is ubiquitous throughout the road-safety literature. This is vital in demonstrating that there is in fact something qualitatively different in terms of the driving skill of expert drivers. However, what is intriguing from the psychological perspective, is whether visual processes such as visual tracking, search and target detection have improved *in general*, i.e., do experts generally get better at visual search, or is the improvement restricted to driving?

The aim of the current project is to look at some of the cognitive/perceptual factors that are important to driving, but to do so independently of the driving context. An experienced or expert driver, has had a lot of time 'behind-the-wheel'. This provides a natural confound, such that the differences that expert drivers may demonstrate in regards to core skills associated with driving, may be due to the familiarity of the driving situation, or more extensive semantic representations of the driving situation, rather than due to any intrinsic cognitive-perceptual differences between expert and non-expert drivers. Thus demonstrating differences between expert drivers and non-expert drivers on visuo-attentional processes in a non-driving context would provide good evidence of real differences between expert and non-expert drivers.

1.2. Visual and cognitive skills in driving

Driving a vehicle requires the development of highly sophisticated and dynamic visuo-spatial attention, and complex decision-making (Groeger, 2000). Some of the critical elements of visuo-spatial attention when driving include: scanning the environment to bring to awareness elements that need to be attended to, the detection of hazards, maintaining attention and managing distraction.

Almost all the qualities of visual attention in driving are predicated on how we move our eyes around the world to acquire information. Hazard detection and visual scanning research frequently go hand-in-hand as the researcher is able to determine whether a hazard has captured attention by looking at whether the driver has moved their eyes to fixate on it. Thus research into eye movements and scanning when driving has attracted significant focus (Shinar, 2008). For example, the predominant finding for young drivers is that they tend to have a truncated scan path compared to experienced drivers, such that they are less likely to take in more peripheral information, are less likely to scan mirrors and instruments than experienced drivers and their fixation durations differ from experienced drivers (Chapman & Underwood, 1998; Crundall & Underwood, 1998; Underwood, Crundall, & Chapman, 2002).

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