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Familiarity breeds contempt for the road ahead: The real-world effects of route repetition on visual attention in an expert driver

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ABSTRACT

The majority of journeys by car take place on familiar roads, with many routes being driven time and time again. This familiarity has been linked to mind wandering and reduced attention to specific elements of the visual scene (e.g. speed signs). The current study presents on-road eye tracking data from a driving instructor who drove the same route 28 times, incorporating two types of suburban roads, dual and multi-lane carriageways, and a country road. Data reveal a significant positive correlation between the number of times the same route is navigated and off-road dwell time across all five road sections. In addition, route familiarity was associated with decreasing dwell time on safety-relevant aspects of the road ahead in four out of the five sections. These data suggest that route familiarity can lead to undesirable changes in visual attention on real roads, even for expert drivers under observation.

1. Introduction

While most tests of driving skill or hazard perception involve drivers encountering a novel environment in videos, simulation or the real-world, the majority of the drives we complete are on routes with which we are familiar. In the UK, 15.3 million people report that they usually drive to work (ONS, 2013), many of whom presumably drive the same route twice a day, five days a week, potentially for many years. Repetition of a task leads to the automatization of its subroutines, with a reduction in conscious attention to the task (Schneider & Shiffrin, 1977). In many cases, this automatization is helpful. Novice drivers will eventually benefit from the freeing up of cognitive resources, as activities such as changing gear become automated and these resources can be allocated to other aspects of the driving task (e.g. Shinar, Meir and Ben-Shoham, 1998). However, researchers have argued that the development of such open-loop behaviour can render drivers insensitive to changes in the driving environment (e.g. Charlton & Starkey, 2013; Harms & Brookhuis, 2016), potentially leaving them vulnerable to hazards.

A deciding factor in whether automation of certain driving sub-routines is beneficial may lie in what the driver chooses to devote their spare attention to. In demanding conditions, as capacity is freed from operational, and perhaps even tactical demands, a driver can pay more attention to strategic problems ahead (e.g. mitigating potential hazards in the road ahead; Pradhan & Crundall, 2017). However, in undemanding conditions, this spare capacity may be redirected to less relevant aspects of the external world in an effort to maintain arousal (e.g. Wilde, 1982), or may even be directed inwards to task-unrelated images and thoughts (TUITS; Chapman, Ismail and Underwood, 1999), often called mind-wandering (Burdett, Charlton, & Starkey, 2016), day dreaming (e.g. Berthié et al., 2015) or driving without awareness mode (DWAM; Kerr,

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1991). Crucially for the current study, instances of driving without awareness are reported more often in relation to highly familiar roads, as well as under conditions of fatigue (Burdett et al., 2016), as if navigation of whole routes become automated. While this extreme argument for automation is unlikely (Groeger, 2000), the evidence that route familiarity reduces awareness is compelling. Given the importance of driving on familiar routes, experimental investigations of repeated-route driving are relatively limited, due to the resources required to familiarise participants with a route. However, simulator studies, in which participants drive parts of the same route on a number of occasions, have begun to indicate that there are measurable changes in driving performance as a route becomes well-practiced. Speed and lane variability have been seen to decrease across a number of free-drives (Charlton & Starkey, 2011). These changes might be indicative of better prediction of the physical road layout, meaning that fewer corrections are required, but this could also suggest that the drivers are less sensitive to the vagaries of on-road hazard levels., perhaps suggesting that drivers are less sensitive to the vagaries of on-road hazard levels. In a follow-up simulator study Charlton and Starkey (2013) had drivers undertake 20 sessions on the same simulated route and assessed their ability to detect changes across the number of sessions (and compared to a control group). They found that drivers' attention for changes in the driving scene (the removal and additional of buildings, the changing of road signs, etc.) diminished with increased route familiarity, suggesting that they were driving without awareness. Certain changes were still detected with high accuracy however, such as the removal of lane markings. Road markings are typically viewed peripherally in order to maintain lane position, and are thus used perhaps more implicitly. The removal of these cues may have thus degraded the otherwise automated task of steering, drawing attention to the absence of lane markings.

The decrease of attention to road-signs with increased route familiarity has been noted by other researchers (e.g. Harms & Brookhuis, 2016), but is this a problem? It is understandable that drivers should pay less attention to a sign that explains a dip in the road ahead, if they are already expecting the dip and therefore have no need to be warned (Charlton & Starkey, 2013). Problems arise however when changes to road layout result in the addition or modification of road signs that may be missed.

Even more concerning however is the possibility that route familiarity may influence the way we behave on the road. In a car following task, Yanko and Spalek (2013) found that on the fifth occasion of driving the same route participants followed the lead car more closely, braked more slowly in response to the lead cars' brake lights, and were slower to respond to pedestrians crossing the road, compared to a control group who had driven five different routes.

The above studies discuss results that have been obtained through simulated driving. This poses one clear possible confound: Drivers may be more willing to allow their minds to wander in a situation where the threat to their safety is only virtual. While it appears easy to accept that reduced attention to road signs should transfer from simulators to the real world (see Martens & Fox, 2007), are drivers really likely to pay less attention to safety–critical aspects of highly familiar roads when they risk injury or even death?

While such on-road studies of familiarity are extremely rare, there is some evidence that speed increases with route-repetition (Colonna, Intini, Berloco and Ranieri, 2016). Without a direct measure of how dangerously the participants were driving however, one could argue that this is a result of the driver better calibrating the demands of the road to their self-perceived skill level (though their participants' choice of speed often exceeded the posted limit). A harder finding to argue against is that of Rosenbloom, Perlman, and Shahar, (2007) who observed drivers on both familiar and unfamiliar routes, noting that dangerous behaviours and driving violations increased on the most familiar of roads. It is unclear however what mechanism lies behind such increases in risk-taking with familiarity.

The current study attempts to bridge the gap between simulator studies of inattention in familiar route driving and studies that suggest on-road behavioural changes. If drivers do become more inattentive on familiar routes on real roads, as suggested by the simulator studies, then this may provide one cause of increased danger on familiar routes. The experiment reported here looks at the effect of increasing route familiarity on an expert driver (an experienced ADI) on a real-world driving route. Specifically, we expand on recent findings by looking, not just at whether the driver does or does not attend to specific signs or markings, but at how they allocate their visual attention across the driving scene and how this changes with exposure. This is examined across five different driving environments, to establish whether different driving demands may affect how attention changes with familiarity.

2. Method

2.1. Expert driver

The same driver was used in all of the drives. To examine the effect of route repetition for a very experienced driver, we recruited a fully-qualified UK Approved Driving Instructor. The instructor was female, aged 45 and had been a practicing ADI for 8 years. The instructor was paid £20 for each drive.

2.2. Apparatus

SMI Eye Tracking Glasses (ETG2), sampling binocularly at 60 Hz and used a forward facing camera recording at 60 frames per second. Fixations were automatically overlaid onto the recorded video from the forward-facing camera by the eye

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