Take me home, country road: Comparative optimism, mind-wandering in an automated simulator

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ABSTRACT

Mind wandering while driving has been shown to factor in distracted driving, a critical cause of road crashes in Australia. With the implementation of autonomous vehicles onto the road network proposed as occurring in the near future, lies the potential for increased mind wandering, as cognitive engagement in driving is lessened. Part of the potential appeal of such vehicles is the ability to perform non-driving related tasks while in an automated driving mode. This study presents an analysis of drivers' subjective experience of two prolonged drives in a driving simulator set to automated driving. Half of the participants were permitted to engage in non-driving tasks, to simulate potential future features. Participants provided summaries of their experience and preparedness to take-over control following two critical events. This study explores the themes of participants' subjective experience and how this relates to mind-wandering, comparative optimism of driving behaviour, and readiness to respond to take-over events.

KEYWORDS

Automated vehicles, comparative optimism, non-driving related tasks, subjective experience, driving simulator

Introduction

Advancements in artificial intelligence, machine learning, and automation technology over the last 30 years as resulted in substantial changes to the technology landscape and by extension the operation of automotive vehicles (de Winter et al., 2014; Merat et al., 2014; Meyer et al., 2017). The release of autonomous vehicles into the road environment has been highly promoted and accompanied with claims of allowing the driver to engage in other non-driving related tasks such as using their mobile phones, working, or even sleeping. Level 3-4 autonomous vehicles require the driver to maintain a degree of environment maintenance for the duration of the drive and be physically and cognitively prepared to take over the if necessary.

The engagement of 'Autopilot' modes reduces the driver's physical and cognitive responsibilities (Endsley, 2017). Such features have the potential to significantly reduce the number of motor vehicle crashes and fatalities by supporting the driver with pre-emptive warnings. However, if the driver is not equipped to take over from the vehicle when prompted, the outcomes have been shown to be serious and even fatal.

This presents an inherent contradiction, with the driver being in a position to respond to the driving environment compared to being 'freed-up' to engage with other tasks. While requiring drivers to remain focused and attentive towards the road, while not driving the vehicle, introduces human factors risks like fatigue, reduced situation awareness, and increased distractibility. These factors have been demonstrated to impact perception, attention and decision-making ability while driving (Guo, et al., 2016).

While physical distractions such as mobile phone use, entertainment systems, and eating have been studied extensively in research, inattention or distraction due to mind wandering does not feature heavily in the road safety literature. Mind wandering occurs without the present of an external stimulus, and is defined as when conscious mental focus deviates to matters unrelated to the task at hand (Smallwood et al., 2003, Smallwood & Schooler, 2006). Research by Burdett and colleagues (2016; 2019) has explored this occurrence in everyday manual driving. Indicating its high prevalence, prevailing even when aware of the phenomena. Mind wandering was found to be more common in unfamiliar environments, when fatigued and when on longer drives (Burdett et al., 2016; 2016). With the advances associated with automated vehicles seen to be a benefit to issues such as fatigued, this would potentially increase the opportunity for mind wandering if sufficient cognitive load is not maintained.

Comparative optimism encompasses the notion that individuals consider themselves to be more skilful and less susceptible to risk than the average person of the same age (Gosselin et al., 2010; Harré & Sibley, 2007; Harris & Middleton, 1994; Shepperd et al., 2002). Comparative optimism is pervasive across age groups, and it is considered that this would extend to participants' perceived ability to monitor an autonomous vehicle.

This paper explores the themes of the participants' subjective experience of an automated vehicle across two different roadways (rural and city); and between subjects' comparison of the engagement of a non-driving related task. The paper considers how this relates to their experience of mind-wandering, comparative optimism of driving behaviour, and their preparedness to two take-over events.

Method

Forty-four participants, (25 female, 19 male) aged between 18 – 36 years ($M = 23.52$, $SD = 4.84$) were recruited the University population. Although external advertising was used, all participants were undergraduate psychology students, receiving research awareness credit points as part of their involvement. Potential participants were screened for susceptibility to simulator sickness. Participants held either a provisional ($n = 17$) or open driver licence ($n = 27$), and therefore were able to drive on their own. All participants drove at least once a week, with most driving occurring on suburban roads (40-50km/hr) and urban roads (60km/hr).

The study incorporated a 2 x 2 mixed design. Roadway was a within-subjects variable including city and rural roadways. The engagement with non-driving related tasks was a between subjects variable, with participants randomly, and evenly allocated to allowing the use of non-driving related tasks while in automation mode, or not. The experiment was part of a larger study testing

This study used a STISIM M300WS Driving Simulator at The University of Newcastle, Callaghan Campus, running a beta version of STISIM Drive 3. The automation software allowed drivers to experience highly automated driving modes by initiating self-driving mode in which the automation offers adaptive cruise control, monitoring both longitudinal and lateral movements. The driving simulator is considered to be medium fidelity (Wynne et al., 2019); encompassing multiple screens and a broad field of view, "arcade" vehicle controls with pedals, seat, and steering wheel, as well as a motion platform. An image of the visual environment and the simulator appear as Figure 1 and 2 respectively.

Figure 1: Example of Typical Road Scape Scene During Experiment

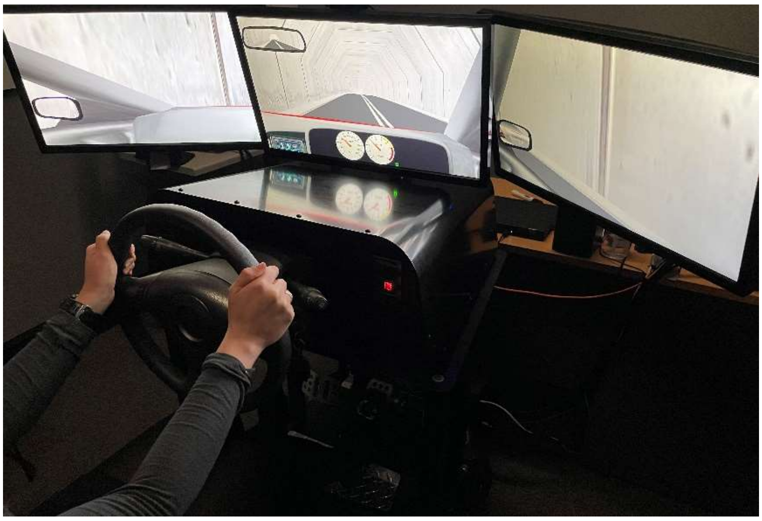

Figure 2: Visual Depiction of Simulator Configuration.

Note. Not visible, motion base and arcade seat.

Prior to the testing session, all participations completed a basic demographics and driving experience questionnaire. Upon arrival at the session and introduction, participants were given a verbal brief regarding study instructions and the capacity of the simulator's self-driving mode. Participants experienced two practice trials approximating five minutes each; the first to familiarise themselves with the physical simulator and the displayed road scape with the second to familiarise themselves with self-driving mode and how to initialise and disengage it safely. During this trial, participants were issued a takeover request from the system during a non-critical point. Those participants assigned to the non-driving related task condition were advised they could use which ever devices or materials they brough with them to the testing session when the vehicle was in automated driving mode.

The main trials ran for approximately 50 minutes each and were counterbalanced (rural or city). Following a prolonged period of automated driving, self-driving mode was automatically disengaged during a critical event, and participants were required to take over control of the vehicle. The take-over-requests consisted of a visual and auditory prompt instructing participants to takeover manual control. One critical event consisted of posted roadworks with workers appearing around heavy machinery. The other event where self-driving mode was disengaged consisted of a car pulled over flashing hazard lights, fallen boxes across the left-hand lane and pedestrians over on the other side of the road. After their main trial had concluded, participants completed an interview on their subjective experience, topics of mind-wandering and what strategies were used to maintain an alert state. Participants were also asked of their preparedness to take back control of the vehicle if, and when, required. The timeline of events appears as Figure 3.

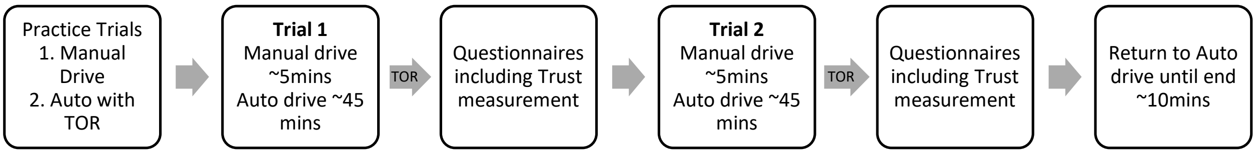

Figure 3: Timeline of Events for Testing Session.

Note. Sessions were counterbalanced for roadway (rural versus city).

Preliminary Results and Discussion

Preliminary analysis of 30 participants of equal non-driving related task conditions has been performed, with the remaining analysis to be conducted imminently. From these analyses, mind wandering was found in both conditions. The content of the mind-wandering, however, was more varied when non-driving related tasks were not permitted. At an individual level, participants reported having varied their thoughts more over the time, and one indicated it was easy to drift off with no engagement. Those able to use non-driving related tasks felt they were able to maintain engagement with the driving task, and the content of their mind wandering was focused on the task they became engaged with (e.g., phone call or social media).

The preliminary results suggest some mental engagement in the driving task was maintained while the use of a non-driving related task, however the impact on driving behaviour and time taken to respond to this request will need to be explored.

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