Accident Analysis and Prevention 122 (2019) 76–84

Contents lists available at ScienceDirect

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap

Mind wandering during everyday driving: An on-road study

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ARTICLE INFO

Keywords:
Mind wandering
Everyday driving
Attention
Context regulation
Thought sampling

ABSTRACT

This study was an investigation into mind wandering during everyday driving, and its association with crash patterns. We selected a 25 km route on urban roads for analysis of crashes, and an on-road study of mind wandering by a sample of drivers familiar with the route. We analysed reported crashes on the route over a five year period from New Zealand's crash database. For the on-road study a researcher accompanied 25 drivers on the route, asking them what they were thinking about at 15 predetermined road sections. The road sections were selected to include a range of different speed limits and traffic volumes as well as roundabouts, priority intersections and midblocks. Thought samples were categorised as either mind wandering or driving focus, and triggered by the senses, or internally. The frequencies of mind wandering at different road sections on the route were compared to the frequencies of reported crashes along the same route over the preceding five years. Results showed that although all drivers reported mind wandering, it was more likely to be reported at slower, quieter, less complex road sections. Overall, more crashes were reported at priority intersections and midblocks than at roundabouts, but the crash rate (per road section) was higher at roundabouts, where mind wandering was least likely to be reported. These findings suggest that although drivers' minds wander constantly, driving focus is commanded in demanding situations and in response to the actions of other road users. While mind wandering is ubiquitous, drivers are least likely to report mind wandering at locations showing the highest crash rates. More work is needed to test these findings and to provide direction for road safety interventions.

1. Introduction

Mind wandering (MW) is a common experience in everyday life. People readily report MW, defined as task-unrelated thought (Smallwood and Schooler, 2006) during both laboratory situations and daily activities (Mooneyham and Schooler, 2013; Smallwood and Schooler, 2015). Experience sampling studies, in which participants are interrupted during their daily life and asked to report their thoughts, have found that MW is reported on between one quarter and half of all responses (Killingsworth and Gilbert, 2010; Song and Wang, 2012; Spronken et al., 2016).

MW is also common during driving. We have previously asked drivers how often they experience MW across a range of different driving situations, such as on familiar and unfamiliar roads, and in their own or an unfamiliar car. Our results revealed that all drivers report experiencing MW at least occasionally, and we found that drivers were most likely to experience MW driving their own car on familiar roads (Burdett et al., 2016).

The link between MW and route familiarity has been corroborated by others. With repeated practice on a simulated route, drivers report more MW (Yanko and Spalek, 2013), and show an increasing tendency to report "'driving without thinking about it', 'zoning out' or 'going on autopilot'" (Charlton and Starkey, 2011, p131). Drivers also report reduced awareness during familiar drives such as the daily commute (Handy et al., 2005; Papp et al., 2004; Steinberger et al., 2016). Respondents in a survey by Berthié et al. (2015) estimated that their mind wandered for an average of 35% of the time during their most recent (real-world) drive, but if that drive was a commute, they were more likely to report a higher proportion of time spent MW.

In an earlier study we explored how drivers experience MW during their daily commute, given that it appears to be the drive where MW is most likely to be experienced. Eleven female participants were asked what they were thinking about (a descriptive experience sampling procedure) between four and six times across each of ten drives per participant. Drivers reported MW on 63% of the 587 thought samples (Burdett et al., 2018a). These findings demonstrated that MW is pervasive during the most familiar of everyday trips, and is not an exceptional or unusual experience.

The preceding section highlights that MW is a common experience during everyday driving but its link with crashes is unclear. Intuitively it seems that MW during driving is probably 'unsafe'. Indeed, a small but growing body of research points towards a causative link between

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https://doi.org/10.1016/j.aap.2018.10.001
Received 24 April 2018; Received in revised form 1 October 2018; Accepted 1 October 2018

MW and crash risk. He et al. (2011) suggested that because MW is associated with performance decrements such as narrowed gaze patterns in driving simulation, it "might easily contribute to… …increased crash risk" (p18). In a simulated car-following task Yanko and Spalek (2013) measured response times to braking vehicles and pedestrians crossing as a function of drivers' reported MW and concluded that MW affects drivers' performance and "may therefore lead to higher crash risk" (p260). Meanwhile, Galéra et al. (2012), who interviewed drivers involved in a crash and asked them to recall what they were thinking about before the collision, resolved that MW is a dangerous and undesirable state which is "threatening safety on the roads" (p1). However, there are several reasons to question the veracity of the conclusions drawn from these studies. They all failed to account for the fact that drivers experience MW during normal everyday trips, which do not result in crashes. This is a problem because evidence from everyday driving suggests that MW is not unusual, but commonplace. If everyday driving involves so much MW, it is unclear which drivers face increased or higher crash risk, and in what situations their safety is being threatened. In addition, there is limited understanding of the association between MW during real driving, and crash patterns, so laboratory-based research that ignores everyday drivers' experiences of MW cannot reasonably be generalised outside of its experimental setting.

It is important to continue investigation into MW and crash risk within an appropriate context (i.e., on roads). There are differences in how people think about a task, and therefore how they experience MW, between the laboratory and everyday life (Kane et al., 2017). During simulated driving studies, the setting as well as the instructions given are likely to affect the way participants think, which is problematic if results about MW are to be generalised beyond the laboratory. For example, participants in the study by He et al. (2011) were "told to keep their attention on the driving task as much as possible" (p15). Instructions concerning attention are not explicit during everyday driving, and our results suggest that drivers do not set out with sustained driving task focus as an obvious goal (Burdett et al., 2018a). Therefore, continued investigation of both crashes and MW in a naturalistic driving context is important if we are to understand how MW is experienced during driving, so that we can work towards interventions that improve road safety.

In another study, we explored a potential link between MW and crash risk (Burdett et al., 2017), building on the evidence that MW is most frequently experienced on familiar roads (Berthié et al., 2015; Burdett et al., 2016). Our research into the 'close to home effect' demonstrated that for New Zealand drivers, crashes are over-represented on roads within 10 km (6 miles) of home, which are probably more familiar to drivers, on average, than roads further away (Burdett et al., 2017). Even though roads close to home are where most driving happens, New Zealand drivers are more likely to have a crash there, mile for mile driven, than on a road further away.

MW and crashes are both relatively common in familiar places, so we explored crash data on familiar roads close to home in more depth (Burdett et al., 2018b). We analysed the errors involved in crashes at different distances from home, differentiating between intentional violations, which are the result of intentional but illegal or dangerous behaviour; and lapses of attention, which are typically unintentional and may be related to MW. We found that in New Zealand, crashes close to home are commonly related to lapses of attention, whereas crashes related to intentional violations are less common. We also explored the places where crashes occur, and found that more crashes close to home happen at relatively simple midblocks (the stretches between intersections) on low-speed (urban) streets than at complex places such as roundabouts (Burdett et al., 2018b). However, it is unclear whether crashes are common at midblocks simply because they make up most of each drive, or whether the pattern may be due in part to drivers' tendency to experience MW in places where nothing risky or demanding usually happens. To date, there have been few studies of how or whether drivers regulate their attention in response to changing demands across a drive on real streets. The evidence falls short of establishing any links between MW and crash risk close to home.

As well as building on a potential link with crash risk, studying MW and driving can inform theories of driver behaviour and general theories of MW. Theories of driver behaviour have for many years assumed that drivers apply conscious focus to maintain a feeling of comfort or safety (Fuller, 2005; Fuller et al., 2008; Lewis-Evans and Rothengatter, 2009; Wilde, 1982, 1998). For example, Fuller et al. (2008) suggest that drivers consciously adjust their speed to stay within some subjective level of comfort.

In contrast with many driver behaviour models, there is growing evidence that the driving task rapidly becomes proceduralised, and does not command conscious focus much of the time (Charlton and Starkey, 2011, 2013; Harms and Brookhuis, 2016). Evidence that many aspects of the driving task (such as maintaining an appropriate speed) happen automatically and not with conscious intent led Charlton and Starkey (2011, 2013) to develop the tandem model of driver behaviour. The tandem model suggests that most of the time, an unconscious monitoring process governs safe behaviour. Conscious driving task focus is engaged only temporarily, typically in response to an unfamiliar or demanding situation. The model provides a rationale for why drivers report MW so frequently during familiar trips, because they are well-practiced and therefore less demanding than an unfamiliar trip on a similar route. More research into where drivers are relatively more or less likely to report MW, and how those situations are associated with crash risk, could help to build on models of driver behaviour.

Evidence that has informed general theories of MW also suggest that its likelihood of occurrence is linked with both task familiarity and momentary demand, but to date few studies have explored MW variation in naturalistic contexts to advance understanding of why and how MW happens. Smallwood and Andrews-Hanna (2013) proposed the Context Regulation Hypothesis (CRH), which suggests that MW is more likely in familiar or less demanding situations because they can be successfully negotiated without applied task focus. The CRH is based on evidence that MW is more commonly experienced in familiar situations of low demand, albeit most studies used to derive the theory were in laboratory settings (Smallwood and Andrews-Hanna, 2013). Driving is a useful context in which to explore and potentially build on this hypothesis, because it is familiar to many people, while also comprising situations of varying demand.

In the current study we compared crash locations from the five-year crash history of a 25 km urban road route to the locations where a sample of drivers reported MW as they drove the route with us. The route comprised situations of varying demand, such as busy intersections and quiet mid-blocks. We first examined how crashes are distributed according to the different road situations (and varying demands) on the route using New Zealand's national database of reported crashes. Second, we explored MW on the same 25 km route by recruiting drivers familiar with the route, and asking them what they were thinking about at predetermined locations. Overall we set out to compare the locations of reported crash numbers with the locations of MW on familiar urban roads.

2. Methods

2.1. The route

A 25 km road route around Hamilton City, New Zealand, was selected for a study of reported crashes, and an on-road study of drivers' reported MW (Fig. 1). The route was selected to include a range of different speed limits, roads with different traffic volumes, and a variety of intersections and midblock sections (lengths between intersections). Signalised intersections were excluded from both the study of crashes and from the on-road study of drivers' reported MW.

For the analysis of reported crashes, the route was divided into road sections with different characteristics. There were 17 roundabouts and