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# Not all minds wander equally: The influence of traits, states and road environment factors on self-reported mind wandering during everyday driving

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ABSTRACT

Inattention is a road safety problem, but few studies have focused specifically on mind wandering during everyday driving. This paper explores differences in self-reported mind wandering according to driver demographic characteristics (including age and gender), cognitive traits (such as tendency toward cognitive failure or mindful attention), states (such as feeling tired or stressed) and road environment factors (such as route familiarity). Five hundred and two participants (113 male, average age 44.4 years, *SD* = 14.0 years) completed a series of questionnaires (Mindful Attention and Awareness Scale (MAAS), Cognitive Failures Questionnaire (CFQ) and Driver Behaviour Questionnaire (DBQ)), as well as study-specific questions about mind wandering during different personal states and across a range of road and traffic situations. All respondents reported mind wandering during driving at least some of the time. Mind wandering was more likely to be reported on familiar roads than on unfamiliar roads and when drivers are tired. Drivers who reported relatively more mind wandering were younger, reported less mindful attention in daily life, more cognitive failures, and more driving violations and lapses. Together, the findings suggest that mind wandering is common in everyday driving, however any link with crash risk remains unclear. Future research using self-report and naturalistic methods could provide more insight into relationships between mind wandering, error and crash risk.



## 1. Introduction

The effects of many different types of distraction on driving performance have been well documented. For example, several studies have found that mobile phone use while driving is relatively unsafe (Caird et al., 2008; Charlton, 2009; Lamble et al., 1999). Other distractions, such as manipulating a car stereo or eating while driving have been studied naturalistically by analysis of in-car video (Klauer et al., 2014; Sayer et al., 2007). However, inattention where there is no overt external stimulus – the driver is simply not thinking about driving – has not been extensively studied. This is despite the fact that over the last decade there has been an increase in research addressing the nature and influence of task-unrelated thought, or mind wandering (MW) generally, across a range of everyday and laboratory situations (for a review see Smallwood and Schooler, 2015).

MW occurs when conscious focus is on matters unrelated to task-related information perceived by the senses (Smallwood et al., 2003; Smallwood and Schooler, 2006). It is enabled by 'perceptual decoupling' which allows two processes to happen simultaneously (Schooler et al., 2011). First, a task and its ongoing sensory and physical demands can proceed without conscious focus, and second, consciousness can roam among all manner of topics. Research by Charlton and Starkey (2011, 2013) into the effects of extended practice supports this idea and suggests that a high degree of automaticity is often present during everyday driving on familiar routes. While this leaves drivers free to focus on other thoughts, it also appears to result in a degree of inattention blindness and change blindness (Charlton and Starkey, 2011, 2013; Martens and Fox, 2007).

One reason that MW during driving has not been studied extensively may be that it is inherently difficult to measure or observe, compared to overt distractions like mobile phones. To date, the small number of laboratory studies that have examined MW and driving have reproduced findings from other laboratory-based studies; its reported frequency increases with practice (Yanko and Spalek, 2014) and in situations of relatively low task demand (He

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et al., 2011). Although not a study of MW, positive correlation has been found between self-reported cognitive failure in daily life, and driving-related lapses of attention (Pearson's r = 0.71) (Roca et al., 2013).

MW has been found to be a common experience across a wide range of everyday tasks. Using an experience sampling procedure in which participants were asked to report their thoughts during their daily lives, Killingsworth and Gilbert (2010) found that people reported MW for 47% of the time on average. Other studies using techniques such as fMRI have found that MW is reported more often during well-practiced tasks that do not require continual focus, such as simple laboratory tests of sustained attention (Kane et al., 2007; McKiernan et al., 2006), and that it increases with task practice (Teasdale et al., 1995).

As well as the relative familiarity of the task, demographic characteristics such as age and cognitive traits such as tendency toward cognitive failure also appear to influence reported MW frequency. For example, older people are less likely to report MW than younger people (Giambra, 1989; Jackson and Balota, 2012; McVay et al., 2013). It has been suggested that this may be due to generally lower incentives for task-unrelated thought in older people, or because MW studies are often carried out on university campuses where there are more opportunities for task-unrelated cues to trigger MW in younger participants (McVay et al., 2013). To date, these findings have not been replicated in relation to MW during driving.

Individual traits associated with executive function and executive control (intentional control of attention and action; Badgaiyan, 2000) also appear to play a role in MW frequency. McVay and Kane (2010) suggested that MW may represent a failure of executive control to inhibit task-unrelated thoughts and therefore, MW may be related to a general propensity toward cognitive failure. Given the putative role of executive function in MW, factors that impair executive control, such as fatigue and stress could also influence MW (Eysenck et al., 2007; McVay and Kane, 2010). More MW has been reported when participants were tired (Kane et al., 2007), or had consumed alcohol (Sayette et al., 2009), however the relative influence of momentary states, cognitive traits and other task factors on reported MW has not been explored in depth during driving, where there can be serious consequences if task performance is compromised.

Like any cognitive process, the way that MW is measured can shape the conclusions drawn about its nature and influence. Methods to measure MW include: asking people to report their thought content (through real time sampling, or retrospectively); infer task focus from performance measures of attention-demanding tasks; and through neuroimaging procedures such as fMRI. Findings from fMRI studies have advanced understanding of the particular brain regions and networks activated when the mind is engaged in some focused task, compared to the restful 'wandering' state involving perceptual decoupling (see for example Gruberger et al., 2011). However, these neuropsychological studies have not yet provided insight into the nature of environmental triggers likely to initiate a change between task focus and MW during performance of a complex task. In part this is because fMRI equipment renders the method impractical for direct study of any aspect of cognition during an everyday activity such as real-world driving (Brookhuis and de Waard, 2010).

The use of thought sampling also has limitations. Interrupting people during performance of any task is intrusive and therefore likely to alter their natural thought patterns. Furthermore, asking a participant to recall their thought content can only capture that component of their attention of which they have been aware (Schooler and Schreiber, 2004). MW can take place without a person's awareness, a so-called 'zone-out', in contrast to task-unrelated thought pursued with intent: a 'tune-out' (Smallwood et al., 2007).

As an alternative to real-time thought sampling, asking people to report their general tendency toward MW retrospectively (for example, with a questionnaire) is not intrusive and can provide insight into differences between individuals, at least in terms of what they recall. Berthié et al. (2015) used a retrospective questionnaire to explore individual and road environment influences on MW frequency during driving. Participants were asked to estimate the proportion of their most recent trip that they spent MW, and how many distinct MW episodes they recalled. Out of 128 participants, 109 (85.2%) reported at least one MW episode. These participants reported MW for an average of 34.7% of the time during their most recent trip, which took place an average of eight hours prior to them completing the questionnaire. Drivers were more likely to report MW if they drove more than 50 km per week on average; and if their most recent trip was a commute to work. There were no noteworthy relationships found between drivers' self-reported proportion of time spent MW during their most recent drive, and age, gender, route familiarity, or prior crash involvement (Berthié et al., 2015).

Berthié et al. (2015) demonstrated the usefulness of a retrospective questionnaire to study MW, and the study supported theoretical predictions that MW is more likely to be reported when driving is well-practiced – that is, by drivers who travel more than 50 km per week or during the commute from home to work (Berthié et al., 2015). They did not, however, provide any insight into the influence of underlying cognitive traits (e.g., executive control) and they were limited to a relatively small sample of drivers' experiences on a single trip. The research could be usefully extended with more information about the incidence of MW during everyday driving, including its variation between individuals and across different road environment situations.

Other studies using questionnaire methods have also explored links between cognitive traits and driving behaviour. Ledesma et al. (2010) developed a questionnaire to study links between error and lapses of attention during driving. The 19-item questionnaire included items indirectly or implicitly related to MW such as "When I head toward a known place, I drive past it for being inattentive" and "For a brief moment, I forget where I am heading to". Ledesma et al. (2010) found that the questionnaire score was not correlated significantly with age or gender, and there was no link between tendency to report lapses of attention and previous injury-crash involvement. Their main finding was that it is possible to study attention-related driving errors using questionnaire methods (Ledesma et al., 2010).

Given that crashes generally and injury crashes in particular are very rare, it is difficult to prove a direct relationship between a subjectively measured phenomenon such as MW and crash risk. However it may be useful to approach the important, broader question of inattention and crash risk through study of self-reported errors and MW. Although previous studies have found no particular link between reported MW tendency and previous crash involvement (Berthié et al., 2015; Ledesma et al., 2010; Qu et al., 2015), its frequency might correlate with driving error.

The notion that drivers are more likely to crash close to where they live also provides some rationale for research into links between attention and driving. A handful of studies have explored crash risk close to home. The main finding to date is that a large proportion of crashes happen within some relatively short distance of a driver's home address (Abdalla et al., 1997; Malek et al., 1990). If crashes are overrepresented relative to travel on roads close to home, it may be that the consequence of reduced conscious focus on familiar roads is that potential hazards are more likely to be overlooked.

In summary, despite gaps in understanding, research suggests that MW is probably common during everyday driving; that it is likely to increase with practice and on familiar roads; and