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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

Table 1
Descriptive statistics for questionnaire responses. MAAS = Mindful Attention and Awareness score; CFQ = Cognitive Failures Questionnaire score; $DBQ_{v,av,l,m}$ = Driver Behaviour Questionnaire (violations, aggressive violations, lapses, mistakes) subscale scores.

	N	Mean	SD
MAAS	501	4.20	0.76
CFQ	485	1.54	0.49
DBQ_v	466	4.87	3.32
DBQ_{av}	466	3.70	2.77
DBQ_l	466	7.52	3.96
DBQ_m	466	7.52	2.96

Responses were averaged across 15 items (MAAS: 6-point Likert scale from 1 (almost never) to 6 (almost always)); 25 items (CFQ: 5-point Likert scale from 0 (never) to 4 (always)); or summed across 6 items (DBQ_v, DBQ_{av}) or eight items (DBQ_l; DBQ_m) (6-point Likert scale from 0 (never) to 5 (all the time)).

that reported MW frequency is likely to vary among the driving population. However, to date these suggestions have not been substantiated with data from drivers themselves. The purpose of this study is to determine whether or not theoretical assumptions about MW and driving are supported by the frequency and circumstances of its occurrence according to drivers' self-reports. This study addresses two questions in particular:

1. Whose mind wanders during driving: How do driver demographic characteristics and cognitive traits predict tendency to report MW, generally?
2. In what types of driving situations and personal states is MW most and least likely to be reported?

2. Method

2.1. Participants

Valid questionnaires were returned by 502 participants (113 male). Participants had an average age of 44.4 years (range 18–85 years, SD = 14.0 years), with an average of 23.1 years with a full drivers' licence (range 0–70 years, SD = 15.3 years).

Ethical approval for the study was granted from the School of Psychology Research and Ethics Committee at the University of Waikato. Participants with a full driving licence were recruited to complete an online questionnaire, through advertising on the intranet of large organisations, on social media, through word of mouth and by mail drop. The large organisations were local government and civic offices based in the Waikato Region, New Zealand, which includes the city of Hamilton (population 140,000) and a rural area including smaller towns and countryside. The online questionnaire link was also distributed on social media. It is likely that participants were a mix of employed and unemployed people, students, and retired people from cities, smaller towns and rural areas across New Zealand. A paper version of the questionnaire was also distributed by post to addresses in a residential suburb of Hamilton, New Zealand. The paper version was included to recruit more older participants, and to test for bias in a sample recruited entirely online.

2.2. Materials

The purpose of the questionnaire was to find out how demographic characteristics, cognitive traits, momentary states and road environment characteristics relate to the tendency to report MW during driving. The survey contained three existing questionnaires as well as new questions related to MW in various driving situations. The three existing questionnaires were the Mindful Attention and Awareness Scale (MAAS) (Brown and Ryan, 2003), the Cognitive Failures Questionnaire (CFQ) (Broadbent et al., 1982), and the Manchester Driver Behaviour Questionnaire (DBQ) (Reason et al., 1990). The driving situations questions asked how task factors (such as a familiar rural road or an unfamiliar vehicle) and personal states (such as when driving tired or stressed) affect MW frequency during driving.

2.2.1. Mindful Attention and Awareness Scale (MAAS)

The MAAS was included to describe participants' general tendency toward mindful attention because it assesses natural propensity to focus on the current moment (Brown and Ryan, 2003). It has fifteen items and a six-point Likert response scale ranging from 1 (Almost always) to 6 (Almost never). Higher average scores indicate higher propensity of an individual toward mindful attention and awareness in their daily life. The MAAS is widely used and has good internal consistency (Cronbach's alpha = .87, Brown and Ryan (2003)).

2.2.2. Cognitive Failures Questionnaire (CFQ)

The CFQ assesses an individual's propensity to make lapse-type errors of memory, attention and motor control (Broadbent et al., 1982). Lapses are defined as an error resulting from unintentional action. The CFQ includes 25 questions with a five-point Likert response scale from 0 (Never) to 4 (Very often). A higher average score is indicative of a higher frequency of cognitive failure in everyday life. The CFQ is well-known and has good internal consistency (Cronbach's alpha = .91, Wallace et al. (2002)).

2.2.3. Manchester Driver Behaviour Questionnaire (DBQ)

The DBQ (Reason et al., 1990) asks about subjective experience of driving error, distinguishing between mistakes, violations, aggressive violations and lapses (Özkan et al., 2010; Reason et al., 1990). The 28 items of the DBQ include some questions related to MW, for example "How often do you realise that you have no clear recollection of the road along which you have just been travelling?". The DBQ subscales have six items (violations and aggressive violations) or eight items (lapses and mistakes) each. Each question has a six-point Likert response scale ranging from 0 (Never) to 5 (All the time). The DBQ has been used across a wide range of driving-related research and shows good internal consistency (Cronbach's alpha range.72–.84, Parker et al. (1992)).

2.2.4. Driving situations questions

As well as demographic questions (age, gender, years with a full drivers' licence and average number of kilometres driven per week), participants were asked about MW during driving. MW was defined for participants as "any time you are thinking about something that has nothing to do with driving, for example something you were doing before driving, something you will do later, thinking about people or a particular person, or thinking about what you might have for dinner." To find out about MW in different driving situations, participants were asked to answer the statement "During this situation, my mind wanders. . ." for fourteen questions, using the same six-point Likert scale as used for the DBQ: 0 (never); 1 (hardly ever); 2 (occasionally); 3 (quite often); 4 (frequently); 5 (all the time). The driving situations included eight road environment settings, two vehicle factors and four personal states. These questions asked about a driver's tendency to experience MW based on road and vehicle factors and personal states that generally prevail for a significant portion of any particular trip. Items were selected to represent a range of typical, everyday road environments and personal states that might reflect different rates of MW during driving.

One of the settings posed in the MW questions ("In the car that I drive most often (e.g. my own car)") was used as the primary indicator of MW during driving. This question was selected because it

Table 2
Descriptive statistics for MW questions ($N = 450$).

	Mean	SD
1 On an *urban* or *city* route that I have driven many times	2.27	1.19
2 On a *rural* or *country* route that I have driven many times	2.31	1.22
3 On a *motorway* that I have driven many times	1.94	1.25
4 On an urban or city route that I have *never* driven on before	0.74	0.82
5 On a country route that I have *never* driven on before	0.80	0.90
6 On a motorway that I have *never* driven on before	0.75	0.87
7 On a long drive (lasting more than an hour) when I am not following any other traffic	2.16	1.18
8 On a long drive (lasting more than an hour) when I am constantly in a line of traffic	1.64	1.27
9 In a car that I don't usually drive (e.g. a rental car)	0.96	1.03
10 In the car that I drive most often (e.g. my own car)	2.27	1.22
11 When I driving while anxious or stressed, for example before an important meeting or appointment	2.06	1.24
12 When I am diving tired, for example at the end of a busy day	2.25	1.17
13 When I am driving under pressure because I am running late	1.75	1.25
14 When I am driving while happy and relaxed	2.05	1.25

The MW responses were to the question 'In this situation, my mind wanders. . .' on a 6-point Likert scale: 0 (never); 1 (hardly ever); 2 (occasionally); 3 (quite often); 4 (frequently); 5 (all the time).

represents everyday driving, independent of road and traffic characteristics or personal states. This indicator question was used to compare general tendency to report MW to demographic characteristics (age and gender), cognitive traits (MAAS and CFQ scores) and to self-reported rates of driving-related error (DBQ scores).

2.3. Data analyses

One-way ANOVAs comparing responses from those who completed questionnaires on paper ($n = 19$, 7 female, mean age = 60.27, $SD = 21.91$) and a subset of online respondents, matched for age and gender ($n = 19$, 7 female, mean age = 55.92, $SD = 19.46$) showed no significant differences across the MAAS, CFQ or DBQ subscale scores (all $ps > 0.06$; all $\eta_p^2 < 0.010$). Therefore, paper and online questionnaire responses were pooled for subsequent analyses.

Descriptive statistics were recorded to summarise responses to the standard questionnaires and the MW questions. Correlations were calculated between the MW indicator question (How often does your mind wander when driving your own vehicle?) and independent variables including age, gender, MAAS and CFQ mean scores, and mean DBQ subscale scores. A multiple linear regression was calculated to predict self-reported MW when driving a familiar vehicle.

To find out when drivers report MW, repeated measures ANOVAs were used to compare means across the MW questions relating to driving tired, stressed, anxious and relaxed. To test road environment influences on reported MW, a 2×3 repeated measures ANOVA was calculated to compare means of reported MW across familiar and unfamiliar roads, and between road types (urban, rural and motorway). Mauchly's tests showed that the repeated-measures data violated assumptions of sphericity, however the departure was not large; adjustments to the degrees of freedom did not change the significance of any main effects or the effect sizes.

3. Results

3.1. Descriptive statistics

Descriptive statistics for the MAAS and CFQ scores and DBQ subscale items are included in Table 1. Cronbach's Alpha results for each scale were 0.88 (MAAS); 0.88 (CFQ) and 0.82 (DBQ). Table 2 lists descriptive statistics for the MW questions. Across 450 respondents who completed the MW questions in whole or part, no participant reported that they 'never' experience MW.

The data in Table 1 show that there was more variation in DBQ scores than there was in MAAS and CFQ scores. Mean MAAS scores were similar to means found previously in normative populations (e.g. Brown and Ryan, 2003). Highest error rates in the DBQ were for lapses and mistakes, however all average subscale scores reflected self-reported error rates of less than 1, where 1 equates to 'hardly ever' on a scale from 0 (never) to 5 (all the time).

Table 3
Correlation matrix. MW = Tendency to report mind wandering when driving a familiar vehicle; MAAS = Mindful Attention and Awareness score; CFQ = Cognitive Failures Questionnaire score; $DBQ_{v,av,l,m}$ = Driver Behaviour Questionnaire (violations, aggressive violations, lapses, mistakes) sub-scale scores. Gender codes were 1 (male) and 2 (female). Correlations > |0.09| were significant at $p < 0.05$ and correlations > |0.12| were significant at $p < 0.01$.

	MW	Age	Gender	MAAS	CFQ	DBQ_v	DBQ_{av}	DBQ_l	DBQ_m
MW	1	−.37	.06	−.46	.40	.30	.14	.37	.20
Age		1	−.04	.28	−.23	−.18	−.20	−.10	−.09
Gender			1	−.18	.13	−.14	−.08	.10	−.03
MAAS				1	−.68	−.32	−.21	−.53	−.34
CFQ					1	.30	.29	.65	.40
DBQ_v						1	.39	.34	.41
DBQ_{av}							1	.26	.31
DBQ_l								1	.51
DBQ_m									1

Table 2 shows that most MW was reported on familiar urban and rural roads, driving a familiar vehicle, and while tired. The mean score for these items was between 2.25 and 2.31 where 2 equates to 'occasionally' and 3 to 'quite often' on the response scale. Least MW was reported across all types of unfamiliar roads: urban roads, rural roads, and motorways. In these situations participants reported mean scores between 0.72 and 0.80 where 0 equates to 'never' and 1 to 'hardly ever' on the response scale.

3.2. Whose mind wanders: predicting self-reported MW tendency based on demographic characteristics, cognitive traits and error

To determine which variables best predicted tendency to report MW during driving, a stepwise multiple linear regression was calculated. Before building the model, correlations were calculated between the MW indicator question, demographic characteristics (age and gender), traits (MAAS and CFQ scores), and DBQ subscale scores. The correlation matrix is shown in Table 3.

The strongest correlations were between MAAS and CFQ (−0.682); and between CFQ and DBQ_l (0.648). Higher MAAS score relate to higher levels of mindful attention in everyday life so its negative correlation with CFQ, where high score relates to high reported rates of cognitive failure is to be expected and aligns with results from previous research (Herndon, 2008). In relation to MW during driving, the strongest correlations were with MAAS (−0.460), DBQ_l (0.370) and Age (−0.365). The direction of the rela-

Table 4
Final regression parameters predicting tendency to report MW during everyday driving. MAAS = Mindful Attention and Awareness Score; DBQl = Driver Behaviour Questionnaire (lapse) sub-scale score; DBQv = Driver Behaviour Questionnaire (violations) sub-scale score.

		b	*SE B*	*β*	*p*
Step 4	Constant	4.391	.465		$p < .001$
$R^2 = 0.524$, $p(\Delta R^2) = 0.010$	Age	−.018	.004	−.210	$p < .001$
	MAAS	−.459	.090	−.269	$p < .001$
	DBQl	.052	.018	.152	$p = .003$
	DBQv	.048	.019	.120	$p = .010$
Final model: $F(4,402) = 38.03$, $p < 0.001$					

tionships between MW, MAAS and lapses of attention suggest that there are links between MW and cognitive failure. The negative correlation between MW and age also replicated findings from previous research into MW (Giambra, 1989; Jackson and Balota, 2012; McVay et al., 2013).

Predictor variables that showed significant correlation with MW above 0.3 were entered in the multiple regression model. To avoid multicollinearity effects, and because there was correlation above 0.6 between CFQ and MAAS, as well as between CFQ and DBQ (lapse), CFQ was not included in the regression model. Age was entered in the first stage (forced entry), followed by stepwise addition of MAAS score, and DBQ violations and lapses. The final regression model is shown in Table 4. These results show that MAAS score and age have similar importance in the model, along with significant contributions from DBQ lapse and DBQ violations subscale scores. Together, the independent variables explain approximately 50% of the variation in tendency to report MW during everyday driving ($R^2 = 0.524$). This analysis suggests that drivers most likely to report MW are aged under 25 years, have low trait rates of mindful attention, and report more driving-related lapses of attention and violations.

3.3. When do minds wander: momentary states and road environment influences on MW during driving

Responses to MW questions (Table 2) show that participants reported similar scores across four personal states (tired, under time pressure, anxious and relaxed). Mean responses across personal states ranged from 1.75 (under time pressure) to 2.25 (tired); the response scale was 0–6 where a score of 2 on the scale indicated "During this situation my mind wanders 'occasionally"'. Statistical analysis comparing the four personal states revealed that these differences were significant [$F(3, 1{,}347) = 34.24$, $p < 0.001$, $\eta_p{}^2 = 0.071$]. Post-hoc pairwise comparisons with Bonferroni correction showed that reported MW when drivers were tired was significantly higher than all other states ($ps < 0.001$). MW under time pressure was significantly lower than all other states ($ps < 0.001$). There was no difference in reported MW relating to drivers feeling anxious or relaxed ($p = 1.00$).

Fig. 1 shows the comparison of reported MW for road environment characteristics; road familiarity and road type. Mean scores showed higher rates of MW on familiarthan on unfamiliar roads, with smaller differences between road types. Mean MW score on familiar roads ranged between 1.94 (familiar motorways) and 2.31 (familiar rural roads), where a score of 2 equates to MW "occasionally". Mean MW score on unfamiliar roads ranged between 0.74 (unfamiliar urban roads) and 0.80 (unfamiliar rural roads), where a score of 1 equates to MW "hardly ever". Statistical analysis showed significant main effects of both familiarity [$F(1, 449) = 1{,}140.81$, $p < 0.001$, $\eta_p{}^2 = 0.718$] and road type [$F(2, 898) = 27.66$, $p < 0.001$, $\eta_p{}^2 = 0.058$], and a significant interaction [$F(2, 898) = 34.70$, $p < 0.001$, $\eta_p{}^2 = 0.072$]. The likelihood of MW was highest when the road was familiar, but this effect was lower for motorway driving, which led to the significant interaction.

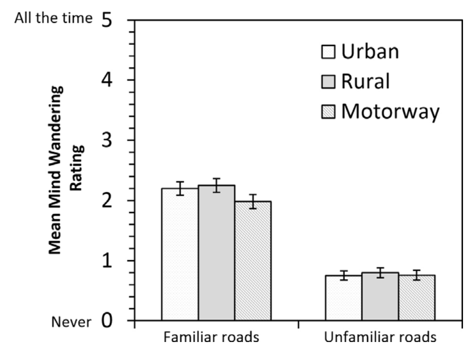

Fig. 1. Average MW ratings for familiar and unfamiliar urban roads, rural roads and motorways. Vertical lines show 95% confidence intervals.

4. Discussion

The aims of this study were to find out whose mind wanders during driving, and to explore differences in its reported frequency according to the effects of personal states and types of road. The results have, for the first time, indicated that MW while driving is a normal rather than an exceptional experience. Further, younger drivers reported more MW than older drivers; MW was reported as most likely on familiar roads and when drivers are tired; and drivers who reported more MW had lower levels of mindful attention and awareness; higher levels of cognitive failure; and reported more driving-related lapses of attention and violations.

Perhaps the most important contribution of this research is the finding that most people report MW occasionally during everyday driving, particularly on familiar roads: it is commonplace in the most common of places. Even though driving is an everyday task carrying considerable risk, people nevertheless admit to driving with less than sustained attention at least some of the time. This extends findings from theories and experience studies that MW is a common experience (Killingsworth and Gilbert, 2010; Smallwood and Schooler, 2006) and provides rationale for more research into MW and driving given the potential adverse consequences of less than sustained task focus.

The results also address the question of who reports MW. First, there was no difference in reported MW between men and women. Although it is a popularly held belief that women are better at multitasking than men, and might perhaps be more likely to experience MW, the limited number of studies in the area suggest there is no noteworthy difference in the tendency to daydream or even in the multitasking abilities of males and females (Lindquist and McLean, 2011; Mäntylä, 2013; Stoet et al., 2013).

Second, younger drivers reported more MW during driving than older drivers. This finding extends predictions from previous studies of MW into the realm of everyday driving. In particular, this study was not carried out on a university campus, so the results go some way to validating claims that older people appear to exhibit lower levels of MW generally, and not only in university laboratories where the environment may be deemed more likely to trigger task-unrelated thoughts in younger participants. As others have noted this result may seem counterintuitive because older people generally have poorer executive function (Krawietz et al., 2012), and might therefore be expected to report more MW. Older people may compensate for reduced levels of executive function by conscious application of attention to tasks such as driving, or at least they tend to report that this is the case.

Although older people are known to be exposed to increased crash risk related to generally reduced levels of cognitive functioning (Stutts et al., 1998), the component of executive control most strongly linked with MW (inhibition) is not associated with reduced driving performance in older people (Adrian et al., 2011). This suggests that older people may compensate for their reduced abilities in some way. Their known tendency to self-regulate their driving environments and hours (Charlton et al., 2006; Kostyniuk and Molnar, 2008) may directly or indirectly result in reduced need for prolonged inhibition of task-unrelated thought, because they rarely drive for very long distances or in environments which they are likely to find particularly demanding.

In terms of cognitive traits, people with lower levels of mindful attention and awareness and higher levels of cognitive failure tend to report more MW during driving. While these results may seem intuitive, further research is needed to establish whether people who exhibit lower mindful attention, for example, also exhibit behavioural changes associated with driving without awareness, and whether they are therefore more likely to be involved in crashes related to attentional failure.

As well as differences related to age and cognitive traits, there was also variation in reported MW tendency according to different momentary states, across different types of road, and according to tendency to report driving-related error. The finding that drivers are least likely to report MW when under time pressure suggests that they perceive some level of control over their attention. Previous research has shown that drivers under time pressure are more likely to report risk-taking (Cœugnet et al., 2013), which may reflect heightened task focus and therefore reduced frequency of MW. It has been suggested that the reason that an individual's mind wanders in the first place is pursuit of current concerns (Klinger, 1975), where the object of attention is whatever is most pressing in terms of momentary motivations. In some situations, such as time pressure, the driving task itself may become the driver's most pressing current concern.

In contrast to more task focus (less MW) reported when under time pressure, drivers reported more MW when they were tired. Some MW researchers suggest that an unintentional zone-out can be the result of a failure of executive control to inhibit task-unrelated thought and that this is more likely when executive resources are low, for example when a person is tired (McVay and Kane, 2010).

Across different types of road situation, most MW was reported on familiar roads. This also raises questions about the underlying role of executive function in MW. More MW might be reported on familiar roads because drivers *allow* their minds to wander intentionally, in pursuit of some pressing current concern, for example (tune-out), or they might experience an unintentional zone-out when driving task demands are low, as is the case on a familiar road. The distinction between tune-out and zone-out is a general challenge of research into MW (Smallwood and Schooler, 2006).

Regulation of MW in different contexts may also explain why drivers report less MW in motorway environments. Relatively high speeds on motorways may affect drivers' perceptions of driving task difficulty, and therefore their estimates of how frequently their minds wander. New Zealand does not have an extensive, intercity motorway network. Many drivers in the sample may encounter motorways only infrequently, so there may be interaction effects (between road type and (un)familiarity, for example) that could not be explored with these data. It would be useful to test this finding by researching MW during driving in countries with more extensive motorway networks.

Drivers who reported more MW also reported more driving-related errors, particularly lapses and violations. Although some researchers have made assumptions about a link between MW and crash risk, (Berthié et al., 2015; Martens and Brouwer, 2013; Galéra et al., 2012; He et al., 2011) the current findings do not support such claims directly. Previous research has found only weak links between error and crash risk (De Winter and Dodou, 2010). It may be that the propensity for cognitive failures leads to both MW and driving error, but there may be some other mediating factor as yet untested. It should be noted that Berthié et al. (2015) asked their respondents some questions regarding their prior crash involvement but were unable to establish any links to MW propensity. Analysis of crash data has found that a high proportion of crashes are reported on roads close to drivers' homes (Abdalla et al., 1997; Malek et al., 1990), however to date these findings have not been matched with information about drivers' exposure on these roads so again, links between familiarity and crash risk remain unclear.

This research has established that MW is a complex and widespread issue during everyday driving. Strengths of this study included its large sample size and age range. One limitation is that it is unclear whether or not drivers' self-reports of their state of mind during driving are accurate. If MW can happen without drivers' awareness, retrospective self-reports might not be reliable. This is also a limitation of the Berthié et al. (2015) study of MW and driving, where drivers were asked to estimate how many distinct task-unrelated thoughts they experienced in their most recent drive. However, with currently available methods we are limited to study of what drivers can report. Understanding could be progressed through a combination of simulation and naturalistic studies of driving, in which not only the influence of MW is investigated, but its overall frequency using some form of thought sampling during the drive.

Although the age range for the sample was broad (18–85 years) there were not enough data in the very young and very old age groups to enable meaningful analysis of these sub-groups. It would be useful to replicate this study with extensions to explore particular interactions such as age, gender and road type, or to ask different questions such as MW at different times of the day, for example, to work towards findings that can inform road safety interventions more directly.

Young drivers report the most MW, so more research is recommended into whether or in what situations drivers regulate their attention. Although drivers report more MW on familiar roads, the issue of what constitutes 'familiar' is difficult to quantify. There are clear poles at either end: roads can be very familiar (such as the daily commute) or completely unfamiliar (a road that a driver has never driven on). Between these extremes, however, there remains work to be done to establish a clear operational definition or measure of familiarity in driving. The increasing availability of more and better data about drivers' travel behaviour may support this kind of enquiry in future (e.g. Schönfelder and Antille, 2002).

It would also be worthwhile to explore regulation of attention further, given potential interactions between independent factors such as time pressure, tiredness, route familiarity and cognitive traits, as well as other unexplored variables such as trip purpose, time of day or the number of passengers in the vehicle. Simply encouraging drivers to 'pay attention' does not seem practical given current findings about the widespread occurrence of MW during everyday driving. A logical next step would be to find out when MW combines with other personal, vehicle and road factors to result in heightened crash risk.

Given the lack of studies linking MW and driving as a whole, it would be helpful to pursue the issue using a wide range of methods to find out which approaches are most promising. These findings could be validated using real driving situations and self-report during or immediately after a drive, for example. Although it is difficult to study, continued research into MW and driving using self-report, and where practical, naturalistic methods can only help as the transportation industry looks to further reduce the social costs of road trauma.

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