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Linking mind wandering tendency to risky driving in young male drivers

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ABSTRACT

Risky driving is a significant contributor to road traffic crashes, especially in young drivers. Transient mind wandering states, an internal form of distraction, are associated with faster driving, reduced headway distance, slower response times, reduced driver vigilance, and increased crash risk. It is unclear whether a trait tendency to mind wander predicts risky driving, however. Mind wandering is also associated with poor executive control, but whether this capacity moderates the putative link between mind wandering tendency and risky driving is uncertain. The present study tested whether mind wandering tendency predicts risky driving behaviour in young male drivers aged 18–21 ($N = 30$) and whether this relationship is mediated by driver vigilance and moderated by executive control capacity. Mind wandering was measured with the Sustained Attention to Response Task (SART) and the Daydreaming Frequency Scale (DDFS). Risky driving was assessed by mean speed in a driving simulator and driver vigilance was quantified by horizontal eye movements measured with eye tracking. Results showed that greater mind wandering tendency based on SART performance significantly predicts faster mean speed, confirming the main hypothesis. Neither driver vigilance mediated nor executive control capacity moderated this relationship as hypothesized. These findings speak to the complexity of individual differences in mind wandering. Overall, mind wandering tendency is a significant marker of risky driving in young drivers, which could guide the development of targeted interventions.

1. Background

Road traffic crashes are the number one killer of young people aged 15–29 globally (World Health Organization, 2015). Young drivers are consistently overrepresented in crashes (Mayhew et al., 2005). Constituting only 12.6% of drivers in Canada, 16–24 year olds represented nearly 21% of fatalities and 20% of those seriously injured from crashes in 2013 (Transportation Canada, 2014). Overall, human factors are estimated to account for 90% of all road traffic crashes (Peden et al., 2004). Human factors, such as inexperience, impulsivity and risky behaviour are especially important in young driver crash risk, with young male drivers being particularly susceptible (Fergusson et al., 2003; Turner and McClure, 2003).

At the same time, there is also substantial within-group variability in certain human factors that contribute to crash risk in young drivers (Fergusson et al., 2003; Jessor, 1987). Previous research investigating why some young drivers are riskier than others has focused largely on personality traits such as sensation seeking (see Jonah, 1997 for a review). More recently, research has begun to focus on cognitive capacities to better understand individual differences in driving performance (Mäntylä et al., 2009; Ross et al., 2015), For example, poor executive control (e.g., low response inhibition) has been found to be associated with risky driving (Jongen et al., 2011).

States of distraction are also strongly linked to decrements in driving performance and subsequently, elevated crash risk (Klauer et al., 2014). A study that used instrumented vehicles to observe driving behaviour found that distraction contributed to approximately 22% of all crashes and near-crash events (Klauer et al., 2006). This is likely due to the increased frequency of inappropriate responses to driving situations that is associated with distraction, including mistaking the accelerator for the brake, misjudging the speed of an oncoming vehicle, or speeding (Young and Salmon, 2012). Importantly, drivers have been found to vary in their susceptibility to distraction from cell phones, in-vehicle entertainment systems, and other captivating stimuli in the

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environment (Lansdown, 2012). Hence, the risk posed by distraction may be greater in some young drivers than in others, but this possibility, and the factors that might influence it, remain poorly understood.

Mind wandering, which encompasses thoughts and feelings unrelated to ongoing tasks, is an internal form of distraction that also has significant traffic safety implications (see Smallwood and Schooler, 2015 for a review). Mind wandering impairs performance on a variety of laboratory tasks and everyday activities, including driving (McVay et al., 2009; Mooneyham and Schooler, 2013; Smallwood and Schooler, 2006). Drivers who retrospectively reported experiencing mind wandering shortly before a crash were more likely to have been responsible for it (Galéra et al., 2012). Episodes of mind wandering have also been linked to risky driving behaviours, including elevated speed, shorter headway distance, slower response time (Yanko and Spalek, 2014), and reduced visual scanning of the environment (He et al., 2011).

While transient states of mind wandering are linked to risky driving, it is possible that the stable tendency to mind wander is also a driving-related risk factor. Indeed, individuals who reported experiencing frequent absentminded errors associated with mind wandering, like having to re-read sections in books, putting things in unintended locations, or failing to see objects in plain view, were also more prone to crashes, injuries, and hospitalizations (Larson et al., 1997; Larson and Merritt, 1991). Moreover, performance on the Sustained Attention to Response Task (SART; Robertson et al., 1997), a paradigm designed to detect lapses of attention thought to underlie absentminded errors, is correlated with self-reported mind wandering (Smilek et al., 2010), absentminded errors (Manly et al., 1999), and speed measured in a driving simulator (Daly et al., 2014). Importantly, SART performance is fairly stable over time. In sum, these findings suggest that the SART is tapping into a stable tendency to mind wander via lapses of attention that may contribute to individual differences in driving risk. While one study explored the link between mind wandering tendency and risky driving using self-report (Qu et al., 2015), this relationship has yet to tested using a combination of subjective and behavioural measures.

Little is presently known about the cognitive mechanisms underlying the relationship between mind wandering and task performance, but they are likely to be complex. Executive control is a cognitive mechanism that directs attention to goal-relevant thought and behaviour. In circumstances where it is important to maintain task focus, such as driving, the occurrence of mind wandering may represent a failure of this mechanism (Kane and McVay, 2012; McVay and Kane, 2009). For example, when task demands are high, individuals with lower executive control report more mind wandering than individuals with greater executive control (Kane et al., 2007). Furthermore, a recent meta-analysis suggests that executive control prevents mind wandering from interfering with task performance, namely when it is disadvantageous (Randall et al., 2013). Hence, executive control, as a stable individual characteristic, may moderate the link between mind wandering tendency and risky driving behaviour, but this hypothesis has not yet been tested.

Vigilance is necessary for detecting road hazards and therefore important for responsive and safe driving (Marple-Horvat et al., 2005; Strayer et al., 2003; Wilson et al., 2008). Performance deficits associated with mind wandering are thought to arise when vigilance is reduced by cognitive resources being diverted from stimuli in the environment to stimulus-independent thoughts (i.e., perceptual decoupling; Smallwood, 2013). No study to date has linked mind wandering tendency to driver vigilance.

The present study examines relationships between mind wandering tendency, executive control capacity, driver vigilance, and risky driving behaviour in young drivers. Based on our review above, we tested a model of how these factors interact (see Fig. 1A). We hypothesized that: H1) greater mind wandering tendency is associated with increased risky driving; H2) greater mind wandering tendency is associated with reduced driver vigilance; H3) driver vigilance mediates the relationship between mind wandering tendency and risky driving; and H4) executive control capacity moderates the association between mind wandering tendency and risky driving (i.e., high mind wandering tendency and low executive control predicts greater risky driving). If this model is supported, it could inform investigations into techniques for mitigating the role of mind wandering tendency in risky driving for some young drivers.

2. Methods

The current study was conducted within a larger study aimed at evaluating the effects of five different road configurations (Ouimet et al., 2015).

2.1. Participants

The study recruited individuals who had participated in previous studies examining the effects of alcohol on driving performance. These participants were initially recruited through advertising at colleges and universities in the greater Montreal area as well as through Facebook and local newspapers. The present study included males, aged 18–21 years old, with a probationary or regular driver's license, who drove no less than once per week over the last three months and had previous experience with alcohol (i.e., at least two drinks in one sitting). Exclusion criteria included simulation sickness, overt signs of intoxication from substance use at the time of testing, significant health problems that could be exacerbated by alcohol, and a diagnosed mental health issue (e.g., attention deficits with or without hyperactivity, depression, anxiety, bipolar, schizophrenia, or another emotional, psychological, psychiatric or learning disability). Participants received $75.00 as compensation for their participation.

2.2. Measures

2.2.1. Independent variables

Commission errors on the SART were used as a behavioural proxy index for mind wandering (Helton et al., 2009; McVay and Kane, 2009; McVay et al., 2013; Smallwood et al., 2004; Smallwood et al., 2007a,b). The SART is a go/no-go task in which participants respond with a keypress to numbers on a screen ranging from 1 to 9, except for the number 3, which appears infrequently (i.e., 11% of the time). The computerized version was adapted from the original by Millisecond Software for their Inquisit© platform (Draine, 2009). Stimuli were presented for 250 ms with an inter-stimulus mask displayed for 900 ms. Total number of commission errors (i.e., pressing the key in response to the number 3) ranged from 0 to 25. In order to prevent confounding effects from external distraction, participants completed the SART in a quiet, windowless room.

The French version of the Day Dreaming Frequency Scale (DDFS) (Giambra, 1993; Singer and Antrobus, 1963; Stawarczyk et al., 2012) provided a self-report measure of daily mind wandering experiences. The DDFS contains 12 questions (e.g., "I daydream at work or in class") that participants respond to using a 5-point Likert scale ranging from 1 "Not often" to 5 "Many times per day." A mean score was calculated for each participant. It has been validated against other measures of mind wandering, including self-reports collected with experience sampling during the SART (Stawarczyk et al., 2012).

2.2.2. Dependent variable

Mean speed (km/h) in driving simulation was calculated to indicate risky driving. Speed, which was constantly displayed on the speedometer of the instrument panel, was recorded at a rate of 60 Hz. The posted speed limits ranged from 45 to 90 km/h (with 66.2% of the drive at 50 km/h). Driving simulation has been shown to validly predict individual on-the-road performance on several behavioural metrics, in particular driving speed (Mullen et al., 2011). Mean speed on the road reliably predicts crash risk, with a 1 km/h increase corresponding to a