Running head: MINDFULNESS PREDICTS DRIVER ENGAGMENT

This version of the article has been accepted for publication, after peer review and is subject to Springer Nature's AM terms of use, but is not the Version of Record and does not reflect post-acceptance improvements, or any corrections. The Version of Record is available online at: https://doi.org/ 10.1007/s12671-018-1060-7

Mindfulness Predicts Driver Engagement in Distracting Activities

Kristie L. Young (Corresponding Author)

Monash University Accident Research Centre, 21 Alliance Lane, Monash University, VIC 3800 AUSTRALIA. Phone: +613 9905 1258, Email: kristie.young@monash.edu

ORCID ID: orcid.org/0000-0002-4999-3424

Sjaan Koppel

Monash University Accident Research Centre, 21 Alliance Lane, Monash University, VIC 3800 AUSTRALIA.

Amanda N. Stephens

Monash University Accident Research Centre, 21 Alliance Lane, Monash University, VIC 3800 AUSTRALIA.

Rachel Osborne

Monash University Accident Research Centre, 21 Alliance Lane, Monash University, VIC 3800 AUSTRALIA.

Richard Chambers

Campus Community Division, Monash University, VIC 3800 AUSTRALIA

Craig Hassed

Monash University, Department of General Practice, Building 1, 270 Ferntree Gully Road, Notting Hill, VIC 3168 AUSTRALIA

Abstract

Distracted driving is a major public health concern because of its potential costs of injury, mortality and property damage. Understanding the psychological factors that underlie drivers' willingness to engage in distracting activities despite the clear safety risks can help to identify interventions to mitigate this dangerous behavior. This study examined if mindfulness, defined as one's attention to and awareness of oneself and the present situation, predicts driver engagement in a wide range of distracting activities, including in-vehicle technology and non-technology based distraction sources, daydreaming/mind wandering and distractions external to the vehicle. A total of 312 drivers completed an online survey assessing levels of mindfulness and the frequency with which they engaged in a range of potentially distracting activities. The results showed that while engagement in distracting activities is common, mindfulness was negatively associated with the frequency of driver engagement in all distraction sources studied, apart from passenger interaction. Our results suggest that a single mindfulness intervention could potentially reduce driver engagement in multiple distracting activities at once, and therefore have significant utility as a distraction mitigation technique.

Keywords: Driver Distraction, Mindfulness, Driving, Attention, Road Safety

Acknowledgement

Dr Kristie Young's contribution to this paper was funded by an ARC Discovery Early Career Researcher Award (DE160100372). We thank Dr Karen Stephan for her statistical advice.

Mindfulness predicts driver engagement in distracting activities

Distracted driving is highly prevalent and is now a major public health concern (World Health Organization, 2011). Many drivers expect that their vehicles will be fitted with a range of technology that enables them to maintain connectivity while driving. Drivers now have easy access to portable and on-board technology that allows them to place and receive calls and texts, access social media and use myriad applications, encouraging their attention to be regularly focused on things other than driving. Such high levels of distraction are having a significant impact on road safety. Talking on a phone while driving, even using hands-free technology, is associated with a four-fold increase in crash risk (McEvoy, Stevenson, & Woodward, 2007) and texting or using the internet while driving can increase the odds of being involved in a safety critical event by up to 164 times (Hickman & Hanowski, 2012). Distracted driving has been found to be the main contributing factor in almost 16 percent of serious casualty crashes resulting in hospital attendance in Australia (Beanland et al., 2013) and in 10 percent of fatal and 15 percent of injury crashes in the United States (National Highway Traffic Safety Administration, 2017).

Being distracted can have a negative impact on driving performance and safety. When attention is diverted from the driving task a range of cognitive processes are impaired, including visual processing of the driving scene, the anticipation and identification of hazards and threats, decision making and the execution of appropriate responses (Strayer, 2015). A consequence of these impairments is that drivers' situation awareness is often degraded. Situation awareness is a critical component of human performance in complex, dynamic environments and, in relation to driving, is defined as a driver's mental model of the driving environment at a specific point in time (Salmon, Stanton, & Young, 2012; Young, Salmon, & Cornelissen, 2013). Situation awareness encompasses a driver's knowledge of the location and behavior of other road users, their current location on the road network in relation to their

destination and other drivers, current driving conditions, and the current speed limit and traffic light status. Drivers use this knowledge or information to anticipate and react to changes and events in the driving environment in order to avoid collisions and conflicts with other road users (Gugerty, 2011). Consequently, when breakdowns in a driver's situation awareness occur, driving safety is compromised (Kass, Cole, & Stanny, 2007; Strayer, 2015; Young et al., 2013).

In recent years, a growing number of studies have examined the psychological predictors of distraction engagement when driving (Walsh et al., 2008; White et al., 2006; Zhou et al., 2012; Zhou et al., 2009). One psychological construct that is gaining attention for its potential to assist drivers to resist the temptation to engage in distracting activities and maintain attention on the driving task is mindfulness. Mindfulness is commonly described as "the state of being attentive to and aware of what is taking place in the present" (Brown & Ryan, 2003, p. 822). Although there is no universally accepted definition of mindfulness, many definitions emphasize that mindfulness involves "being aware" and "paying attention" to current internal experiences and external events (Bishop et al., 2004; Brown & Ryan, 2003, 2004). They also generally include an attitudinal component of nonjudgement/openness to whatever is experienced (Kabat-Zinn, 2003).

Increased mindfulness is associated with a number of positive outcomes to psychological functioning and cognitive performance. It enhances subjective wellbeing, the management of physical pain, reduced negative emotional reactivity, and improved behavioral regulation (Brown, Ryan, & Creswell, 2007). It has also been shown to strengthen attentional networks, improving sustained attention and memory (Chambers, Lo, & Allen, 2008). With respect to driving, higher levels of mindfulness have been linked with improved concentration and situation awareness while driving (Kass et al., 2011). In a driving simulation study, Kass et al. found that drivers who received mindfulness training had

increased concentration, greater situational awareness and were less likely to commit stopping violations than a control group who did not receive mindfulness training.

The linking of mindfulness with distracted driving behavior is relatively new and minimal research has been conducted, much of it focusing on text messaging. In a seminal study, Feldman et al. (2011) studied female undergraduate students and found that mindfulness and texting while driving were negatively correlated. Drivers who scored lower on a trait-level measure of mindfulness reported a greater frequency of texting while driving when compared to more mindful drivers. The authors also found that drivers who were aware they needed to regulate their attention were less likely to report engaging in texting while driving; while those individuals who engaged in texting to reduce their negative emotions reported greater frequency of texting while driving. These results suggest that drivers higher in mindfulness might be better equipped to resist any temptations to text while driving (Feldman et al., 2011).

A number of subsequent studies have also found trait mindfulness is negatively associated with frequency of texting while driving (Panek et al., 2015; Terry & Terry, 2015). Terry and Terry (2015) studied the association between mindfulness and near crashes related to talking and texting on a phone. Two of the five facets of mindfulness studied – "acting with awareness" and "nonjudging of inner experience" – negatively predicted phone-related near-crashes. Drivers who scored lower on these two dimensions had a higher incidence of phone-related near-crashes after controlling for frequency of phone use while driving. Panek et al. (2015) also found that the "acting with awareness" dimension of trait mindfulness negatively predicted the frequency of texting while driving and walking.

In a driving simulation study, Valero-Mora et al. (2015) examined the association between mindfulness and two driving performance measures: mean speed and lateral control. They found that mindfulness had no significant correlation with either driving performance

measure. Taken together, the results of the previous mindfulness and texting research suggests that mindfulness, or lack thereof, can influence drivers' willingness to engage in at least one form of distracting activity.

Drivers engage in myriad distracting tasks and it cannot be assumed that the strength of the relationship between mindfulness and engagement in text messaging while driving is generalizable to these other activities. The various sources of distraction that exist have diverse characteristics and can have different behavioral predictors. Indeed, research has found that text messaging differs to other distracting activities in a number of important ways that could influence its relationship with mindfulness, including having a higher level of perceived and measured risk (Young & Lenné, 2010) and being an habitual behavior, often engaged in with limited conscious awareness, attention, control, and intention (Bayer & Campbell, 2012; Oulasvirta et al., 2012; Panek et al., 2015). Moreover, recent research indicates that there is a number of distraction sources with a much higher prevalence rate than text messaging, including passenger interaction, conversing on a phone and interacting with built-in vehicle devices such as the radio and climate controls (Dingus et al., 2016; Young et al., in press). Given the vast array of distracting activities engaged in by drivers and the different prevalence, attentional attributes and risk levels associated with each, it is important to examine the relationship between mindfulness and a range of other distraction sources beyond text messaging.

The aim of the current study was to expand on previous mindfulness and texting research to examine if self-reported mindfulness predicts the frequency of driver engagement in a wider range of distraction sources. These sources included in-vehicle technology and non-technology based distraction sources such as eating and drinking and being distracted by things outside the vehicle. Mindfulness was measured using the Mindfulness Attention Awareness Scale (MAAS; Brown & Ryan, 2003). The MAAS is one of the most widely used

measures of mindfulness and assesses the presence (or absence) of attention to, and awareness of, events occurring in the present moment. The focus of the scale on the attention/awareness dimension of mindfulness makes it directly applicable to distracted driving, given that distraction is fundamentally related to the construct of attention and its (inappropriate) distribution (Lee, Young, & Regan, 2009) and safe driving is heavily dependent on maintaining constant attention to, and awareness of, surrounding events, in a highly dynamic environment (Strayer, 2015). It should be noted that the MAAS, being a unidimensional scale, does not assess other dimensions or attributes of mindfulness, such as acceptance, trust, empathy and non-judgmental awareness. However, these aspects of mindfulness are unlikely to be closely related to engagement in distracted driving, thus, the MAAS was deemed appropriate for the purposes of this study.

Based on the findings of previous research, we hypothesized that drivers who scored lower on the MAAS would report greater frequency of engagement in all of the distracting activities studied while driving.

Method

Participants

A sample of 312 adults (254 [81.4%] female; 57 [18.3%] male; 1 [0.3] other) participated in the current study. Participants ranged in age from 18 to 86 years (M = 46.0, SD = 13.7). Two hundred and eighty-one (90%) participants reported that they drove four or more times per week and 273 (87.4%) drove over 5,000 km in the past year. In the last two years, 49 (15.8%) participants reported being involved in a motor vehicle crash and 17 (5.4%) had received a traffic infringement for failing to stop, 59 (18.9%) for speeding and 16 (5.1%) for other driving offences, including cell phone use.

A power analysis using GPower revealed that with an estimated small effect size and an alpha of 0.05, an n of 55 would be required to obtain statistical power at the .80 level. Thus, the sample size obtained was adequate.

Procedure

The survey was administered online using Qualtrics between March and June 2017. Participants were eligible to participate if they were: aged 18 years and over; held a valid driver's license; were an "active" driver (i.e., drive at least 2-3 times per week), and were proficient in English. The survey was advertised internationally using the not-for-profit organization Smiling Mind and Monash University social media and newsletters to increase the representativeness of the sample. The potential audience for the two advertising platforms combined was over 2 million people worldwide. The survey did not require participants to report how they became aware of the survey and, consequently, the proportion of participants recruited through each advertising platform cannot be determined.

The advertising invited participants to take part in a survey examining the "impact of mindfulness on real-world, everyday driving experiences and performance" and directed them to an online link to learn more about the study and complete the online survey. The online survey took approximately 15 minutes to complete. Participants who completed the online survey were able to opt into a draw to win an iPad Air 2.

Measures

Demographics. The survey included several questions related to participants' demographic and socio-economic characteristics (e.g., age, gender, marital status and highest level of education), driving experience and exposure, license history, and motor vehicle crash and driving infringement history.

Driving distraction items. The distracted driving component contained 24 items

measuring how frequently respondents' engage in distracting activities while driving. Information was collected on a range of activities, including mobile phone use, satellite navigation use, Internet and social media access, interaction with passengers, eating/drinking, and distraction from outside objects and events (see Table 2). Respondents were asked to indicate how often they engage in each activity when driving using a five-point Likert scale (1 = never, 2 = occasionally, 3 = sometimes, 4 = often, 5 = always).

Mindful Attention and Awareness Scale. Mindfulness was measured using the Mindful Attention and Awareness Scale (MAAS) (Brown & Ryan, 2003). The MAAS measures general tendencies toward mindful attention because it assesses natural propensity to focus on the current moment. The MAAS contains 15 items on a six-point Likert scale (1 = almost always; 6 = almost never). Scores are determined by calculating the mean of all items, with higher scores indicating a higher propensity towards mindful attention and awareness. The MAAS has demonstrated construct validity in community samples (MacKillop & Anderson, 2007) and has good internal consistency (Cronbach's alpha = .87) and test-retest reliability (r = .81) in an adult sample (Brown & Ryan, 2003). The MAAS was found to have excellent internal consistency in the present study (Cronbach's α = .91).

The survey also included the Driving Anger Scale (Deffenbacher, Oetting, & Lynch, 1994) and the Driver Behavior Questionnaire (Reason et al., 1990). For the purposes of the current paper, only the demographic, MAAS and distracted driving survey items were analyzed.

Data Analysis

Descriptive statistical analyses were first conducted to examine the frequency of driver engagement in the 24 distracting activities. To examine the relationship between mindfulness and engagement in distracting activities, a number of related distraction items were combined into smaller categories by averaging the relevant items (see Table 1). Rather than statistically

determine these distraction categories, which would have reduced the ability to compare distraction tasks of interest, the items were combined into the various distraction sub-categories based on previous distraction classification categories (e.g., Regan et al., 2009) and on functional similarities; for example, whether items related to use of technology other than phones or were non-technology-based. The text messaging items were also grouped separately from items relating to talking on phone to facilitate comparison of text messaging to other sources of phone-related distraction. This distinction brings the current results in line with published research in the driver distraction and crash risk domain (e.g., Caird et al., 2008; Donmez & Liu, 2015). Internal consistency of each sub-scale ranged from excellent for text messaging and Advanced Driver Assistance Systems ($\alpha = .89$) to low for the phone talking ($\alpha = .46$) and non-technology ($\alpha = .49$) sub-scales (see Table 1). The phone talking and non-technology subscales were retained for analysis despite having lower internal consistency on the grounds that the scales contained a small number of items (Loewenthal, 1996) and as mentioned above there are theoretical reasons for assuming that these distraction sources differ from text messaging in ways that may influence their relationship with mindfulness. Two items, lost in thought and external to vehicle distraction, that did not logically fit into categories were retained and analyzed as separate items. Given the high number of cells with zero values for these two items it was not appropriate to use ordinal regression. Hence, these items were re-coded into a binary response format according to whether respondents engaged or did not engage and analyzed using logistic regression. Two additional items, interacting with pets and smart watches, were excluded from the analyses as they contained too much missing data. Statistical associations between mindfulness and distraction engagement were examined using Pearson's correlation coefficient. A series of linear and logistic regression models determined whether mindfulness predicts engagement in various distracting activities.

Driver age, gender and driving frequency were included in the regression models as these variables have been associated with willingness to engage in distracting activities and associated crash risk (Donmez & Liu, 2015; McEvoy, Stevenson, & Woodward, 2006; Pöysti, Rajalin, & Summala, 2005; Young & Lenné, 2010; Young, Regan, & Lee, 2009). We were, therefore, interested to see the relative variance explained by these variables compared to mindfulness. As displayed in Table 2, these variables were significantly related to a number of the distraction items.

Results

Descriptive statistics for all study variables are presented in the right-hand column of Table 1. As shown, engagement in distracting activities while driving is common. All drivers reported that they interact with adult passengers at least occasionally. This was followed by interacting with climate controls, being distracted by something outside of vehicle, changing music, and not thinking about driving (e.g., daydreaming/lost in thought). Phone use was also a common activity, with 79% of the sample reporting talking on a hands-free phone when driving and 37% talking on a hand-held phone. A total of 62% of the sample also reported reading text messages when driving, while 43% reported sending texts on some occasion.

Bivariate correlations are displayed in Table 2. As expected, significant negative correlations were observed between self-rated mindfulness and reported engagement in all of the distracting activities, apart from interaction with child passengers. Unsurprisingly, mindfulness was most highly negatively correlated with drivers not thinking about their driving because they were daydreaming or lost in thought.

Six simultaneous linear regression models and two logistic regression models examined whether mindfulness predicts driver engagement in a range of distraction activities (see Tables 3 to 8). Correlations among the predictor variables were low (see Table 2). Tests for

multicollinearity indicated that, for all predictor variables, tolerance was greater than 0.10 (0.987 to 0.994) and the variance inflation factor was less than 10 (1.006 to 1.013), suggesting that multicollinearity was not an issue.

Results of the linear regressions show that mindfulness was a significant negative predictor of the frequency of talking and texting on a mobile phone, using other technology, engaging in non-technology-based distractions, and being distracted by Advanced Driver Assistance Systems. That is, respondents who scored higher on the MAAS were less likely to report engaging in these distracting activities while driving. Mindfulness, however, was not a significant predictor of interacting with passengers.

Both age and driving frequency were also significant negative predictors of engagement in talking and texting on a mobile phone, using other technology and engaging in non-technology-based distractions.

Two logistic regression models examined if mindfulness was associated with drivers failing to think about their driving (e.g., becoming lost in thought) or were distracted by events outside of the vehicle. The model for becoming lost in thought was statistically significant ($\chi^2(7) = 38.04$, $p < .001$). The model explained 27.6% (Nagelkerke R^2) of the variance in becoming lost in thought while driving and correctly classified 93.1% of cases. Higher levels of mindfulness were associated with a decreased likelihood of becoming lost in thought while driving (Exp(B) = 0.148; 95%CI 0.069 - 0.317). For each point level increase in mindfulness as measured by the MAAS, the odds of being lost in thought while driving decreased by 85%. Age, gender and driving frequency were not significantly associated with drivers becoming lost in thought.

The logistic regression model for distractions outside the vehicle was also statistically significant ($\chi^2(8) = 25.53$, $p = .001$). The model explained 15.6% (Nagelkerke R^2) of the variance in drivers being distracted by outside events and correctly classified 96.4% of cases.

Higher levels of mindfulness were associated with a decreased likelihood of being distracted by events outside the vehicle (Exp(B) = 0.320; 95%CI 0.140 - 0.734); showing that for each point increase in trait mindfulness the odds of distraction by events outside the vehicle decreased by 68%. Age, gender and driving frequency were not significantly associated with being distracted by events outside the vehicle.

Discussion

This study examined if mindful awareness and attention predicts the frequency of driver engagement in a variety of distracting activities. Driver engagement in distracting activities is common, with drivers reporting that they engage in all of the distracting activities examined at least occasionally. We found that mindfulness was significantly negatively associated with frequency of driver engagement in all distracting activities studied, with the exception of driver-child interaction. Individuals who scored lower in self-reported mindfulness reported a higher frequency of driver engagement in the use of mobile phones and other technology, non-technology based activities, not thinking about driving (i.e., daydreaming/lost in thought) and distractions external to the vehicle.

Our findings are consistent with previous research that has found a negative relationship between mindfulness and frequency of text messaging while driving (Feldman et al., 2011; Panek et al., 2015; Terry & Terry, 2015). The significance of the present study is that it extends these earlier findings to demonstrate that mindfulness, or rather a lack of mindfulness, predicts engagement in a wider variety of distracting activities that have different levels of perceived and actual risk, psychological mechanisms, and, in many cases, higher levels of engagement than text messaging. Text messaging is associated with automatic tendencies, attention switching and a high level of perceived risk (Drews et al., 2009; Panek et al., 2015; Young & Lenné, 2010). Our findings demonstrate that a lack of

mindful attention and awareness can also predict engagement in tasks that involve a conscious decision to engage (e.g., entering an address into a navigation system), divided attention (e.g., conversing on a phone) and lower levels of perceived risk (e.g., eating and drinking).

The fact that mindfulness is negatively associated with engagement in several distracting activities suggests that a single mindfulness intervention can address multiple distracting activities at once, rather than requiring a different intervention to reduce engagement in each specific distraction source. This finding is of significance as it would be impractical to develop and implement an intervention for every source of distraction, when one will suffice. Having one intervention that can reduce engagement in a large proportion of distracting behaviors could potentially have enormous benefits for distraction-related road trauma given the evidenced risk associated with a variety of distraction sources.

A notable exception in our findings was that mindfulness did not predict drivers' interaction with adult and child passengers combined. We found that mindfulness was significantly correlated with drivers' interaction with adult passengers, but not with their interaction with child passengers. It is likely that by combining these two passenger categories in the regression model, the relationship between mindfulness and passenger interaction was attenuated. Nonetheless, the finding does raise an interesting question about goal conflicts and how the influence of different psychological and social correlates of distraction may differ across distraction sources. Due to a range of biological or social influences, drivers may find it difficult or even impossible to ignore child passengers (Hancock, Mouloua, & Senders, 2009; Lee, Regan, & Young, 2009). That is, engagement with a child passenger can be viewed as a source of distraction that is less ignorable and more unpredictable than engagement with an adult. When interacting with adult passengers, drivers can readily regulate the amount of attention devoted to the passenger (Regan et al., 2009)

and, likewise, adult passengers often regulate their interaction with drivers so that they are not distracting them at times of high demand (e.g., when overtaking). It is possible that increased mindfulness may not influence engagement in certain types of un-ignorable and unpredictable distractions, which drivers find themselves compelled to engage in, but over which they have little control in terms of onset or the level of demand they impose.

The negative association between distraction engagement and mindfulness is consistent with the conception that a core characteristic of mindfulness is sustained attention to, and awareness of, present events and experiences (Brown & Ryan, 2003). It is logical, therefore, that individuals who are more mindful engage less in distracted driving because they are better able to maintain sustained attention on the driving task and resist the temptation to engage in other tasks. Further, individuals who are less mindful have a tendency to act with limited concern for consequences or outcomes (Abdul Hanan, King, & Lewis, 2010) or may be less able to avoid engaging in low-awareness habits like checking an incoming text message while driving. This aspect of mindlessness may also explain the greater propensity to engage in distracted driving because less mindful individuals have diminished regard for the safety risks associated with such behavior.

In addition, the results indicated that the four predictor variables – age, gender, driving frequency and mindfulness – included in the models accounted for only a small portion of the variance in distraction engagement, ranging from 5.0 to 27.6 percent. This suggests that there are a host of other factors that govern drivers' willingness to engage in distracting activities. These factors are likely to include not only other psychological determinants, but also dynamic contextual factors, such as current traffic and road conditions, and even the characteristics of the distraction task itself, such as when a greater level of impairment is observed if the task is more incongruent with driving (Sasai et al., 2016). Understanding the

predictors and correlates of distracted driving may help to identify relevant targets for interventions to reduce this risky behavior.

As discussed earlier, our study provides evidence for the utility of promoting a greater awareness of one's actions through mindfulness interventions as a means of reducing distracted driving. Mindfulness training has been shown to have a range of potential road safety benefits, including reduced stress and anxiety (Kabat-Zinn, 2003), improved situation awareness (Kass et al., 2011) and reductions in driver anger and aggression (Kazemeini, Ghanbari-e-Hashem-Abadi, & Safarzadeh, 2013). The fact that mindfulness is significantly negativity associated with driver engagement in multiple distracting activities suggests that training drivers to improve their mindful attention and awareness is likely to have merit as a preventative measure for distracted driving as a whole. Mindfulness training that focusses on improving drivers' ability to maintain attention on the driving task and to be more aware of their actions and associated consequences is likely to be particularly effective. Further research is required, however, to determine the exact form of mindfulness training that is likely to be most effective at reducing driver engagement in distracted driving and how this can best be incorporated into existing driver training programs.

Limitations and Future Research

Interpretation of the findings should be done in light of several limitations. First, the study involved a non-representative, convenience sample of drivers who were largely female (81%) and had completed an undergraduate or postgraduate university degree, which may reduce the generalizability of findings to the broader driving community. Future research would benefit from a stratified sampling strategy to ensure that the sample is representative of the wider driving population. For reasons of parsimony, a small number of distraction items asked about multiple tasks, such as the item 'eating, drinking and smoking'. While these items are commonly grouped together in distraction research (see Donmez & Liu, 2015), it is

possible that the frequency of engagement in these tasks differs. Future research should seek to examine the relationship between distraction and mindfulness for individual distraction tasks of interest. The use of self-report to assess distraction engagement may also have reduced accuracy due to recall errors and social desirability effects. However, given the large number of drivers reporting engagement in risky and illegal activities and the fact that the participants were able to complete the survey at a time and location of their choosing, social desirability effects are likely to be minimal.

Finally, the MAAS is not without controversy. The MAAS was selected because its focus on the attention/awareness dimension of mindfulness makes it directly applicable to distracted driving. Nonetheless, the MAAS has been criticized for failing to adequately assess mindfulness (Grossman, 2011). In addition, the scale's conceptualization of mindfulness as a unidimensional construct limited the examination of mindfulness to only the attention and awareness dimension. Using a multifaceted mindfulness scale, such as the Five Facet Mindfulness Questionnaire (Baer et al., 2006), may provide a more comprehensive understanding of the relationship between mindfulness and distracted driving.

Our results suggest that the relationship between mindfulness and distraction deserves further research attention. Research to date has examined the relationship between mindfulness and drivers initiating engagement in a distracted task. Further research should determine if mindfulness is associated with how attention is distributed and prioritized across driving and distracter tasks once engaged. Additionally, given that the current study has established that mindfulness does have a relationship with engagement in various distracting activities, research should systematically examine if this relationship differs according to various task attributes such as perceived risk, attention allocation patterns and whether tasks are voluntary, involuntary or habitual. Indeed, our finding in relation to child and adult passengers provides evidence that the relationship between mindfulness and distracted

driving may be moderated by characteristics of the task itself, such as whether it is ignorable and unpredictable.

In summary, the present study provides preliminary evidence that higher levels of mindfulness are associated with a reduced frequency of engaging in a range of distracting activities when driving. As technology becomes more ubiquitous, distracted driving will continue to present a major road safety risk. Our results suggest that a single mindfulness intervention could potentially reduce driver engagement multiple distracting activities at once, and therefore have significant utility as a distraction mitigation technique.

Compliance with Ethical Standards

Conflict of Interest

The authors declare that they have no competing interests.

Ethical Approval

All procedures in the current study were approved and in accordance with the ethical standards of the Monash University Human Research Ethics Committee (Approval No.: 2017-7955).

Informed Consent

Informed consent was obtained from all individual participants included in the study.

Author Contributions

KLY: collaborated with the design of the survey, analyzed the data and wrote the paper. SK: designed and executed the survey and assisted with editing of the final manuscript. ANS: collaborated with the design of the survey, assisted with data analysis and editing of the final manuscript. RO: wrote part of the introduction. RC and CH: collaborated with the design of the survey and editing of the final manuscript.

References

Abdul Hanan, S., King, M. J., & Lewis, I. M. (2010). Are you a mindful driver? A review of the potential explanatory value of mindfulness in predicting speeding behaviour. *Paper presented at the 2010 Australasian Road Safety Research, Policing and Education Conference*, Canberra, Australia.

Baer, R. A., Smith, G. T., Hopkins, J., Krietemeyer, J., & Toney, L. (2006). Using self-report assessment methods to explore facets of mindfulness. *Assessment, 13*(1), 27-45.

Bayer, J. B., & Campbell, S. W. (2012). Texting while driving on automatic: Considering the frequency-independent side of habit. *Computers in Human Behavior, 28*(6), 2083-2090.

Beanland, V., Fitzharris, M., Young, K. L., & Lenné, M. G. (2013). Driver inattention and driver distraction in serious casualty crashes: Data from the Australian National Crash In-depth Study. *Accident Analysis & Prevention, 54*(0), 99-107.

Bishop, S. R., Lau, M., Shapiro, S., Carlson, L., Anderson, N. D., Carmody, J., Segal, Z. V., Abbey, S., Speca, M., Velting, D., & Devins, G. (2004). Mindfulness: A proposed operational definition. *Clinical Psychology: Science and Practice, 11*(3), 230-241.

Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology, 84*(4), 822.

Brown, K. W., & Ryan, R. M. (2004). Perils and promise in defining and measuring mindfulness: Observations from experience. *Clinical Psychology: Science and Practice, 11*(3), 242-248.

Brown, K. W., Ryan, R. M., & Creswell, J. D. (2007). Mindfulness: Theoretical foundations and evidence for its salutary effects. *Psychological Inquiry, 18*(4), 211-237.

Caird, J. K., Willness, C. R., Steel, P., & Scialfa, C. (2008). A meta-analysis of the effects of cell phones on driver performance. *Accident Analysis & Prevention, 40*(4), 1282-1293.

Chambers, R., Lo, B. C. Y., & Allen, N. B. (2008). The impact of intensive mindfulness training on attentional control, cognitive style, and affect. *Cognitive Therapy and Research, 32*(3), 303-322.

Deffenbacher, J. L., Oetting, E. R., & Lynch, R. S. (1994). Development of a driving anger scale. *Psychological Reports, 74*(1), 83-91.

Dingus, T. A., Guo, F., Lee, S., Antin, J. F., Perez, M., Buchanan-King, M., & Hankey, J. (2016). Driver crash risk factors and prevalence evaluation using naturalistic driving data. *Proceedings of the National Academy of Sciences, 113*(10), 2636-2641.

Donmez, B., & Liu, Z. (2015). Associations of distraction involvement and age with driver injury severities. *Journal of Safety Research, 52*, 23-28.

Drews, F. A., Yazdani, H., Godfrey, C. N., Cooper, J. M., & Strayer, D. L. (2009). Text messaging during simulated driving. *Human Factors, 51*(5), 762-770.

Feldman, G., Greeson, J., Renna, M., & Robbins-Monteith, K. (2011). Mindfulness predicts less texting while driving among young adults: Examining attention-and emotion-regulation motives as potential mediators. *Personality and Individual Differences, 51*(7), 856-861.

Grossman, P. (2011). Defining mindfulness by how poorly I think I pay attention during everyday awareness and other intractable problems for psychology's (re) invention of mindfulness: Comment on Brown et al. *Psychological Assessment, 23*, 1034–1040.

Gugerty, L. (2011). Situation awareness in driving. In J. Lee, M. Rizzo, D. Fisher & J. Caird (Eds.), *Handbook for driving simulation in engineering, medicine and psychology* (pp. 265-272). Boca Raton, FL: CRC Press.

Hancock, P. A., Mouloua, M., & Senders, J. W. (2009). On the philosophical foundations of the distracted driver and driving distraction. In M. A. Regan, J. D. Lee & K. L. Young (Eds.), *Driver distraction: Theory, effects and mitigation* (pp. 11-30). Boca Raton, FL: CRC Press.

Hickman, J. S., & Hanowski, R. J. (2012). An assessment of commercial motor vehicle driver distraction using naturalistic driving data. *Traffic Injury Prevention, 13*(6), 612-619.

Kabat-Zinn, J. (2003). Mindfulness-based interventions in context: Past, present, and future. *Clinical Psychology: Science and Practice, 10*(2), 144-156.

Kass, S. J., Cole, K. S., & Stanny, C. J. (2007). Effects of distraction and experience on situation awareness and simulated driving. *Transportation Research Part F: Traffic Psychology and Behaviour, 10*, 321-329.

Kass, S. J., VanWormer, L. A., Mikulas, W. L., Legan, S., & Bumgarner, D. (2011). Effects of mindfulness training on simulated driving: Preliminary results. *Mindfulness, 2*(4), 236-241.

Kazemeini, T., Ghanbari-e-Hashem-Abadi, B., & Safarzadeh, A. (2013). Mindfulness based cognitive group therapy vs cognitive behavioral group therapy as a treatment for driving anger and aggression in Iranian taxi drivers. *Psychology, 4*(08), 638.

Lee, J. D., Regan, M. A., & Young, K. L. (2009). What drives distraction? Distraction as a breakdown of multilevel control. In M. A. Regan, J. D. Lee & K. L. Young (Eds.), *Driver distraction: Theory, effects, and mitigation* (pp. 41-56). Boca Raton: Florida: CRC Press.

Lee, J. D., Young, K. L., & Regan, M. A. (2009). Defining driver distraction. In M. A. Regan, J. D. Lee & K. L. Young (Eds.), *Driver distraction: Theory, effects, and mitigation* (pp. 31-40). Boca Raton: Florida: CRC Press.

Loewenthal, K. M. (1996). *An introduction to psychological tests and scales*. London, UK: UCL Press Limited.

MacKillop, J., & Anderson, E. J. (2007). Further psychometric validation of the mindful attention awareness scale (MAAS). *Journal of Psychopathology and Behavioral Assessment, 29*(4), 289-293.

McEvoy, S. P., Stevenson, M. R., & Woodward, M. (2006). The impact of driver distraction on road safety: Results from a representative survey in two Australian states. *Injury Prevention, 12*(4), 242.

McEvoy, S. P., Stevenson, M. R., & Woodward, M. (2007). The contribution of passengers versus mobile phone use to motor vehicle crashes resulting in hospital attendance by the driver. *Accident Analysis & Prevention, 39*(6), 1170-1176.

National Highway Traffic Safety Administration. (2017). *Distracted driving 2015: Traffic safety facts research note (Rep. No. DOT HS 812 381)*. Washington, DC: US Department of Transportation, National Highway Traffic Safety Administration.

Oulasvirta, A., Rattenbury, T., Ma, L., & Raita, E. (2012). Habits make smartphone use more pervasive. *Personal and Ubiquitous Computing, 16*(1), 105-114.

Panek, E. T., Bayer, J. B., Dal Cin, S., & Campbell, S. W. (2015). Automaticity, mindfulness, and self-control as predictors of dangerous texting behavior. *Mobile Media & Communication, 3*(3), 383-400.

Pöysti, L., Rajalin, S., & Summala, H. (2005). Factors influencing the use of cellular (mobile) phone during driving and hazards while using it. *Accident Analysis & Prevention, 37*(1), 47-51.

Reason, J., Manstead, A., Stradling, S., Baxter, J., & Campbell, K. (1990). Errors and violations on the roads: A real distinction? *Ergonomics, 33*(10-11), 1315-1332.

Regan, M. A., Young, K. L., Lee, J. D., & Gordon, C. P. (2009). Sources of driver distraction. In M. A. Regan, J. D. Lee & K. L. Young (Eds.), *Driver Distraction: Theory, effects and mitigation* (pp. 249-279). Boca Raton, Florida: CRC Press.

Salmon, P. M., Stanton, N. A., & Young, K. L. (2012). Situation awareness on the road: Review, theoretical and methodological issues, and future directions. *Theoretical Issues in Ergonomics Science, 13*(4), 472-492.

Sasai, S., Boly, M., Mensen, A., & Tononi, G. (2016). Functional split brain in a driving/listening paradigm. *Proceedings of the National Academy of Sciences*, 201613200.

Strayer, D. L. (2015). Attention and driving. In J. Fawcett, E. Risko & A. Kingstone (Eds.), *The handbook of attention* (pp. 423-442). Cambridge, MA: MIT Press.

Terry, C. P., & Terry, D. L. (2015). Cell phone-related near accidents among young drivers: Associations with mindfulness. *The Journal of Psychology, 149*(7), 665-683.

Valero-Mora, P., Pareja, I., Pons, D., Sánchez, M., Montes, S. A., & Ledesma, R. D. (2015). Mindfulness, inattention and performance in a driving simulator. *IET Intelligent Transport Systems, 9*(7), 690-693.

Walsh, S. P., White, K. M., Hyde, M. K., & Watson, B. (2008). Dialling and driving: Factors influencing intentions to use a mobile phone while driving. *Accident Analysis & Prevention, 40*(6), 1893-1900.

White, C., Fern, L., Caird, J., Kline, D., Chisholm, S., Scialfa, C., & Mayer, A. (2006). The effects of DVD modality on drivers' performance. *Paper presented at the 37th Annual Conference of the Association of Canadian Ergonomics*, Banff, Canada.

World Health Organization. (2011). *Mobile phone use: A growing problem of driver distraction*. Geneva, Switzerland: World Health Organization.

Young, K. L., & Lenné, M. G. (2010). Driver engagement in distracting activities and the strategies used to minimise risk. *Safety Science, 48*, 326-332.

Young, K. L., Osborne, R., Koppel, S., Charlton, J. L., Grzebieta, R., Williamson, A., Haworth, N., Woolley, J., & Senserrick, T. (in press). What are Australian drivers doing behind the wheel? An overview of secondary task data from the Australian Naturalistic Driving Study. *Journal of the Australasian College of Road Safety*.

Young, K. L., Regan, M. A., & Lee, J. D. (2009). Factors moderating the impact of distraction on driving performance and safety. In M. A. Regan, J. D. Lee & K. L. Young (Eds.), *Driver distraction: Theory, effects and mitigation* (pp. 335-351). Boca Raton, FL: CRC Press.

Young, K. L., Salmon, P. M., & Cornelissen, M. (2013). Missing links? The effects of distraction on driver situation awareness. *Safety Science, 56*, 36-43.

Zhou, R., Rau, P.-L. P., Zhang, W., & Zhuang, D. (2012). Mobile phone use while driving: Predicting drivers' answering intentions and compensatory decisions. *Safety Science, 50*(1), 138-149.

Zhou, R., Wu, C., Patrick Rau, P.-L., & Zhang, W. (2009). Young driving learners' intention to use a handheld or hands-free mobile phone when driving. *Transportation Research Part F: Traffic Psychology and Behaviour, 12*(3), 208-217.

Table 1

Distraction items and categories used for analysis and reported participant engagement in each activity while driving

Distraction Categories	Distraction items	Never (%)	Occasionally (%)	Sometimes (%)	Often (%)	Always (%)	Cronbach's Alpha
Talking on mobile phone	Talk on mobile phone - hands free	21.6	33.3	18.6	20.6	5.9	.46
	Talk on mobile phone – hand-held	63.0	30.6	5.8	0.3	0.3	
Text messaging	Read mobile phone text message	38.5	41.4	11.7	7.8	0.6	.89
	Write mobile phone text message	56.9	30.9	9.3	2.9	0	
Other technology	Mobile device to access Internet	69.5	22.2	5.1	2.9	0.3	.79
	Add on media device (iPad or tablet)	77.0	16.4	3.9	2.0	0.7	
	Wear headphones on mobile device	85.7	9.4	4.2	0.6	0	
	Take photo or video with phone	80.7	16.0	2.6	0.3	0.3	
	Access social media	76.9	15.6	5.2	1.6	0.7	
	Interact with climate controls	2.9	24.8	29.3	35.4	7.7	
	Change music	3.8	28.2	23.7	30.8	13.5	
	Enter destination into GPS system	37.3	34.0	19.3	7.8	1.6	
Non-technology sources	Eat, drink, smoke	11.9	34.9	32.6	18.1	2.6	.49
	Read a map	45.2	37.5	14.3	2.3	0.7	
Advanced Driver Assistance Systems	Distracted by lane departure warning	46.4	40.6	11.7	0.4	0.8	
	Distracted by blind spot warning	63.3	30.6	5.2	0.4	0.4	.89
	Distracted by collision warning	62.7	27.9	8.6	0.4	0.4	
Interacted with passengers	Interact with adult passengers	0	8.4	23.2	49.5	19.0	.58
	Interact with child passengers	17.0	20.2	16.3	26.5	20.1	
	Not thinking about driving (daydreaming or lost in thought)	7.7	46.8	26.9	17.3	1.3	
	External to vehicle distraction	3.5	53.6	35.3	7.1	0.6	

Table 2

Descriptive statistics and correlation matrix

	M (SD)[1]	1	2	3	4	5	6	7	8	9	10	11	12	13
1 Age	46.0 (13.73)	-												
2 Gender	-	.02	-											
3 Driving frequency	1.53 (0.67)	.08	-.02	-										
4 Mindfulness (MAAS)	3.68 (0.79)	.07	-.07	.01	-									
5 Talking on mobile phone	2.00 (0.77)	-.17**	-.03	-.26**	-.13*	-								
6 Text messaging	1.74 (0.81)	-.23**	.06	-.20**	-.19**	.59**	-							
7 Other technology	1.87 (0.52)	-.22**	-.01	-.24**	-.19**	.59**	.73**	-						
8 Adult passenger interaction	3.79 (0.84)	-.10	-.04	-.07	-12*	.31**	.20**	.36**	-					
9 Child passenger interaction	3.13 (1.33)	.05	.09	-.22**	-.04	.19**	.11	.12*	.48**	-				
10 Non-technology sources	2.20 (0.74)	-.14*	.03	-.17**	-.14*	.42**	.44**	.52**	.36**	.21**	-			
11 Advanced Driver Assistance Systems	1.56 (0.67)	.08	.14*	-.01	-.23**	.09	.15*	.13*	.02	.09	.14*	-		
12 Not thought about driving (e.g., daydreaming, lost in thought)	2.58 (0.91)	-.04	.08	-.04	-.52**	.24**	.27**	.36**	.26**	.08	.32**	.22**	-	
13 External to vehicle distraction	2.48 (0.71)	-.03	-.04	.03	-.34**	.25**	.27**	.38**	.25**	.12*	.38**	.27**	.45**	-

[1] Mindfulness rating scale was 1 – 6; Distraction items rating scale was 1 – 5.

* $p < .05$ ** $p < .01$

Table 3

Linear regression analysis results: mindfulness predicting talking on cell phone

Variable	B	95% CI	SE(B)	β	t	p
Age	-.26	-.47 – -.05	.11	-.14	-2.48	.014*
Gender	-.07	-.28 – .14	.11	-.04	-.67	.505
Driving frequency	-.29	-.41 – -.17	.06	-.25	-4.59	.000**
MAAS	-.12	-.22 – -.01	.05	-.12	-2.15	.033*

Note. $R^2 = .105$

* $p < .05$ ** $p < .01$

Table 4

Linear regression analysis results: mindfulness predicting text messaging

Variable	B	95% CI	SE(B)	β	t	p
Age	-.41	-.62 – -.19	.11	-.21	-3.78	.000**
Gender	.12	-.09 – .34	.11	.06	1.10	.272
Driving frequency	-.22	-.35 – -.09	.07	-.18	-3.34	.001**
MAAS	-.17	-.28 – -.06	.06	-.16	-2.99	.003**

Note. $R^2 = .118$

* $p < .05$ ** $p < .01$

Table 5

Linear regression analysis results: mindfulness predicting other technology use

Variable	B	95% CI	SE(B)	β	t	p
Age	-.24	-.38 – -.10	.07	-.19	-3.42	.001**
Gender	-.03	-.18 – .11	.07	-.03	-.46	.644
Driving frequency	-.18	-.26 – -.09	.04	-.23	-4.19	.000**
MAAS	-.11	-.18 – -.04	.04	-.17	-3.14	.002**

Note. $R^2 = .126$

* $p < .05$ ** $p < .01$

Table 6

Linear regression analysis results: mindfulness predicting engagement with non-technology sources

Variable	B	95% CI	SE(B)	β	t	p
Age	-.21	-.41 – -.01	.10	-.12	-2.06	.000**
Gender	.04	-.17 – .25	.11	.02	.35	.724
Driving frequency	-.18	-.29 – -.06	.06	-.16	-2.88	.004**
MAAS	-.11	-.22 – -.01	.05	-.12	-2.14	.033*

Note. $R^2 = .06$

* $p < .05$ ** $p < .01$

Table 7

Linear regression analysis results: mindfulness predicting engagement with ADAS

Variable	B	95% CI	SE(B)	β	t	p
Age	.16	-.06 − .37	.11	.09	1.46	.147
Gender	.22	.00 − .43	.11	.13	1.99	.047*
Driving frequency	-.01	-.14 − .11	.06	-.01	-.21	.837
MAAS	-.20	-.31 − -.09	.05	-.24	-3.74	.000**

Note. $R^2 = .08$

* $p < .05$ ** $p < .01$

Table 8

Linear regression analysis results: mindfulness predicting interaction with passengers

Variable	B	95% CI	SE(B)	β	t	p
Age	.02	-.24 − .28	.13	.01	.13	.898
Gender	.12	-.15 − .39	.14	.05	.90	.368
Driving frequency	-.26	-.42 − -.10	.08	-.19	-3.27	.001**
MAAS	-.09	-.22 − .05	.07	-.07	-1.28	.202

Note. $R^2 = .04$

* $p < .05$ ** $p < .01$