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The Temptation to Text When Driving - Many Young Drivers Just Can't Resist

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Abstract

When questioned, people clearly understand that texting while driving is a dangerous behaviour. However, evidence convincingly shows that a meaningful proportion continue to both read and write texts. Why is this? We prospectively recognise the risks associated with the task; yet in context, many of us are unable to restrain our behaviour for the greater good. This paper reports a simulator study investigating young drivers' engagement with texting. It considers, i) willingness to text, and ii) the nature of the temptation (modest financial reward or penalty).

The study had a mixed design with all Participants experiencing a 'temptation to text' condition (and a control). During the 'temptation to text' condition, half the sample were offered either the financial reward to incentivise responses, while the others had an equivalent penalty. Ultimately, all participants received full compensation. Driver performance and mental workload measures were collected as proxy indicators for behavioural impacts.

Results are consistent with previous published studies and showed significantly increased workload. Similarly, vehicle performance was also found to be significantly worse when texting and driving. However, the primary goal of this study was to explore the willingness of young drivers to read and respond to mobile phone 'texts' when tempted to do so. Engagement with texting was found to be significantly higher than hypothesised with 60% of participants responding to text messages. Adoption of short headways was found to be predictive of an inclination to text. Socio-technical implications are considered with respect to the potential to reduce texting while driving.

Keywords: driver, distraction, SMS, messaging, workload.

The Temptation to Text When Driving - Many Young Drivers Just Can't Resist

Drivers recognise that texting while driving is a dangerous activity (Hosking, Young, & Regan, 2007). For example, one substantial Australian survey reported 86% of respondents thought they were more likely to have an accident if they used their phone while driving (Petroulias, 2011). Numerous studies (Basacik, Reed, & Robbins, 2011; Caird, Johnston, & Willness, 2014; Caird, Johnston, Willness, & Asbridge, 2013; Rumschlag et al., 2015) have clearly demonstrated the increased risks from engaging with in-vehicle messaging. Data from road trials (Klauer, Dingus, Neale, Sudweeks, & Ramsey, 2006), driving simulator studies (Drews, Yazdani, Godfrey, & Cooper, 2009) along with user interface evaluations (Salvucci & Beltowska, 2008), have all highlighted 'deleterious effects on driving' from in-motion mobile phone use. Studies frequently suggest mobile phone use may result in hazardous increases in reaction time, and general degradation in driving performance (Horrey & Wickens, 2006), including periods when the vehicle is stationary, for example, from reduced situational awareness (Bernstein & Bernstein, 2015). Thus, the potential for increased demands to be placed on the driver from internet-connected cellular telephones is a well-established road safety problem.

Given that when questioned, drivers recognise and acknowledge the dangers to road safety from reading or writing texts when driving (Petroulias, 2011), why might the disconnect exist between some drivers' evaluations and their subsequent behaviours. Data is frequently obtained via surveys (e.g., Lansdown, 2012), and these are often completed online, in person, or over the telephone. Thus, their context is remote from the actual task. Researchers do not (generally) question participants about their ability to drive while they are actually performing the task; doing so, could impose an additional demand on the drivers. Consequently, there is a potential variance between their state while performing the driving task, and their reflections on their state when recalling it at a later point. There appears to be an incompatibility between (almost all) drivers acknowledging the dangers from messaging (Petroulias, 2011); and a sizeable proportion of them still engaging in such risks while driving (Gras, Cunill, Sullman, Planes, Aymerich, & Font-Mayolas, 2007; Lansdown, 2012). Why might drivers' analysis of risk (when reflecting on a task), differ from the behaviours of some when actively engaged in the task at hand? It may be pertinent to consider drivers' risk appraisal as a dynamic factor (Ram & Chand, 2016). Thus, propensity to engage in a secondary mobile phone task has been shown to be influenced by both the driving environment (Hancox, Richardson, & Morris, 2013), along with individual differences (Oviedo-Trespalacios, Haque, King, & Washington, 2018a). Phillips, Saling, & Blaszczynski (2008) present data suggesting that extraverts are inclined to greater phone use than others. They argue that those with low impulse control may less able to resist mobile phone use. Studies have previously shown (Briggs, Hole & Land 2011; Roshandeh, Zhou & Behnood, 2016; Gugliotta & Ventsislavova, 2017) that our ability to make sound judgments may become compromised during some actions. One notable example surveyed sexual activity, demonstrating significantly more liberal attitudes from participants questioned during 'the heat of the moment' (Ariely & Loewenstein, 2006). Consequently, perhaps it is plausible that (in addition to user interface considerations) emotional or social factors may influence our behaviour, and lead to shifted judgments regarding the wisdom of some task engagements.

The role of emotion on our ability to control the vehicle has been demonstrated in several previous studies. Contentious conversations between passenger and driver have been shown to compromise vehicle control (Lansdown & Stephens, 2013). Anger has been reported to result in engagement with hazardous manoeuvring (Stephens & Groeger, 2011). Further, parents attending to children have been demonstrated to be significantly more distracted than when driving alone (Koppel, Charlton, Kopinathan, & Taranto, 2011). These studies contribute towards a growing body of evidence of the potentially compromising impact of social-emotional factors on road safety. It is suggested that these factors may be responsible for the compromised judgments some drivers make when deciding whether to engage with in-vehicle messaging while driving.

The nature of messaging has undergone great change in recent years. The fundamental concepts of what a phone is, when it's available, and how we operate it, have all shifted substantially in the early 21st century. Ranney (2008) summarised the issues as two converging trends, i) the continuing increase in cell phone user numbers, and ii) phone use for more than just conversation. With the widespread adoption of the 'smartphone', we are now equipped with devices that enable us to be continuously connected to each other. Thus, it is further suggested that smartphones have introduced three new distraction challenges, i) the increased connectivity, ii) the availability of rich multimedia content, and iii) the unpredictability of alerts, notifications and updates; all of which compete and vie for our limited attention.

How widespread is driver engagement with text messaging? Numerous studies have now explored this issue with figures between 16.6% and 62% reported (Huisingh, Griffin, & McGwin, 2014; Lansdown, 2012; Oviedo-Trespalacios, Haque, King, & Washington, 2018b; White, Hyde, Walsh, & Watson, 2010). Are particular groups at more risk of compromised decision-making? For example, Caird, Johnston, & Willness (2014) state 45% of young drivers have been reported to text while driving. In 2009, the figure was reported to be 26% (Madden & Lenhart, 2009); while percentages as high as 72.5% have been reported (Bergmark, Gliklich, Guo, & Gliklich, 2016; Nelson, Atchley, & Little, 2009). In their simulator study, Hosking, Young and Reagan (2007) found that young novice drivers spent up to 400% more time looking away from the road when texting, than when not texting. Results suggested that retrieving and sending text messages had a significantly detrimental effect on driving performance. Specifically, when text messaging, drivers were more likely to experience greater lateral deviation and were less likely to respond appropriately to traffic signs. Gauld, Lewis, White, Fleiter and Watson (2017) present an interesting analysis of smartphone use suggesting structurally different processes are involved in i) initiation of messaging, when compared to ii) monitoring/reading, and iii) responding. Using an Extended version of the Theory of Planned Behaviour (Ajzen, 1985), the authors present Perceived Behavioural Controls, Subjective Norms, Cognitive Capture and Attitudes (except for Monitoring/Reading) as consistent significant predictors of intentions to message; for all three identified components of messaging. Considering the differences between messaging behaviours, for Initiating/Monitoring/Reading, Moral Norms were identified as significant negative predictors; while Anticipated Action Regret was significant for Responding behaviours. Thus, there appears to be fundamental difference between particularly Monitoring/Reading and Responding behaviours. Gauld et al.'s (2017) findings support driver's recognition of the societally inappropriate nature of messaging. Further, for those contemplating Responding to messages, their findings suggest rational evaluation of the personal implications of the behaviour.

Despite the risks, there continues to be a prevalence of mobile phone use while driving (Lansdown, 2012; McEvoy, Stevenson, & Woodward, 2006; Pennay, 2006). Further, youth has also been shown to be predictive of increased engagement with distracting driving behaviours (Lansdown, 2012). Thus, texting while driving, represents a particular increased risk for the younger age group. Further the potential danger for this cohort is exacerbated to the extent that such activity may be being performed by people without fully-developed driving skills. Factors shown to produce performance decrements for drivers interacting with in-vehicle information systems have included driving experience (Lamble, Laakso & Summala, 1998), attentional allocation (Liu, 1996; Matanzo & Rockwell, 1967) and mental workload (Hancock & Verwey, 1997; Lansdown, Brook-Carter, & Kersloot, 2004).

Perhaps there is something about the nature of the information drivers receive that particularly tempts them to respond. Temptation has been characterised as having two key components, i) an attractive element (the desire to engage with a behaviour) and, ii) a forbidden one (an implicit recognition that there is something wrong about the behaviour, Hughes, 2002). For example, an email from a work colleague might not have the same personal salience as a plea for help from a loved one but would still be recognised as inappropriate to respond to while driving. Bassick, Reed and Robins (2011) studied the effects of using social networking applications while driving. Such ‘apps’ have many of the same interface components as a ‘traditional’ text (SMS) messaging interaction. The participants experienced a multiple distraction environment with cognitive, physical and visual components. Reaction times were found to be 30% slower during smartphone use. Further, lane deviations and departures were also significantly increased. Participants were found to spend 40-60% of the time looking down when engaging with the Social Networking condition, with a level of 10% found during the Control drive.

The simulator study reported here investigates young drivers’ inclination to read and respond to text messages. Considering Gauld et al.’s (2017) classification of messaging, this study considers Monitoring/Reading and Responding behaviours. Initiating of messaging was not explored here to minimise the experimental variability of the participant’s experience. The participants were ‘tempted’ to read and respond to messages using either a reward or penalty manipulation; while vehicle control and subjective mental workload measures were taken as proxies for task performance. The rationale for this design was to introduce an incentive component akin to the socio-emotional factors that may compromise ‘out of task’ decision-making. The reward/penalty manipulation was investigated to further determine the relative merits of one ‘draw’ over another. Risk taking has been suggested to depend on the one's perceptions of the scenario; such that in a 'gainful' environment, participants will be risk adverse, while more risky in a lossy setting (Kahneman & Tversky, 1979). Therefore, it was anticipated that participants would be more inclined to respond to text messages in the penalty condition.

Overall, during the Texting condition, it was hypothesised that:

- participants will not respond to text messages
- if responding, participants in the Penalty group will respond to more text messages than those in the Reward group
- participants will have higher mental workload than in the Control
- participants will have reduced longitudinal vehicle control than in the Control
- participants will have reduced lateral vehicle control than in the Control.

Method

Design

The experiment had a mixed design with two factors. The factor Temptation had two levels (Texting or a Control), and was a repeated measure, and the factor Payment had two levels (Reward or Penalty) and was administered between participants. The presentation of conditions was counterbalanced, and participants were randomly assigned to groups. Each condition lasted approximately ten minutes and was followed by a short break lasting no more than five minutes.

The study aimed to 'tempt' participants to both read and respond to text messages, much like the everyday experience of millions of drivers today throughout the world. Consequently, after data collection was completed, the experimenters explained the nature of the study and stressed the extreme risk from interactions with text messaging while driving.

Participants

Thirty participants were recruited from the student population of Heriot-Watt University, Edinburgh. No indication of payment was provided to potential participants during recruitment, aside from course credit. Fifteen were male. In the Penalty Condition there were seven males, in the Reward condition, there were eight. All participants had at greater than one year of driving experience (mean = 4.3 years, SD = 2.86) with an annual average mileage of six thousand miles (SD = 4,429). Ages ranged from 18 to 30 (mean = 22.7, SD = 3.51). All participants self-reported 'normal' or 'corrected to normal' vision.

Equipment

The study was performed in a fixed-base driving simulator. The simulator is an STI SIM Model 100. It displays a 60° forward view, using 1280×800 pixels. The system presents 7.1 channel Dolby surround sound and is controlled using a Logitech G25 steering wheel with a manual gearbox. The scenario drivers experienced in each condition had two sections. The 66% was a rural simulation, with counterbalanced random events occurring four times throughout this section of the drive. Events were either, a vehicle unpredictably pulling out in front of the driver, or a vehicle joining the lane in front of the driven vehicle and driving slowly. The final 33% was a road section with a central reservation and two lanes on either side. The driver was instructed to accelerate to 50 mph and then follow a white sports utility vehicle at a safe distance (of approximately 2 secs time headway; DfT, 2010), in the left-hand lane (driving on the left hand side of the road). The participants drove for approximately eight miles (13km) in each condition. The lead vehicle's speed varied following a sinusoidal pattern increasing and decreasing by up to 10 mph (16.1 km/h). The period of the sine wave was 60 secs, so that assuming participants travelled at 50 mph, they would experience approximately six interactions of the lead vehicle speeding and slowing. The combination of the mildly varying bends on the road and the lead vehicle's speed changes created a varying lateral and longitudinal driving task. Vehicles were displayed travelling on the other side of the road and also travelling in the driver's direction. The vehicles would periodically overtake the driven vehicle. Vehicles behave 'semi-intelligently' in the simulation by attempting to brake, accelerate, or move to avoid collisions.

Procedure

In overview, all participants were welcomed to the simulator laboratory, introduced to the study, and then experienced two driving scenarios. These were the Control and Temptation to Text conditions; the presentation order was counterbalanced across the participants. Half of the participants were financially rewarded for responding to the text messages, while the other half were financially penalised for failing to respond. Subjective mental workload measures were taken after each condition and participants were thanked for their contribution after data collection.

In detail, informed consent was obtained from all participants on arrival at the driving simulator laboratory. Ethical approval for the study was granted by the Heriot-Watt University, School of Life Sciences Ethics Committee.

Participants were introduced to the simulator and familiarised with its controls. They were informed they may need their mobile phone during the study and test text messages were exchanged with the experimenter. The test text had the following content, “Hey how’s things? Are we still ok to meet at 7 tonight for food?”. Response times were recorded with the vehicle stationary. Subsequently, participants undertook a five-minute familiarisation drive in the simulator. Participants were explicitly instructed to “Please drive as you would in a real vehicle, comply with road instructions to the best of your ability”. Additionally, drivers were instructed to perform an embedded divided attention task. In this task, red diamonds are continually presented in the top right and left corners of the simulation display. At approximately every 2000ft (610m), the diamonds changed shape to equilateral triangles. At this point the drivers were tasked to respond to these changes as swiftly as possible by pressing a button on the corresponding side of the steering wheel. During both the Control condition and the Texting conditions, there were twenty presentations of the embedded divided attention task per condition. The task was included in the study as visual peripheral detection tasks have been previously shown to be sensitive to changes in workload (Jahn, Oehme, Krems & Gelau, 2005). It was anticipated that this measure would provide data related to Hypothesis 3.

Participants subsequently experienced both the Control condition (normal driving with the addition of the embedded divided attention task) and the Texting condition (the Control conditions with the addition of the texting task described below), according to the counterbalancing schedule. During the Texting condition, participants received (up to four) text messages, defined as temptations for the purposes of the study. The initial message described the nature of their texting task, i.e., “You’ll be sent some text messages. You have £2.50 to start, but you’ll get a 50p REWARD for each that you respond to within one minute. Deal with the texts as you would if driving a real car” (for the Reward condition) or “You’ll be sent some text messages. You have £5 to start, but you’ll get a 50p PENALTY for each that you fail to respond to within one minute. Deal with the texts as you would if driving a real car” (for the Penalty condition). The initial message was sent at the start of the condition while the driver’s vehicle was stationary. Subsequent messages were sent pseudo-randomly after a one-minute warm up period of driving, and never during a simulator ‘event’. Within the next minute a message was sent, giving the participants two minutes to respond, before repeating the cycle. Up to four messages were sent depending on available time in the condition. There were no failures to receive messages, and message content is presented in Table 1. Messages were structured so as to be semi-realistic in nature, with matched numbers of characters, and requiring either relatively simplistic or complex responses.

After each condition, drivers were instructed to complete the NASA R-TLX (Byers, Bittner, & Hill, 1989) and asked if they wish to continue after a short break; all participants elected to proceed. The NASA TLX is a multidimensional scale eliciting overall subjective mental workload ratings. It is composed of sub-scales for mental demand, physical demand, temporal demand, performance, effort and frustration (Hart & Staveland,1988). Administration of the R-TLX (Byers, Bittner, & Hill, 1989) is equivalent to the TLX, but without a card-sorting stage, and has been shown to be psychometrically equivalent.

[Insert Table 1 about here]

Results

Study results are presented in three sections, corresponding to the study hypotheses, i) response rates to texting temptations, ii) mental workload findings, and iii) vehicle performance data.

Response Rates

Hypothesis 1 asserts that participants will not respond to the temptation to text and will ignore messages received on their phones. A binomial test indicated that the proportion of those showing 'willingness to respond' (18/30) was significantly higher than hypothesised (0/30), $p < .0001$. Therefore, the null is accepted for Hypothesis 1. Three further participants read the incoming texts in the Texting condition, and subsequently pulled their 'vehicle' to the side of the road prior to responding. They elected to read but not respond until the vehicle was stationery. Thus, while the vehicle was in motion, 21/30 participants read the text messages, while 18/30 both read and responded.

Hypothesis 2 supposes that participants in the Penalty group would be more inclined to respond to text messages than their counterparts in the Reward group. A 2 × 2 Chi-square test was performed and found to be not significant (χ^2 (1, n = 30) = 0.16, $p = 0.69$) for the groups (Reward vs. Penalty) by text message responses (Response vs. No response) analysis, see Table 2.

[Insert Table 2 about here]

Texting performance was also analysed. Considering the pre-drive baseline measurements. There were no significant differences between the Penalty (M = 37.00 secs, SD = 13.19 secs) and the Reward groups (M = 30.84 secs, SD = 11.62 secs) for independent subjects t-tests. Suggesting the groups were homogeneous before experiencing the Payment factor. For those who elected to respond to the text message prompts during the Texting condition, no significant difference was found between the Reward (M = 29.66 secs, SD = 17.66 secs) and Penalty groups (M = 39.81 secs, SD = 28.9 secs) for mean response times. Consequently, the null is accepted for Hypothesis 2, participants in the Penalty group were not found to respond to a significantly greater number of text messages.

Mental Workload

In Hypothesis 3, participants in the Texting condition are suggested to experience significantly higher mental workload (Byers, Bittner, & Hill, 2015). Overall (mean) subjective mental workload was found to be significantly greater in the Texting condition (M = 58.9, SD = 14.6) than the Control (M = 42.7, SD = 11.8), $t(29) = -5.52$, $p < 0.0001$, $d = 1.01$. All of the NASA-TLX sub-scales were also found to be significantly greater in the Texting condition, i.e., Mental Demand ($p < 0.0005$), Physical Demand ($p < 0.005$), Temporal Demand ($p < 0.001$), Effort ($p < 0.005$), and Frustration ($p < 0.0001$); with the exception of Performance (which was not significantly different), see Figure 1. The compelling data provides evidence to reject the null for Hypothesis 3.

[Insert Figure 1 about here]

Potential interactions were explored using a two-way mixed ANOVA. The between-participants factor Payment had two levels (Reward or Penalty) and the within-participants factor Texting also had two levels (Temptation to text or Control). No significant differences were found for either factor, nor any interactions for Overall subjective mental workload (or any of the sub-scales).

Data from the embedded divided attention task was investigated using a two-way mixed ANOVA. The factor Payment had two levels (Reward or Penalty) and the factor Texting also had two levels (Temptation to text or Control). No significant differences were found for either factor, nor any interactions for the dependent variables, Reaction Time, Correct, Incorrect or Missed Responses, see Table 3.

[Insert Table 3 about here]

Vehicle Performance Data

Longitudinal vehicle performance data is initially presented; this is then followed by lateral performance metrics.

Hypothesis 4 predicts that longitudinal vehicle control will be reduced in the Texting condition with respect to the Control. Median 'time to collision' was analysed using a paired t-test. No significant differences were identified between the Control (M = 2.14, SD = 0.88) and Texting (M = 1.98, SD = 0.71) conditions. Median minimum headway was also subjected to a paired student's t-test. Results revealed that minimum headways were significantly shorter ($t(29) = 5.05$, $p < 0.001$, $d = 0.92$) during the Texting condition (M = 44.2ft, SD = 17.4) than the Control (M = 57.5ft, SD = 20.1), see Figure 2. Consequently, it is considered that available data supports rejection of the null for Hypothesis 4. Given that the participants appeared to be less able to regulate headways to vehicles in front, was their lateral control effected by the temptations to text?

[Insert Figure 2 about here]

Hypothesis 5 asserts that lateral control will be compromised during the Texting condition relative to the Control. A paired t-test revealed significantly more ($t(29) = 4.29$, $p < 0.001$, $d = 0.78$) lane exceedances during the Texting Condition (M = 6.07, SD = 2.66) than in the Control (M = 3.27, SD = 1.98). Much like the longitudinal control data reported above, lateral control appears to be compromised during the Texting condition, see Figure 3. Therefore, the null is rejected for Hypothesis 5.

[Insert Figure 3 about here]

Collision data was also explored to investigate the functional impact of compromised vehicle control reported above. A binomial test revealed a significantly higher than chance number of collisions occurred during the Texting condition (13), in comparison to the Control (3, $p < 0.05$). Collisions were hypothesised to be equally likely to occur in each condition.

A logistic regression was performed to determine the impact of vehicle control factors (in Block 1), along with the factor Payment as a categorical variable in the Block 2) on the dependent variable response to text messages (Yes or No). The Block 1 contained four independent variables (with Variance Inflation Factors stated), Lane exceedances (1.30), Minimum headways (1.26), Time to collision (1.07) and Collisions (1.11). The Variance Inflation Factors are all sufficiently low to indicate no potential problems with collinearity. The second Block added the Reward or Penalty allocation as an additional categorical potential contributor to the model. The Block 1 model containing all the predictors was statistically significant $\chi^2 (4, N = 30) = 12.14$, $p < 0.05$, indicating the model was able to distinguish between participants who texted and those that did not. The Block 1 model explained between 33.3% (Cox and Snell R Square) and 47.2% (Nagelkerke R Square) of the variance in likelihood to text, and correctly classified 80.0% of cases. As indicated in Table 4, only one of the independent variables made a unique significant contribution to the model. The sole predictor of likelihood to text was Minimum headway, with an odds ratio of 0.9, indicating that for every reduction in headway of 1ft, respondents were 0.9 times more likely to text, controlling for other factors in the model. Block 2 did not improve the predictive strength of the model and the factor Payment was found not to be a significant contributor.

[Insert Table 4 about here]

Discussion

The aim of this study was to examine whether drivers could be tempted to read, and respond to text messages while driving, contrary to the current national legislation. Further, whether such behaviour would be influenced by a modest reward or penalty. Considering the Texting condition, it was hypothesised that i) participants would resist the temptation to respond to texts, ii) should any participants respond, they would be more likely to do so if messages were penalising in nature, and iii) that mental workload and vehicle performance would be degraded with respect to the Control condition. In summary, the results provided evidence of a willingness to engage with tempting text messages, and consequently, participants experienced significantly greater mental workload along with reductions in their ability to control the simulated vehicle, with respect to driving alone.

In review of the financial incentives to respond to the temptation texts. Baseline data were collected to ensure no structural differences existed in the performance of the Reward and Penalty groups. No significant differences were found and consequently it was assumed that any differences emerging from the data would be attributable to the experimental manipulation. However, no significant differences were identified between participants in either the Reward or Penalty groups. Indeed, even numbers responded (nine in each group) to the text temptations. This was a surprising finding as a similar manipulation had previously demonstrated the use of rewards to have a positive impact on performance (Lansdown & Saunders, 2012). This study aimed to substantiate this effect along with investigation of the utility of a penalty condition. A substantive literature exists concerning the relative merits of rewards vs penalties during task performance, and the position is somewhat complex. For example, in a meta-analysis of disease-prevention messaging, reward-framed appeals were found to be significantly more persuasive than penalties (O'Keefe & Jensen, 2007). However, it should be stated that no effect was found for safe-sex, skin cancer prevention or diet/nutritional behaviours. In a driving context, another meta-analysis of the driver improvement literature reports that the most effective measures for crash reduction were found to penalties, e.g., suspension from driving (Masten & Peck, 2004). The authors do indicate though that this effect may be attributable to reductions in driver exposure. Perhaps the manipulation in this study was not effective because the task in question was one that responsible drivers should not engage with. Alternatively, the magnitude of the temptations may not have been sufficient to overcome ‘rational resistance’, as it was only a modest sum (50p) per text.

At the core of this paper is the recognition that drivers know that it is dangerous (and in many nations illegal) to message while driving (Hosking, Young & Regan, 2007; Petroulias, 2011). Yet, our experience, observations, and data provide a compelling case that, in situ, we are less able to moderate our behaviour to protect society at large, than we might wish to be. Substantial proportions of the drivers on our roads today are (under certain circumstances) willing to read messages, and in many cases also respond to them (Madden & Lenhart, 2009, Caird et al., 2014). Findings from this paper provide empirical evidence of this effect. The interesting questions that remain are which factors attenuate such behaviours, and which exacerbate them (e.g., Phillips, Saling, & Blaszczynski, 2008). Further, what solutions may be proposed to remove such temptations.

The reward-penalty manipulation outlined above was an attempt to start to understand the nature of the factors influencing our propensity to be tempted to text. It is not clear whether the study had insufficient power to substantiate an effect or whether no effect exists; concerning the general notion of whether a reward or penalty is more likely to lead one to text. Considering the frequency of responders—even though the sums were modest—a significant proportion of the participants were sufficiently tempted to engage with the texting; a behaviour well recognised to be unsafe by drivers (Petroulias, 2011). Also, engagement with texting was consistent with the previously published literature (e.g., Horrey & Wickens, 2006). Further, when texting participants reported significantly greater mental workload and revealed degraded ability to control the vehicle. One has to question why participants were tempted to text? Perhaps they were victims of a Milgram-type (Milgram, 1963) compliance with the experimenter as an authority figure. However, the experimenter was also responsible for an explicit statement to comply with the rules of the road as if driving a real vehicle. It may be that the responders were purely driven by the prospect of either a gained reward or reduced loss. It is suspected that the actuality probably lies somewhere between these extremes. It is interesting to consider the participant's engagement with the temptations, and the commonalities of that behaviour to those on the public roads. For example, receiving a message from a loved one seeking urgent help, or one from a manager concerning a pressing work matter; either might lead to a reduced resistance to the adverse behaviour. In combination with the complex multi-faceted nature of the driving task, such temptations seem to lead (in some circumstances) to a failure to do what we recognise to be the right thing. Perhaps this is from a conflict between temporally-distinct codes of appropriate behaviour (e.g., Hancox et al., 2013). Thus, in one situation drivers may be tempted to undertake inappropriate behaviours; while in the other (perhaps more typical) case, rational re-scheduling of a ‘risky’ task would go on (e.g., Salvucci, Taatgen & Borst, 2009). A driver might recognise a messaging notification tone and decide to respond to it at the end of the journey or during a period of stationary traffic, rather than immediately. Logistic regression findings may provide some insight here in that those electing to adopt the shortest headways (to the lead vehicle) were significantly predicted to be more likely to read and respond to the text messages. Perhaps the drivers in the sample who texted represent a ‘risky driving trait’ cohort. However, the behaviour is too widespread to be attributable to a generalised group or a simple flagrant disregard for the law or other individuals. It is argued that efforts need to be invested in developing a better understanding of these socio-technical conflicts, along with well-conceived technical solutions sympathetic to our behaviours.

The ubiquitous availability of personal messaging is substantially the responsibility of the mobile telephone providers. They make the devices we all consider to be indispensable to modern life. Similarly, they have recognised the dangers of the interaction of their devices with our road users. Consequently, these providers have started to iterate their software systems to protect us from our inability to focus on the driving task alone. In this context, some successes should be recognised. One might suggest that the safe behaviour is just to remove your device from view or access while driving. Yet the constructive utility of these mobile computers is too great, and potentially positive to the driving experience for many people to take that stance. For example, the widespread availability of (up to date) route guidance information. Therefore, the challenge to present drivers with supporting information while minimising distractions is ongoing. Systems like Android Auto and Apple’s Carplay are becoming more common in the vehicle fleet; and such integrated and consistent interfaces, offer substantial promise for safer driving (e.g., Gable, Walker & Amontree, 2015), with respect to nomadic device use.

The study had several limitations. Users were largely (but not exclusively) drawn from an undergraduate population, and they were allowed to use their own devices (for personal familiarity). It seems highly likely that the embedded divided attention task would have imposed additional cognitive demands on the participants with respect to the ‘normal’ driving task. However, this additional demand was judged to be relatively minor, and was consistently applied in all conditions. As ever, findings from a simulator study to not indicate performance on the real roads, but sufficiently troubling behaviours were recorded (consistent with both existing survey data and experimental studies), that would indicate caution in a more ecologically valid setting. It may have been that participants felt pressured to comply with instructions received (Milgram, 1963), but no explicit nor repeated pressure to comply was imposed. Also, specific repeated efforts were made to impress on participants the importance of driving as one would on the real road. It would be an interesting area for further work to try to mediate this potential limitation.

Conclusions

Findings from this study provide convincing novel evidence that when tempted, significant numbers of participants are willing to both read and respond to messaging (for financial reward). Engagement with messaging, as has been substantially demonstrated in previous research, resulted in significant increases in subjective mental workload for the participants. Further, during the Texting condition, the participants’ lateral and longitudinal control of the vehicle was significantly degraded with respect to the Control. Further, adoption of short headways was found to be significantly predictive of reading and responding to texts. No significant difference was found between those receiving either a Reward or Penalty as an incentive to respond to the text messages.

The findings support existing data concerning the hazardous consequences of messaging while driving. More substantially though, they consider and question the fundamental motives, and propensity to engage with this anti-social behaviour. This paper makes a case for a better understanding of 'why' many of us undertake these behaviours (knowing them to be wrong) and how we might reduce them.

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Table 1. Experimental text message contents

Order	Message	Characters	Response
1	Do you have a car at the moment? Can you give a lift to a friend	64	Simple
2	Hi, know any Indian restaurants? Preferably, one near a good pub	64	Complex
3	Hey, you know Dan? Coming to the party at his flat this weekend?	64	Simple
4	It’s my mum’s birthday soon, can you suggest some presents, help	64	Complex

Table 2. Financial incentives by response rates (parentheses indicate participants reading the texts, and responding with the vehicle stationary)

	Texted	**Did not Text**
Reward	9 (1)	6
Penalty	9 (2)	6

Table 3. Summary Statistics (Mean and Standard Deviation) for the Divided Attention Task

	Reward		**Penalty**	
	Control	**Temptation to Text**	**Control**	**Temptation to Text**
Frequency: Correct Responses	11.4 (2.59)	12.1 (1.30)	11.2 (2.31)	9.87 (3.38)
Frequency: Incorrect Responses	3.93 (2.02)	3.33 (1.18)	3.87 (1.73)	5.33 (2.92)
Frequency: Misses	4.53 (2.39)	4.53 (1.19)	4.93 (1.75)	4.53 (2.13)
Reaction Times	2.14 (1.19)	2.4 (1.39)	1.83 (1.15)	1.96 (0.81)

Table 3. Logistic regression predicting likelihood of texting

	B	**S.E.**	**Wald**	**df**	***p***	**Odds Ratio**	**95% C.I. for Odds Ratio**	
							Lower	Upper
Collisions	-.812	.750	1.173	1	.279	.444	.102	1.930
Lane Exceed	.413	.254	2.637	1	.104	1.51	.918	2.488
Minimum Headway	-.106	.052	4.189	1	.041	.900	.813	.996
Time to Collision	-.965	1.02	.905	1	.341	.381	.052	2.782
Constant	5.03	2.80	3.222	1	.073	152.58		

Figure 1. Subjective mental workload

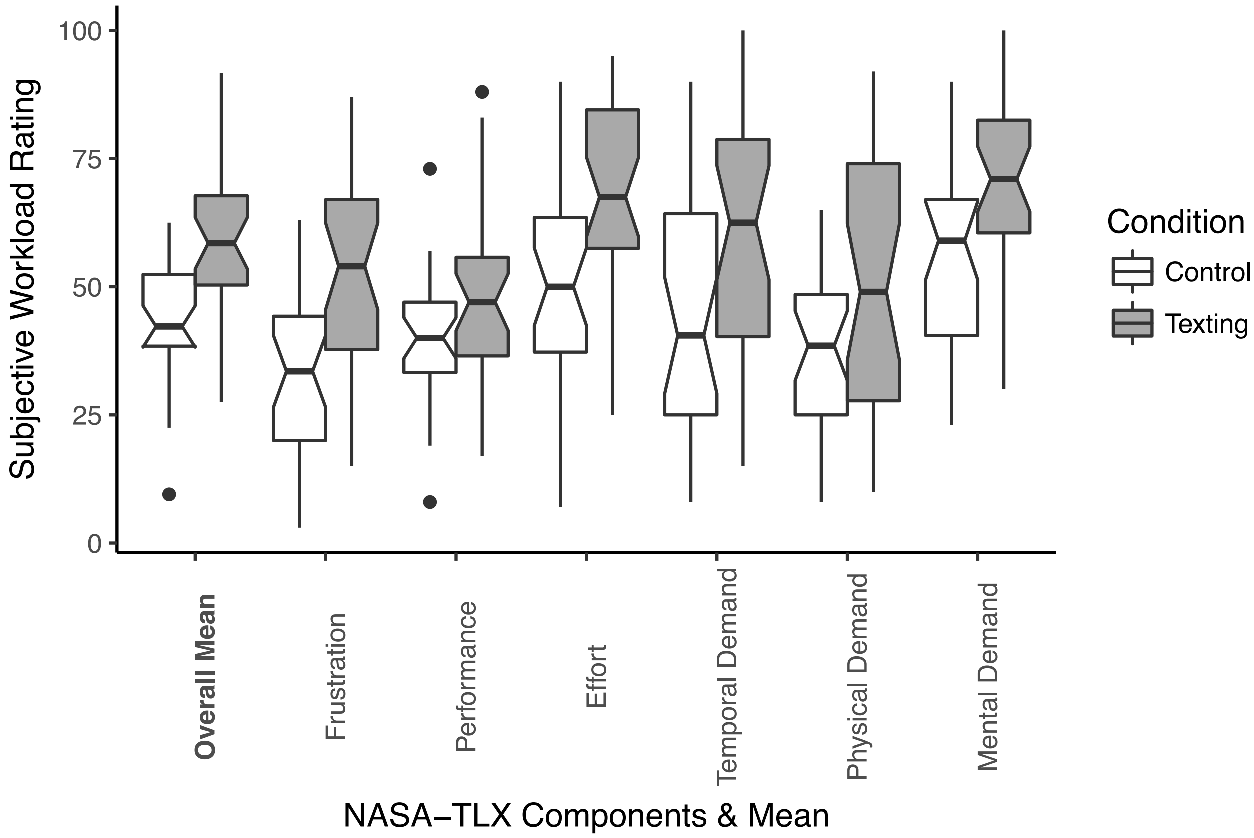

Figure 2. Median minimum headway

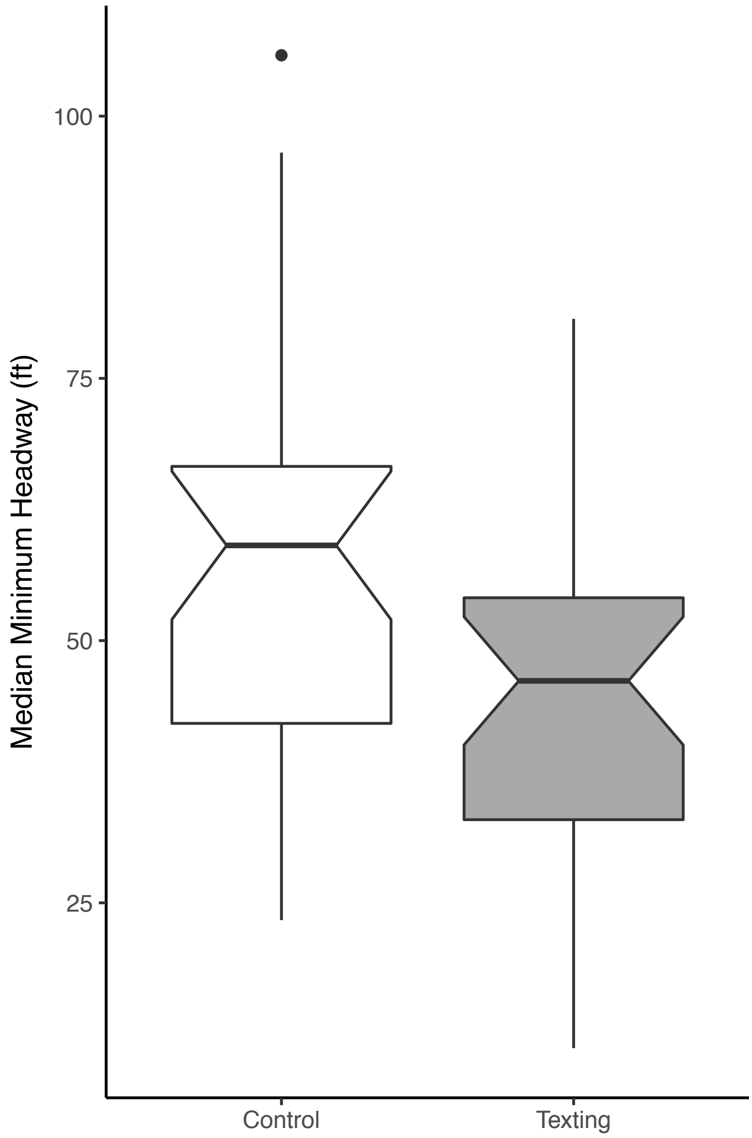

Figure 3. Lane exceedances