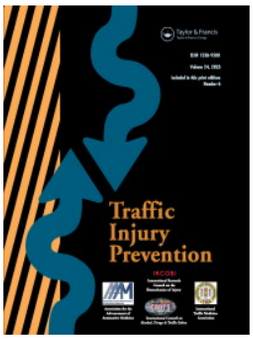

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Drive in the Moment: An evaluation of a web-based tool designed to reduce smartphone use among young drivers

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ABSTRACT

Objective: Young drivers are overrepresented in road traffic crashes and fatalities. Distracted driving, including use of a smartphone while driving (SWD), is a major risk factor for crashes for this age group. We evaluated a web-based tool (Drive in the Moment or DITM) designed to reduce SWD among young drivers.

Methods: A pretest-posttest experimental design with a follow-up was used to assess the efficacy of the DITM intervention on SWD intentions and behaviors, and perceived risk (of having a crash and of being apprehended by the police) associated with SWD. One hundred and eighty young drivers (aged 17-25 years old) were randomly assigned to either the DITM intervention or a control group where participants completed an unrelated activity. Self-reported measures of SWD and perceptions of risk were obtained pre-intervention, immediately post-intervention and at a follow-up 25 days after the intervention.

Results: Participants who engaged with the DITM showed a significant reduction in the number of times they used their SWD at follow-up compared to their pre-intervention scores. Future intentions to SWD were also reduced from pre-intervention to post-intervention and follow-up. There was also an increase in the perceived risk of SWD following the intervention.

Conclusions: Our evaluation of DITM suggests that the intervention had an impact on reducing SWD among young drivers. Further research is needed to establish which particular elements of the DITM are associated with reductions in SWD and whether similar findings would be identified in other age groups.

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Young drivers; distracted driving; cell phones; mobile phones; evaluation

Introduction

Worldwide, roughly 1.3 million people are killed in road traffic crashes each year (WHO 2022). Young people are overrepresented in these statistics, with road traffic injuries being the leading cause of death for those aged 5 - 29 years (WHO 2022). For the 15 - 24 year-old age group, road traffic crash fatalities are the second leading cause of death in Australia (AIHW 2022). In 2021, 19% of road fatalities occurred among those aged 17-25 years (BITRE 2022).

Mobile or smartphone use while driving (SWD) is one factor which has been identified as a major road safety risk. Naturalistic data suggests that drivers using a handheld phone increase their crash risk, particularly for some smartphone functions (Dingus et al. 2016; Neuroth et al. 2021). In Australia, it is an offense to use a hand-held mobile phone while driving a vehicle (VicRoads 2021; Transport for NSW 2019) although there are variations in laws by jurisdiction. Despite legislation banning or restricting SWD, it is still very common, with very high levels reported among younger/novice drivers (Brown et al. 2019). This suggests that further interventions, beyond legislation, may be required to decrease this common risky behavior.

Research also suggests that young adults are highly involved with their mobile phones and use them to stay connected (Deloitte 2017), and that mobile phone involvement is related to higher levels of SWD (Brown et al. 2021; Gauld et al. 2014; Mostyn-Sullivan et al. 2021). A survey of young Australian drivers found that the majority had tried to reduce their in-vehicle smartphone use *via* a number of different strategies, including placing the phone out of reach, switching the phone off and activating "do not disturb" mode (AAA 2020a, 2020b; Watson et al. 2020). However, this research also found that the employed strategies were not always effective and that young drivers were often not implementing the strategies they believed would be the most effective ones. Unfortunately, while there are multiple studies identifying predictors of SWD, *interventions* for reducing SWD are lacking.

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Gauld et al. (2021) examined whether an intervention designed to elicit cognitive dissonance about SWD could reduce the behavior. Results demonstrated a greater reduction in self-reported SWD at one-week follow-up among intervention group participants compared with controls. While limited to texting while driving (TWD), Suffoletto et al. (2022) identified a reduction in TWD after 12 wks among young adults assigned to receive automated/interactive text messages related to goal setting and self-regulation. Taken together, these studies show the potential utility in applying psychological theories to inform interventions for SWD. Given the novelty of these studies, and, as noted by Maldonado and Flaherty (2022), that a "multipronged approach is necessary" (p. 382) to address the behavior, we also need to consider other methods of intervention. Moreover, it remains unknown whether being informed of the risks of SWD and personalizing strategies to reduce the behavior will be effective in reducing SWD, despite some studies highlighting the association of perceived risk with SWD (e.g., Brown et al. 2019; Nguyen-Phuoc et al. 2020; Rajesh et al. 2017). Informed by commissioned research (from Center for Accident Research and Road Safety – Queensland; see AAA 2020a, 2020b) the Australian Automobile Association (AAA) developed the Drive in the Moment (DITM) toolkit with input from ED.Creative Studio and from Dr Mark Elliot, University of Strathclyde (for further information on the development of the DITM contact AAA: https://www.aaa.asn.au/). The DITM was made available nation-wide in Australia in 2020. The DITM is a web-based app which has two key elements: 1. a risk-rater tool aimed at educating young drivers about the relative risk of SWD (compared to other risky driving behaviors such as speeding, driving while impaired, driving while fatigued); and, 2. a plan-builder tool which allows users to identify the critical driving situations that tempt them to use their SWD and to link these situations with goal-directed responses or strategies to resist the temptation (or implementation intentions; AAA 2020b; Gollwitzer and Schaal 1998). In 2021, the AAA commissioned our research team to evaluate the efficacy of the DITM in reducing self-reported SWD among young Australian drivers.

Perceived risk

The DITM toolkit provides users with information about the relative crash risk of several driving behaviors (e.g., speeding, driving while impaired, driving while fatigued) including using a phone while driving. Relative risk refers to how risky (with respect to having crash) certain driving behaviors are relative to other driving behaviors. The relative risk is based upon expert rankings (as described in the Method). Perceived risk is our cognitive assessment of how vulnerable we are to the negative outcomes associated with a given behavior (Pearson and Hamilton 2014). SWD has been perceived by young drivers as less risky than some other risky driving behaviors, such as drink driving, and young drivers have expressed greater willingness to engage in SWD relative to drink driving and not wearing a seatbelt (Harbeck and Glendon 2018). Recent research with young drivers found that SWD is seen as commonplace and that drivers engage in self-regulatory behaviors to mitigate the perceived risks of SWD (Kaviani et al. 2021).

Perception of risk has been found to influence intentions to engage with risky driving behaviors, including SWD. With respect to TWD, Walsh et al. (2008) measured two types of perceived risk: risk of apprehension (by the police) and risk of crashing. They found perceived risk of apprehension was a significant predictor of intentions to TWD while perceived risk of having a crash was not. However, Brown et al. (2019) found perceived crash risk was a significant negative predictor of intentions to TWD but perceived apprehension risk was not. One key element of the DITM is a risk-rater tool designed to make users aware of the crash risk of SWD relative to other risky driving behaviors. As such, we expected that perceived crash risk would increase in response to engagement with the DITM. In addition, we also assessed effects on perceived apprehension risk in an exploratory analysis to determine if engagement with the DITM makes people actively think about the influence of phone use while driving more broadly (beyond just the physical dangers).

Implementation intentions

The approach used in the plan builder or 'make a plan' section of the DITM is based on the model of action phases (Gollwitzer 1990) which suggests that individuals go through two distinct phases when performing a behavior – a motivational action phase which leads to forming a goal intention, followed by a volitional action phase where the goal intention is converted into an action. Implementation intentions form in the volitional phase when a critical situation is identified in which a behavior is likely to be performed (or there is likely to be the temptation to perform a risky behavior) (Elliott and Armitage 2006; Elliott et al. 2021; Gollwitzer and Schaal 1998). A link is formed between a cue and a specific behavioral response (Rhodes et al. 2020). Implementation intentions specify when, where and how a specific goal-directed response will be initiated (Keller et al. 2020). They should lead to the automatic initiation of the specified goal-directed response when encountering the critical situation. Strategies are then identified that could be used to resist the temptation present in the critical situation. Implementation intentions follow simple IF-THEN rules, for example, "IF I am tempted to use my phone to read or send a message (behavior) when I'm in a traffic jam (critical situation), THEN I will remember to check messages before driving (strategy)".

Implementation intentions have been shown to be effective for modifying a range of behaviors including healthy eating and physical activity (Bélanger-Gravel et al. 2013; Gollwitzer and Sheeran 2006; Vilà et al. 2017). Previous research demonstrated that implementation intentions reduced self-reported speeding behavior (Brewster et al. 2016; Elliott and Armitage 2006). A recent study by Elliott et al. (2021) tested whether implementation intentions could reduce mobile phone use while driving. Participants were assigned to either an implementation intention condition or a control condition. In the implementation intention condition participants were instructed to specify driving

situations that would tempt them to use their mobile phone while driving and to link these with strategies they could use to help them resist the temptation. A month later, those in the implementation intention condition reported a reduction in mobile phone use in the specific driving situations they had identified compared to the control condition. However, this effect did not generalize to driving situations that were not previously specified by the participant.

The current study

This study evaluated the efficacy of the DITM in reducing SWD among young drivers *via* the mechanisms (risk-rater tool and plan builder tool) outlined above. We employed a pre-posttest experimental design (with follow-up) to evaluate the efficacy of engagement with the DITM toolkit in the reduction of SWD among young drivers and its influence on their perceptions of risk. Participants were randomly assigned to either interact with the DITM or were in a control group. Participants completed self-report measures of SWD and perceived risk prior to, and immediately following, intervention (or control) and at a follow-up approximately 3 wks following the initial intervention. It was predicted that self-reported SWD would be lower at follow-up compared to pre-intervention levels for those who undertook the intervention. Likewise, it was predicted that those in the intervention condition would have lower intentions to SWD at post-intervention and follow-up compared to pre-intervention. Finally, it was predicted that engaging with the DITM toolkit would increase the level of perceived risk of using a SWD from pre-intervention to post-intervention and to follow-up.

Method

Participants

Only participants who met the study eligibility criteria (owning a smartphone, regularly driving a car at least once a week, aged between 17 and 25 years, Australian resident) were included in the sample. There were 180 young drivers aged between 17 and 25 years (91 males, 87 females, 2 non-binary) who had been driving for 4.62 years on average ($SD = 2.16$) and who drove on average for 8.81 h per week ($SD = 7.38$). Additional participant characteristics, across conditions, are provided in Table A1 (see supplementary material).

Table 1. Smartphone functions used while driving by young adults in the past week.

Phone function	*n* (%)
Reading text messages	70 (38.9)
Sending text message	45 (25.0)
Making phone calls	76 (42.2)
Answering phone calls	97 (53.9)
GPS (using a map)	114 (63.3)
Listening to music	129 (71.7)
Snapchat	23 (12.8)
Other	61 (33.9)

Note. Other is a collation of all uses indicated by less than 10% of participants. This included any use of Facebook, Instagram, Twitter, YouTube, WhatsApp, taking or sending photos/videos, browsing internet, playing games and online shopping.

Design and procedure

Prior to commencement of the study, institutional ethics approval was obtained (University of Canberra, HREC 2021-6936). The study used a randomized experimental design with groups of participants randomly assigned to either an *intervention* or a *control* condition (*Intervention* = 93, *Control* = 87). Participants took part in three phases of the study: *pre-intervention*, *post-intervention*, and *follow-up*.

Due to the impact of COVID-19, recruitment and participation utilized both face-to-face and online methods. Participants were recruited *via* flyers distributed across a university campus, announcements on university online learning sites and targeted social media advertising *via* Facebook and Instagram. Three face-to-face sessions ran in the month of August, 2021, before a COVID-19 lockdown was instated. At this point, research transitioned to an online method. Online participants expressed their interest in participating by accessing an online survey (*via* Qualtrics) *via* a link in the advertising material and were provided with a list of scheduled sessions times when they could complete the study online.

A total of 191 participants attended the 38 sessions (N = 1-17 participants per group) that ran from 9th August until 3rd November 2021. Only those ($n = 180$) who met the study eligibility criteria were included in the final sample. Thirteen participants attended three sessions that were conducted in a face-to-face mode (August 9th – August 12th). One hundred and seventy-eight participants attended the 35 sessions that were conducted in an online mode using Zoom. Sessions ranged from 20-40 min in duration. Only one condition was run per session. To ensure consistency across sessions, while also limiting the potential for experimenter bias, each session was run with adherence to a script.

All study sessions except *follow-up* had a researcher present to guide participants through use of the DITM and answer questions. The researcher engaged with the *control* and *intervention* groups to the same extent. Please see Figure 1 for a summary of the phases of the study.

Pre-intervention

At the commencement of the study, informed consent was obtained and participants were provided with a link to the *pre-intervention* questionnaire (administered *via* Qualtrics). Participants created a unique, de-identified code to allow for participant responses to be matched across the different phases of the study. After completion of the *pre-intervention* questionnaire, participants either took part in the intervention or control conditions.

Intervention

Participants in the *intervention* condition were shown the DITM (https://www.driveinthemoment.com.au/) and guided to self-complete specific components: to complete a quiz on risky driving behaviors (risk-rater quiz) and make a plan regarding their own driving habits (plan builder). They had up to 10 min to engage with the DITM, although all had completed it prior to the end of the 10 min.

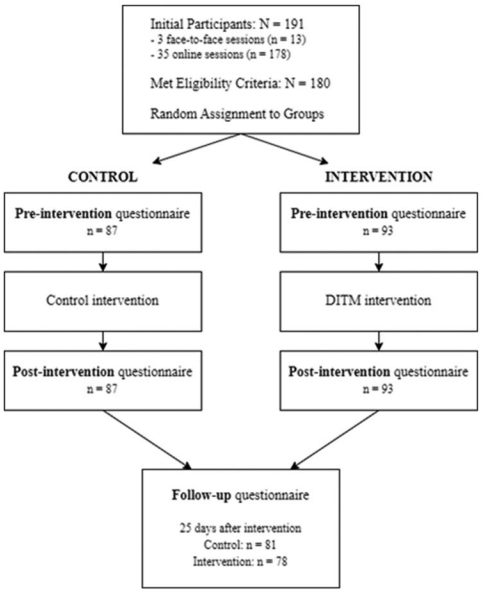

Figure 1. Flowchart of stages of the study.

The risk-rater quiz presents users with eight risky driving behaviors (e.g., talking on the phone, driving fatigued, driving impaired by alcohol, speeding) which they rank in terms of which are more likely to cause a crash. On completion, they are presented with ratings of the relative crash risk associated with each behavior, based on the rankings of international road experts (AAA 2020b; Oviedo-Trespalacios et al. 2019). These rankings indicate that using a phone while driving (holding and looking at screen for more than 2 s) is the most risky behavior, associated with almost four times the average crash risk.

The plan builder tool in the DITM asks users to identify up to three situations or 'moments', from options provided, in which they are likely to be tempted to use their phone while driving (e.g., to read or send a message) and to add detail about where or when this happens (e.g., when I'm driving to work). Users then choose a strategy or 'plan' which represents the action they will take instead of the risky behavior (e.g., remember to check messages before driving). Users then make a pledge which involves committing to their plan. The plan builder tool allows users to create a bespoke plan to reduce their SWD. Once the plan has been committed to (*via* the pledge), users receive email messages to prompt them regarding their plan.

Participants in the *control* group were guided to the Australian Road Rules (as at 28 May 2021) and advised to read a particular section (Part 14– Rules for Pedestrians accessed *via* this link, https://tinyurl.com/745yxcze). They had 5 min to read as much of the Australian Road Rules as possible. In sum, the explanation, demonstration and availability of the researcher was comparable across groups.

Post-intervention

All participants then completed a second online questionnaire (*post-intervention*). Upon the completion of this questionnaire (3-5 min) participants were invited to leave their mobile phone number to participate in a follow-up survey in 25 days' time. Participants were thanked for their time and provided with links to Australian road rules.

Follow-up

Participants received an SMS message 25 days after completion of the initial phase of the study which had a link to an online questionnaire (*follow-up*). The period of 25 days was chosen as participants were independently and automatically sent a reminder email to use their plan by the DITM platform 28 days after their initial engagement with the tool. We wanted to ensure the reminder email did not impact our evaluation. Upon completion of the *follow-up* questionnaire participants were again provided with links to Australian road rules and sent an AUD$75 online gift card *via* an SMS text message to their mobile phone.

Measures

Participants responded to items presented in online questionnaires at *pre-intervention*, immediately *post-intervention* and at *follow-up*, 25 days after the intervention. For questions relating to use of a smartphone while driving, the following definition was provided: *We want to know about when you use a* hand-held *smartphone (i.e., holding phone or touching phone when not securely mounted) for any activity (e.g., making calls, using maps, texting, playing music, social media) while driving. Social media refers to a range of platforms including, but not limited to, Facebook, Instagram, Snapchat, WhatsApp etc. Remember being stopped at traffic lights, or in similar stationary situations, is still considered 'driving'.*

Demographics

All participants were initially asked their age, gender, type of license held, place of residence, employment status and educational attainment. They were also asked to indicate on a sliding scale (0 – 10) how many years they had been driving for and how many hours they drive in a typical week (0 – 50).

Smartphone use while driving

Participants were asked how often they had used their smartphone while driving in the past week (5-point response scale from *never* to *very often*) and to provide an estimate of the number of times they had used their smartphone while driving in the past week. These items were completed at *pre-intervention* and at *follow-up*. In addition, they were asked to choose from a list all the ways they had used their smartphone while driving in the previous week (e.g., sending text messages, making phone calls, GPS, social media, music etc.).

Intentions

Three items measured intentions to use a SWD in the next week ("I intend to use my smartphone while driving in the next week", "It is likely that I will use my smartphone while driving in the next week", "I would be willing to use my smartphone while driving in the next week"). These items were adapted from previous studies (e.g., Gauld et al. 2014).

Participants responded on a 7-point scale from *strongly disagree* to *strongly agree*. Intentions were measured at *pre-intervention*, *post-intervention* and *follow-up*. Scores were summed across these three items to form a composite measure of intentions (Cronbach's α's = .91 - 93).

Perceived risk

Perceived risk was measured *via* two items, adapted from Walsh et al. (2008) and Brown et al. (2019) which measured perceived apprehension risk ("If I used my smartphone while driving the chances of me getting caught by the police would be high") and perceived crash risk ("If I used my smartphone while driving the chances of me having a crash would be high"). Agreement with these items was indicated on a 7-point scale from *strongly disagree* to *strongly agree*. Perceived risk was measured at *pre-intervention*, *post-intervention* and *follow-up*.

Statistical analyses

The *jamovi* statistical package (2.0.1.0) was used for data analysis. Descriptive statistics are reported for the prevalence of SWD and for prevalence of other types of mobile phone related activities while driving at pre-intervention. Rating data on SWD and perceived risk were analyzed using linear mixed models with Time (pre-intervention, post-intervention and follow-up), and Group (intervention, control) as factors. Continuous data on SWD and interval data on future intentions were skewed and were analyzed using generalized linear mixed models (GLM), with Poisson distributions, and log link functions. It is also possible to (log-) transform data, but GLM are preferable (O'Hara and Kotze 2010). Post-hoc tests were conducted with *jamovi*, using the Bonferroni correction. The reported *p*-values for these tests are reported as Bonferroni corrected.

Results

Effect of intervention on SWD

Participants were asked at pre-intervention to estimate the number of times they had used their SWD in the previous week and how often they had used their SWD in the previous week. Only 26.2% participants had never used their SWD in the previous week, with participants reporting using their SWD on average 3.11 times in the previous week (range = 0 – 30, $SD = 4.42$). The top five ways participants reported using their SWD were: listening to music, GPS, answering phone calls, making phone calls and reading text messages. See Table 1 below for full details regarding how participants used their SWD.

Prior to investigating the effects of the intervention, we tested for differences across the control and intervention groups at pre-intervention on key variables. Independent *t* tests showed no significant differences across groups for years of driving experience (p = .85) and average hours spent driving per week (p = .94). Chi-square tests of independence found no significant differences across groups for gender, age and license type (see Table A1).

To analyze the number of times participants used their SWD during the previous week, we used a generalized linear model. We analyzed number of times participants used their SWD dependent on the Group (control, intervention), and the Time (pre-intervention and follow-up), and the interaction. Random effects were included for the intercept. We found a significant effect of Time (pre-intervention, follow-up; $X^2(1) = 4.47$, $p = .035$), and a non-significant effect of the Group ($X^2(1) = 2.98$, $p = .084$). Importantly, there was a significant interaction ($X^2(1) = 11.17$, $p < .001$). Post-hoc tests with Bonferroni corrections indicated a significant change in SWD for the intervention group from pre-intervention to the follow-up ($Z = 3.83$, $p < .001$). No other comparisons were significant. Figure 2 shows the estimated marginal means of SWD, dependent on Time and Group. Although the intervention group appears to start at a higher level, this is not significant ($Z = 1.73$, $p = 0.51$).

We analyzed the scale ratings of SWD, using a linear mixed model. Time and the interaction between Time and Group were significant ($F(1, 161.33) = 9.19$, $p = .003$, and $F(1, 161.33) = 8.80$, $p = .003$) mirroring the effects found above for number of times participants had used their SWD. The effect for Group was non-significant, ($F(1, 176.78) = 0.16$, $p = .69$). Post-hoc tests again indicated that the only significant difference was a decrease in SWD between pre-intervention and follow-up in the intervention group ($t(164.95) = 4.21$, $p < .001$). An important element of our evaluation was to ensure that engaging with the DITM toolkit did not unexpectedly increase SWD. Thus, we included participants in our analyses who indicated at pre-intervention that they had not used a SWD in the previous week. We also repeated our analyses for the two measures of SWD (number of times used per

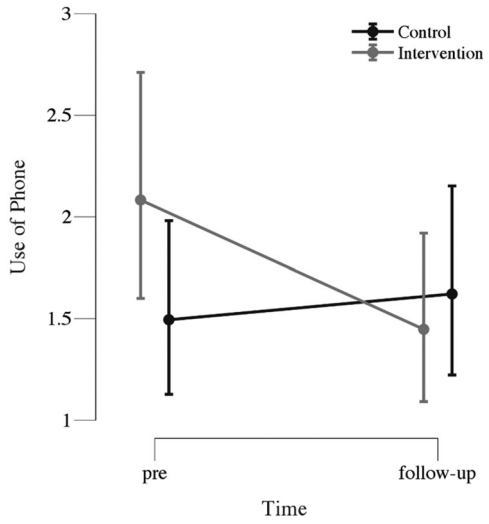

Figure 2. The effect of Time and Group on number of times participants used SWD in previous week. The only significant effect is the decrease in SWD in the intervention group. Estimated marginal means, with error bars denoting 95% confidence intervals.

week and scale response) excluding those who indicated at pre-intervention that they had not used a SWD in the previous week. These results reflected the findings reported above. As such, we have retained the original analyses.

Effect of intervention on intentions to SWD

To analyze future intentions to use a SWD, we calculated the sum of the three intention-related questions, with higher scores indicating a higher likelihood of intending to use a SWD. We used a generalized linear model to investigate the influence of Time (pre-intervention, post-intervention, follow-up), Group (intervention, control) and their interaction. The overall difference between the Groups was not significant ($X^2(1) = 0.385$, $p = .535$). The factor Time was significant ($X^2(2) = 18.83$, $p < .001$), while the interaction was not ($X^2(2) = 4.19$, $p = .123$). As can be seen in Figure 3, intentions to use a SWD decreased from pre-intervention to post-intervention before appearing to remain the same at follow-up.

Effect of intervention on perceived risk of SWD

We analyzed the perceived risk of having a crash while using a SWD with a linear mixed model, with Group (intervention, control) and Time (pre-intervention, post-intervention, follow-up) as factors. The Time effect ($F(2, 335.38) = 3.75$, $p = .024$) was significant, while the Group ($F(1, 175.22) = 0.11$, $p = 0.74$), and the interaction ($F(2, 335.38) = 2.42$, $p = .09$) were not. Given the interaction effect was trending toward significance, we conducted post-hoc tests consistent with our hypotheses. These indicated that the difference between pre- and post-intervention was only significant in the intervention group ($t(335.15) = -3.40$, $p = .011$). No other comparisons were significant. The quantitative data indicated that the perceived risk of having a crash was increased directly after the intervention (post-intervention) and decreased again afterwards to pre-intervention levels (see Figure 4).

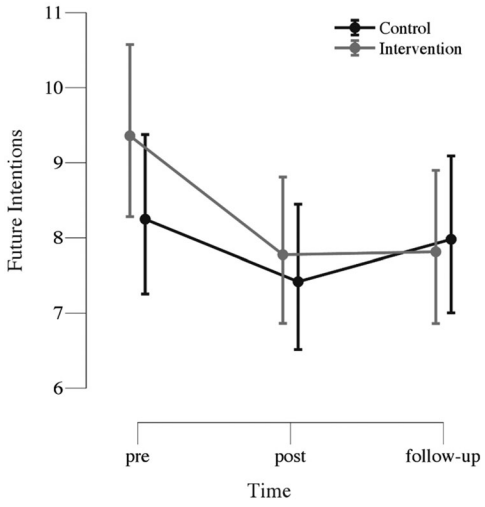

Figure 3. The effect of Time and Group on future intentions. There is a significant effect for Time and no other significant effects. Estimated marginal means, with error bars denoting 95% confidence intervals.

We analyzed the perceived risk of being apprehended by the police with using a linear mixed model, with Group and Time as factors. The Time effect ($F(2, 335.69) = 6.83$, $p = .001$) was significant, as was the interaction ($F(2, 335.69) = 3.90$, $p = .021$), while Group was not ($F(1, 176.45) = 1.63$, $p = .20$). Post-hoc tests indicated that the difference between pre- and post-intervention was only significant in the intervention group ($t(335.07) = -3.68$, $p = .004$). The quantitative data indicated that the perceived risk of being apprehended was increased directly post-intervention, and this was maintained at follow-up (see Figure 5).

Discussion

The current study evaluated the efficacy of the DITM in reducing SWD among young drivers in an Australian context. We aimed to determine if engagement with DITM influenced self-reported SWD use, intentions to engage in SWD and perceived risk of SWD among a sample of young drivers aged 17-25 years. There was a high level of SWD

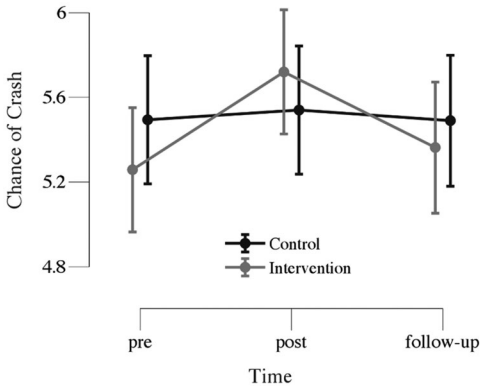

Figure 4. The effect of Time and Group on the perceived risk of having a crash. The intervention group showed a transient effect on the perceived risk of having a crash after the intervention. This effect did not persist at follow-up. Estimated marginal means, with error bars denoting 95% confidence intervals.

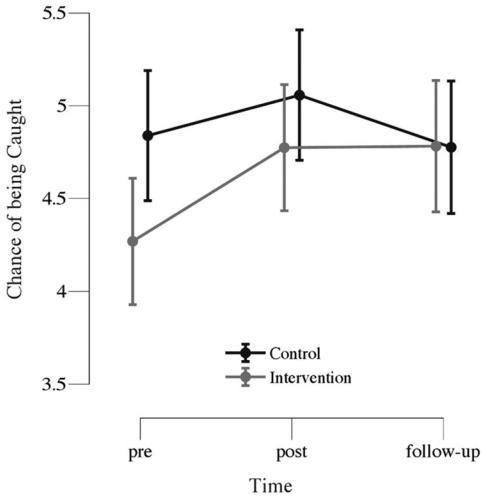

Figure 5. The effect of Time and Group on the perceived risk of being apprehended by police while using a SWD. There is a significant effect in the intervention group which was maintained at follow-up. Estimated marginal means, with error bars denoting 95% confidence intervals.

among the sample, with 74% reporting having used their phone while driving in the prior week (measured at pre-intervention). The most common phone functions used while driving were to listen to music, for navigation, and to answer a phone call. The use of the phone most frequently for music and navigation is consistent with prior research from a sample of young drivers in the Australian Capital Territory region (George et al. 2018).

Effectiveness of DITM intervention

We assessed the efficacy of the intervention on SWD behaviors (use, future intentions) and perceived risk of SWD at two time points: directly after the intervention and at a follow up 25 days later. Consistent with our hypotheses, we found that those participants who engaged with the DITM (completing the risk-rater and plan-builder elements) reported a significant reduction in the number of times the smartphone was used while driving at follow-up compared to their pre-intervention scores. In terms of future intentions to SWD, there was a significant reduction from pre-intervention to post-intervention and from pre-intervention to follow-up for both groups. This suggests that the engagement with the DITM was associated with a reduction in SWD use. While the plan-builder was only one element of the intervention, our results are consistent with previous research showing implementation intentions (such as those implemented in the plan-builder) can reduce mobile phone use while driving (Elliott et al. 2021) and with other research in the driving domain (Brewster et al. 2016; Elliott and Armitage 2006). This suggests that identifying critical situations where there is the temptation to use a SWD (e.g., stuck in a traffic jam) and forming a strategy to respond to such situations may be effective in reducing this behavior. It is argued that forming such implementation intentions should generate a mental representation of that specific situation and the associated response to that situation. In the future, being presented with the specific situation (traffic jam) should cue the associated response for responding to the temptation to use a SWD (Gollwitzer and Sheeran 2006). While participants in this study identified specific driving situations in the DITM and chose response strategies specific to those situations, the variety of choices available to participants makes it difficult to draw definitive conclusions with respect to the impact of implementation intentions on SWD.

Additionally, we considered the impact of engaging with the DITM on perceived risk of SWD. Perceived risk was assessed in two ways: perceived risk of a having a crash and perceived risk of being apprehended by the police for engaging in SWD. We found that while there was an effect of the intervention on perceived crash risk directly after the intervention (increased perceived risk), this effect was not maintained at follow-up. Interestingly, perceived crash risk demonstrated an inverted U-shape pattern, rising sharply post-intervention then falling back to pre-intervention levels at follow-up. In comparison, in the control group perceived crash risk remained constant across time. It is possible that the increase in perceived risk post-intervention could be due to the increased salience of risk (i.e., participants have been primed to think about risk). The steeper decrease for the intervention group compared to the control group, from post-intervention to follow-up could be attributed to reactance whereby an increased awareness of persuasive communications regarding risk leads to a reactance against that persuasive attempt (Reynolds-Tylus 2019). These possibilities require more rigorous investigation in future research. For perceived apprehension risk, results showed an increase in perceived risk for those who engaged with the DITM toolkit immediately after the intervention (post-intervention), with this effect maintained at follow-up. While there was no emphasis on apprehension risks in the DITM itself, engagement with the DITM may have made participants more aware of the potential seriousness and consequences of SWD. However, previous research (Brown et al. 2019; Walsh et al. 2008) has shown mixed findings regarding the impact of apprehension risk on SWD. In the current study, perceived apprehension risk at both post-intervention ($r = -0.06$, $p = .480$) and follow-up was not significantly related to SWD measured at follow-up ($r = -0.13$, $p = .115$); however, perceived crash risk was (post-intervention: $r = -0.19$, $p = .02$, follow-up: $r = -0.25$, $p = .001$). The potential relationships between perceived risks associated with SWD and SWD behavior warrant further exploration in future studies to determine which types of perceived risks may be most effective to target in order to reduce SWD.

Strengths and limitations

While there were numerous strengths of the current investigation, such as the use of an experimental design with a control group and a follow-up, and inclusion of participants from multiple geographic areas across Australia, it is important to acknowledge limitations when interpreting findings. While the study demonstrated an effect of the DITM on SWD, it was not possible to identify which aspects of the toolkit were effective. This is because participants engaged with both the risk-rater quiz and the plan-builder elements of the toolkit. Likewise, because of the diversity in possible DITM plans and forms of SWD which participants may have chosen when devising their plan, it is not clear what aspects of the plan builder had an impact on subsequent intentions and behavior. Future research could assess the impact of specific types of plans on specific SWD behaviors. We were not able to control for the level of engagement participants had with aspects of the DITM toolkit, although they were guided through the various functions, such as the risk-rater quiz and plan builder. The disruption to recruitment as a result of COVID-19 necessitated a shift to online, rather than face-to-face, sessions. While this had the advantage of allowing recruitment across more jurisdictions in the country, it provided less control in terms of how participants engaged with the DITM. However, we also note that the online sessions were more likely to mimic how young drivers would engage with the platform in a real world setting and, furthermore, may have reduced the likelihood of eliciting socially desirable responses regarding their own SWD. It is also possible that COVID-19 restrictions may have impacted

on how frequently participants were driving during this period and their opportunities to engage in SWD. We do not know the average time that participants engaged with the DITM (while 10 min was available, all participants had completed the required tasks before the end of this time). Whether differences may be apparent with longer engagement to the DITM is not known. Finally, our study used self-report measures and the use of single item measures for a number of outcome variables. While similar measures have been used in previous studies investigating SWD (e.g., Brown et al. 2019; Gauld et al. 2014, 2021; Nemme and White 2010), it is possible that self-report measures may be susceptible to recall bias and social desirability bias. The reliance on self-reported data could be addressed by naturalistic or driving simulator studies following the DITM in future research. Single item measures were employed to reduce participant fatigue and maximize response rates. While they have been successfully used in previous studies (e.g., Brown et al. 2019; Elliott and Thomson 2010) their use may oversimplify measurement of underlying constructs.

Implications and conclusions

The DITM was developed as a tool to potentially reduce SWD among younger drivers. The current study demonstrated that the toolkit showed some merit in reducing SWD use. The impact of the toolkit on the perceived risk associated with SWD was less clear, with some increase observed in the perceived risk associated with having a crash and being apprehended by the police after engaging with the toolkit.

Our study represents an initial evaluation of the DITM with young Australian drivers. This could be extended in future studies to include other age groups and settings. Further evaluations could also enable the identification of the best aspects of the DITM for addressing SWD by exposing participants to either the risk-rater quiz or the plan-builder tool. In the current study participants were recruited to use the toolkit and were reimbursed for doing so. Consideration needs to be given to how the toolkit could be made visible and available to a wide range of drivers. Promoting the toolkit on social media platforms is one suggestion for reaching a wider audience. We would suggest that the efficacy of the DITM be examined when there is no reimbursement regarding its use to assess the applicability of the toolkit as a voluntary tool or whether it would be better placed in an educational setting (or offered with ongoing incentives for use). Finally, we recommend evaluation with a longer follow-up period to help determine duration of effects.

The DITM was developed to make drivers aware of the relative risk of SWD and to reduce SWD by enabling drivers to create strategies that allow them to identify and resist temptation to SWD. Our evaluation shows initial promising support for the efficacy of the DITM in reducing self-reported SWD and future intentions to SWD. However, further evaluation is needed to identify the most effective elements of the DITM and to assess efficacy among other age groups and settings.

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Credit author statement

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