



# Can voluntary apps reduce mobile phone use while driving?

February 2019





## Royal Automobile Club of Victoria (RACV) Ltd

Report No.	Date	ISBN	Pages
19/01	February 2019	978-0-9945666-6-9	39

### Title

Can voluntary apps reduce mobile phone use while driving?

### Authors

Dr Oscar Oviedo-Trespalacios  
Dr Mark King  
Verity Truelove  
Rachel Kelly

### Acknowledgements

Heidi Mangan  
Amy Williamson  
Melinda Spiteri  
Elvira Lazar

### Abstract

The high prevalence use of mobile phones in Australia has led to concerns about the rates and impact of driver distraction, and how technology can be harnessed as an effective countermeasure. In recent years, mobile phone apps have been designed to act as voluntary 'workload managers', which work to prevent distracted driving due to mobile phone use. This study investigates the potential use of voluntary apps through four empirical studies utilising both qualitative and quantitative methods – a driver acceptance assessment study, an expert-based risk assessment study, an online-based case-scenario analysis, and an in-vehicle study. Results demonstrate a general willingness to use voluntary apps to reduce distraction, especially among high-risk drivers who report higher levels of visual-manual interaction with their mobile phones. Despite the general acceptance of voluntary apps, there was still reluctance among participants to give up certain benefits of mobile phones. During the in-vehicle survey, there were self-reported reductions in phone use and decreased mental demand while participants were using the voluntary app. However, participants' intentions to use the voluntary app were influenced by the features and performance of the apps, such that they showed less intention to use the app if they had a negative user experience. Overall, there is value in promoting the benefits of voluntary app use to prevent driving while distracted by a mobile phone. However, only voluntary apps that function reliably, and provide a satisfactory level of integration with the vehicle and the functions drivers use, should be promoted. This report also proposes standard guidelines and recommendations to ensure users make the best use of voluntary apps, and to encourage the relevant organisations to consider advocacy or incentive-based approaches to encourage use.

### Key Words

Mobile phones; voluntary apps; workload managers; distraction; distracted driving;

Level of acceptance; Intentions; Design and situational parameters; Good practice for driver use; Risks of use; High-risk groups

## Disclaimer

The research presented in this report has been commissioned and funded by RACV and is released in the public interest. The views expressed, and recommendations made are those of the authors and do not necessarily reflect RACV policy.

Although the report is believed to be correct at the time of publication, RACV, excludes, to the maximum extent permitted at law, all liability for loss (whether arising under contract, tort, statute or otherwise) arising from the contents of the Report or from its use. Where such liability cannot be excluded, it is reduced to the maximum extent permitted at law. Discretion and judgement should be applied when using or applying any of the information contained within the Report.

# Executive Summary

## BACKGROUND

The high prevalence of mobile phone use in Australia calls for the need to develop more effective countermeasures to prevent mobile phone distracted driving. In recent years, mobile phone apps have been designed to provide distraction-free driving when voluntarily implemented by drivers. These apps typically integrate sensors to detect motion and disable mobile phone features such as audio, text, social media, and browsing while driving. There is limited evidence however regarding the effectiveness of voluntary phone apps targeted at preventing phone use while driving. The aim of this research is to investigate the potential use of voluntary apps to prevent mobile phone distracted driving in Australia, and in particular to:

- Examine the level of acceptance of voluntary apps to prevent mobile phone distracted driving among motorists and identify potential facilitators of, and barriers to, successful implementation;
- Explore motorists' intentions to use (and misuse) voluntary apps to prevent distracted driving, and examine if these intentions influence effectiveness;
- Identify design and situational parameters that contribute to the effectiveness or ineffectiveness of voluntary apps to prevent distracted driving;
- Propose good practices for driver use of voluntary apps and programs (such as promotion of these good practices) that have the potential to address the distracted driving problem;
- Investigate potential risks of the use of these apps including transference of risky behaviour to other potential distractions;
- Identify high-risk groups who are unlikely to benefit from the use of these voluntary apps.

## METHODOLOGY

Following a literature review on existing voluntary apps to prevent distracted driving, four empirical studies were conducted using different methods:

1. A driver acceptance assessment study conducted using qualitative methods (focus groups and interviews, via Skype and Google Hangout) with 35 Victorian drivers.
2. An expert-based risk assessment study conducted via interviews with 10 experts drawn from road

safety practitioners, human computer interaction experts and developers of apps to prevent mobile phone distracted driving.

3. A case-scenario analysis undertaken in the form of an online experimental study.
4. An in-vehicle study of the use of the 'Do Not Disturb While Driving' app or the 'Android Auto' app by 33 participants.

## RESULTS

Existing voluntary apps focus on blocking primary phone functions such as texting, browsing, and other visual-manual tasks. The most popular app is the 'Do Not Disturb While Driving' app that is pre-installed in all iOS mobile phones. This particular app was therefore used as the focus for the research.

In the driver acceptance study, perceived benefits of the 'Do Not Disturb While Driving' app included 1) limiting phone use and distractions and 2) increasing road safety. However, participants also reported a number of concerns including the ability to be contacted during emergencies, accessibility of other apps, and excessive battery drainage while the voluntary driving app was active.

Experts in the field of road safety and app development reported that the adoption of voluntary apps aimed at preventing mobile phone distracted driving, even if adopted by a small number of drivers, for a short duration of time, would have positive outcomes in terms of reducing mobile phone distracted driving. The visual-manual blocking function was highlighted as a limitation to widespread acceptance of the app however, with experts reporting that it could lead to frustration and stop people from using the app. Some concern was also raised about the reliability of voice-command technology. Provision of incentives and improved communication between mobile devices and the vehicle were noted as potential opportunities.

In the online experimental study, approximately two-thirds (66.3%, n = 339) of participants reported that they would be willing to install and activate an app that blocks text messages, browsing, and mail (including notifications) and enable calls (dialled or incoming) using a Bluetooth or hands-free device only. Drivers who use their phones for visual-manual tasks and hands-free conversations appeared more likely to install and activate voluntary applications. This is encouraging given that these apps might offer a potential solution

for targeting high-risk groups. The subscales for both the Technology Acceptance Model (TAM) (i.e. perceived usefulness and perceived ease of use) and the Theory of Planned Behaviour (TPB) (i.e. subjective norms, perceived control, and attitudes) were positively correlated with behavioural intentions. These findings provide support for the use of the TAM and TPB as theoretical tools to predict participants' acceptance of the voluntary apps.

Finally, in the in-vehicle study, self-reported mobile phone use behaviours while driving, including visual-manual phone interactions, handheld conversations, hands-free conversations and even the use of other phone functions such as GPS applications or music significantly decreased during the course of the study, while participants were using the voluntary app. There were no significant changes in perceived usefulness, ease of use, behavioural control or subjective norm of the voluntary applications to prevent mobile phone distracted driving after the completion of the study. Behavioural intentions related to the use of the application significantly decreased over time, meaning participants' intentions to use the application decreased after experience with the application. Positive experiences related to using the voluntary phone application while driving were related to the application working as outlined and starting automatically when the car started moving. In addition, the ability to access music and GPS functions of the phone and take calls via Bluetooth further contributed to positive experiences with the application. Negative experiences with using the voluntary application while driving were related to the application not working as it was supposed to, especially if it could not start automatically.

## **LIMITATIONS**

Due to the nature of the research, the results of this study are subject to self-report and selection biases. A longer period of monitored experience would have been desirable, but was outside the scope of the project.

## **CONCLUSION**

Participants in the different stages of the research showed (on average) a willingness to consider use of voluntary apps as a means of reducing distraction and contributing to road safety, while at the same time being reluctant to forego certain benefits of mobile phones. Of particular interest was the finding in the online survey that drivers defined as high risk because

of their higher levels of visual-manual interaction with mobile phones when driving were more likely to be willing to use voluntary apps to control such use. This was unexpected, as it had been hypothesised that those most willing to use voluntary apps would be drivers who already had low levels of use. The in-vehicle survey, although brief, resulted in reductions in phone use and a decrease in mental demand over the course of the trial. However, participants' intention to use the apps decreased during the trial, which may have been related to some participants experiencing instances where the app did not operate as it was supposed to. There were also some issues of usability that could be addressed through improvements in design and function.

Based on the results of this research, there is value in promoting the benefits of the use of voluntary apps by drivers to prevent or reduce mobile phone distracted driving, since there is a sufficient level of acceptance by drivers, including those who would be considered at high risk of distracted driving. However, the features and performance of the apps themselves contribute to negative experiences in usage, so that only voluntary apps that provide a good level of integration with the vehicle and the functions drivers use, and which operate reliably, should be promoted. Standard guidance could be provided to users to ensure they make the best use of the device (see proposed list at the end of the Executive Summary), and relevant organisations could consider advocacy or incentive-based approaches to encourage use.

## **FUTURE DIRECTIONS**

Further evaluations including the use of naturalistic studies are necessary to more objectively measure the impact of mobile phone apps on driver distraction. Further research should also be conducted to optimise the usability of these types of apps from a driver's perspective, particularly among high risk groups who might benefit from such technology. The role of app designers, mobile phone companies, and vehicle manufacturers should be considered further from a policy and practice perspective. For example, improving access to navigation applications, and integrating functions into the vehicle system (i.e. buttons on the steering wheel controlling certain phone functions). The overall findings of this research provide support for the potential use of voluntary apps to reduce mobile phone distraction.

## **PROPOSED GUIDELINES AND RECOMMENDATIONS FOR VOLUNTARY APP USERS**

- Take some time to learn about the app and the importance of using it.
- Remember to activate the app before starting to drive as well as GPS and music.
- The recommended setting is to allow the app to automatically detect driving.
- Always keep your eyes focused on the road as the app will not help if you continue looking at your phone. Even looking at your phone to change a song will take your eyes off the road and can be dangerous.
- Only allow phone calls from family members who might need you in an emergency. Inform them to only contact you through phone calls in the case of an emergency instead of text.
- Remember that the phone can ring at any moment, regardless of what driving demands you are experiencing, so don't try to reach for it immediately, wait until you can safely stop the vehicle and always use hands-free methods of communication (e.g. Bluetooth).
- Do not make exceptions to allow you to receive messages. If someone needs to contact you urgently, they can contact you through a phone call.
- Young drivers (25 years or less) should always turn their phones off before they drive.
- The main incentive for using the app is to ensure the safety of yourself and others.
- Remember that the apps do not always activate automatically. Make sure that the app is working before starting to drive.
- If a different application on your phone is not supported by the voluntary application, it is best not to use it while driving; your focus should be on the road, not the phone.





# Table of Contents

<b>1. Introduction</b>	<b>1</b>
1.1 Background	1
1.2 Aims of the current study	3
<b>2. Driver acceptance analysis</b>	<b>4</b>
2.1 Methods	4
2.2 Results	5
2.3 Summary	10
<b>3. Risk analysis with experts</b>	<b>11</b>
3.1 Methods	11
3.2 Results	11
3.3 Summary	12
<b>4. Case-scenario analysis: an online experiment</b>	<b>13</b>
4.1 Methods	13
4.2 Results	13
4.3 Summary	23
<b>5. In-vehicle study</b>	<b>24</b>
5.1 Method	24
5.2 Overview of findings: Longitudinal survey	24
5.3 Overview of findings: Diary entries	27
5.4 Summary	30
<b>6. Conclusion</b>	<b>32</b>
6.1 General discussion	32
6.2 Conclusion	33
6.3 Guidelines and recommendations of use of voluntary applications aimed at preventing mobile phone distracted drivers	35
<b>7. References</b>	<b>37</b>
<b>Appendix I</b>	<b>39</b>



# 1 Introduction

The widespread uptake of mobile phone use in today's society has raised serious concerns about the prevalence and impact of driver distraction, and how to address the problem through technology. In recent years, mobile phone apps have been designed to provide distraction-free driving, once initiated voluntarily by the driver. This voluntary aspect distinguished the approach from mobile phone blocking technologies imposed on drivers (by employers, for example). Some voluntary apps integrate sensors to detect motion and disable mobile phone features such as audio, text, social media, and browsing while driving, and are in effect managing workload. Additionally, some voluntary apps (i.e. voluntary apps to prevent mobile phone distracted driving) would shift manual forms of distracted driving, such as holding a phone in one's hand, to auditory forms of distracted driving.

The Royal Automobile Club of Victoria (RACV) has commissioned the Centre for Accident Research and Road Safety - Queensland (CARRS-Q) at the Queensland University of Technology (QUT) to undertake a study encompassing the following:

- Literature Review on Voluntary Apps to Prevent Distracted Driving;
- Driver Acceptance Assessment Study;
- Expert-based Risk Assessment Study;
- Case-Scenario Analysis: An Online Experiment Study;
- In-vehicle Study.

The research was approved by the Queensland University of Technology Human Research Ethics Committee.

## 1.1 Background

Unsafe interactions between drivers and vehicles play a significant role in vehicle collisions, which may result in serious injury or fatality (Oviedo-Trespalacios et al., 2016). Driving performance is influenced by a wide range of factors, including fatigue, distraction, and alcohol and other drugs. While advancements in vehicle automation are expected to benefit road safety in the long term, there is a need to understand and address current road safety issues such as distraction in order to prevent road trauma.

Mobile phone distracted driving is recognised as one of the most important human factor issues in road safety worldwide (World Health Organization, 2015). In the US, mobile phone distraction is reported to contribute to approximately ten percent of road traffic crashes (NHTSA, 2016). A recent naturalistic driving study reported that handheld interactions with mobile phones increase the odds of crash risk as much as 3.6 times (Dingus et al., 2016). Mobile phone distracted driving is also a pervasive issue in Australia with the most recent review confirming the role of mobile phone distraction in road crashes (King et al., 2017). This study found that in Queensland, between 2010 and 2014, an average of 12 (5%) fatalities per year were the result of a crash involving a distracted driver or rider. In 2015, this increased to 25 (10%). In Victoria, over the 3 years from June 2010 to July 2014, an average of 216 (4%) people per year were hospitalised from crashes involving distracted drivers or riders. In the 2014/15 financial year there were 223 (5%) people hospitalised in distraction related crashes. These figures are believed to underestimate the true scale of the problem by a significant margin (King et al., 2017). A comprehensive breakdown of self-reported mobile phone use while driving across Australian jurisdictions can be found in the report on the 2013 Community Attitudes to Road Safety survey (Petroulias, 2014). The values highlighted in the study indicate high levels of phone ownership and use by motorists in Australia; reading and sending texts (which are both illegal and extremely risky) were reported by about quarter and an eighth of respondents respectively. In a recent study conducted by Oviedo-Trespalacios et al. (2017c), nearly one third of drivers reported engaging in texting/browsing while driving on a typical day and one-quarter reported engaging in handheld conversations while driving on a typical day. The high prevalence of mobile phone use calls for the need to develop more effective countermeasures to prevent mobile phone distracted driving in Australia.

An emergent countermeasure for distracted driving that utilises mobile phone technology involves voluntary apps which are designed to stop certain phone behaviours while driving. These voluntary apps are intended to prevent interactions with the mobile phone while the vehicle is moving (Siuhi & Mwakalonge, 2016), however the extent to

which interactions are blocked depends on the specific app/technology. Most voluntary apps disable the use of texting while driving. For example, the app ‘Do Not Disturb While Driving’, which now comes preinstalled on all iOS mobile phones, disables a variety of phone functions, including texting when it is detected that the car is in motion. Similarly, a popular voluntary app for android phones includes the ‘Android Auto’ app which is also able to detect a moving vehicle and block a number of visual-manual phone tasks. This is encouraging as texting involves the driver taking their eyes away from the road and links have consistently been made connecting crash risk to sharing visual attention with the road and a mobile phone (NHTSA, 2016; Oviedo-Trespalacios, Haque, King, & Washington, 2015; Oviedo-Trespalacios, Haque, King, & Demmel, 2018a; Oviedo-Trespalacios, Haque, King, & Demmel, 2018b; Oviedo-Trespalacios, 2018c; Oviedo-Trespalacios, Haque, King, & Washington, 2016; Simmons, Hicks, & Caird, 2016).

The five most popular apps were identified using a search in Google Play and Apple store. Given the ‘Do Not Disturb While Driving’ feature is pre-installed in iOS phone systems, this was the most popular. As this is pre-installed, ‘Do Not Disturb While Driving’ may be considered a function of the phone. However, for clarity, and as in-built phone functions such as ‘calculator’ and ‘calendar’ functions can be considered applications (Zheng & Ni, 2010), this function will be referred to as an app throughout this report. Due to the popularity of this app, it will be used as the focus for the subsequent study (driver acceptance analysis). Table 1.1 provides an outline of the apps which met the search criteria and their primary characteristics.

**Table 1.1**  
**Popular voluntary smart phone apps aimed at reducing mobile phone use while driving identified during online searches**

Mobile phone app to reduce mobile phone use while driving	Version	Number of Installs	Access (Free, Pay, Mix)	Platform		
				iOS	Android	Blackberry
Android Auto (company: Android)	3.1	10,000,000 – 50,000,000	Free		x	
AT&T DriveMode (company: AT&T)	3.3	10,000,000 - 50,000,000	Free	x	x	
Do Not Disturb While Driving (company: Apple)	N/A	500,000,000 +	Free	x		
DriveSafe.ly (company: iSpeech)	3.8	1,000,000 - 5,000,000	Mix		x	x
Safe Driving App: Drivemode (company: Drivemode)	7.1.1	1,000,000 - 5,000,000	Mix (in app purchases)		x	

Table 1.2 identifies the overall functions each app allows and does not allow. Most apps allow the use of music and navigation apps while driving. Texting and other visual-manual tasks are limited on each app while calls are allowed on most apps, with some restrictions. These apps are very similar in content and functionality.

**Table 1.2**  
**Functions permitted on popular voluntary apps to prevent mobile phone distracted driving**

Name of mobile phone app	Functions allowed on each Mobile phone app			
	Calls	Texting and other visual-manual tasks	Maps/Navigation	Music
Android Auto	Yes (make calls with Google Assistant and answer calls with a tap)	Yes (via Google Assistant)	Yes	Yes
AT&T DriveMode	Yes (will silence call but will not block call)	Silent notifications	Yes	Yes
Do Not Disturb While Driving	Yes (can be restricted to few contacts)	Silent notifications (if desired by the sender)	Yes	Yes
DriveSafe.ly	Yes	No	Not stated (unknown if other apps work at the same time)	Not stated
Safe Driving App: Drivemode	Yes (option to ignore calls in ‘do not disturb’ mode)	Yes (limited – only using voice commands)	Yes (allows use of 3 chosen apps)	Yes (allows use of 3 chosen apps)

Despite the potential that voluntary apps pose for reducing crash rates associated with mobile phone use while driving, there has been limited research assessing how effective these voluntary apps are in reducing mobile phone use while driving, as well as the perceived acceptance of drivers of the use of such apps. The scant literature surrounding this topic has suggested that many mobile phone apps are difficult to use and are inconsistent, therefore not always reliable (Sousa, 2015; Tchankue et al., 2012). One of the only in-depth studies on voluntary phone apps while driving examined whether the use of psychosocial variables (i.e., attitudes, likelihood of engaging and frequency of reported texting and driving behaviours) predicts the use of the voluntary app DriveSafe.ly (McGinn, 2014). The results showed that these variables had little success in predicting drivers' on-going use of this voluntary app.

## 1.2 Aims of the current study

This research aims to study the potential of voluntary apps to prevent mobile phone distracted driving. In particular, to

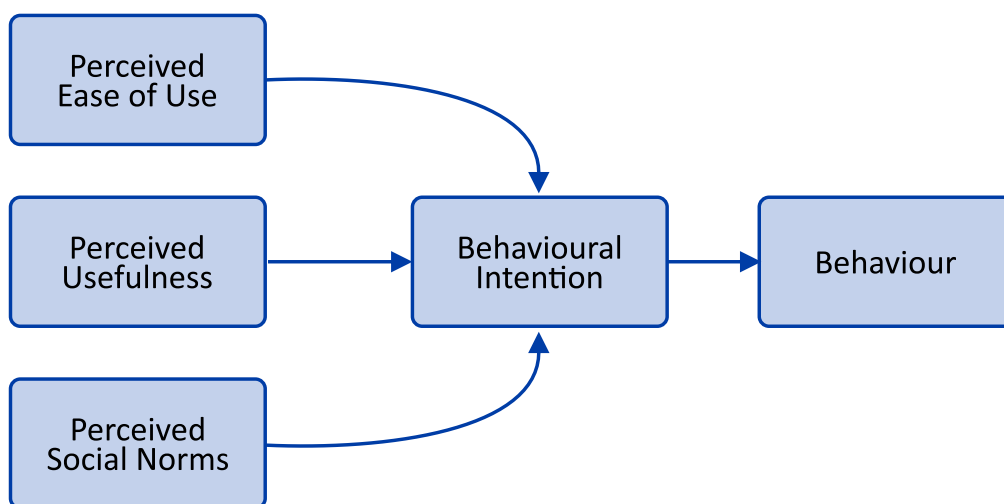
- Examine the level of acceptance of voluntary apps to prevent mobile phone distracted driving among motorists and identify potential facilitators of, and barriers to, successful implementation;
- Explore motorists' intentions to use (and misuse) voluntary apps to prevent distracted driving, and examine if these intentions influence effectiveness;
- Identify design and situational parameters that contribute to the effectiveness or ineffectiveness of voluntary apps to prevent distracted driving;
- Propose good practices for driver use of voluntary apps and programs (such as promotion of these good practices) that have the potential to address the distracted driving problem;
- Investigate potential risks of the use of these apps including transference of risky behaviour to other potential distractions;
- Identify high-risk groups who are unlikely to benefit from the use of these voluntary apps.

# 2 Driver acceptance analysis

## 2.1 Methods

### 2.1.1 Driver acceptance study

This study aimed to attain a deeper understanding of the acceptability of voluntary apps to prevent mobile phone distracted driving as a means of reducing the risk of phone use while driving. Focus groups and interviews were conducted with Victorian participants via Skype and Google Hangout, utilising open-ended questions that cover the six main themes identified in the Technology Acceptance Model (TAM). The TAM is one of the most popular models used to understand the determinants of user acceptance of technology while driving (Horberry et al., 2014). This approach focuses on how perceptions regarding the usefulness and ease of use of computer information systems impact upon attitudes toward use, intentions to use and subsequent actual system use (Davis et al., 1989). The TAM (see Figure 2.1) has been identified as a highly reliable, valid and robust approach to measuring instrument design (Taylor & Todd, 1995). In addition, questions focusing on a) system design considerations; and b) implementation strategies were included.



**Figure 2.1**

Technology Acceptance Model (TAM)

Thirty-five participants were included in this study. Participants consisted of 20 females and 15 males, aged between 19 and 44 years ( $M = 28.43$ ;  $SD = 6.5$ ). In order to attract a good cross section of the driving population and to acknowledge the time commitment involved, participants were offered a \$50 gift voucher each.

### 2.1.2 Data analysis

Each interview was audio recorded and transcribed verbatim by the research team member who conducted the interview. The transcripts were analysed using directed content analysis. This approach allowed the data to be condensed into manageable, meaningful data sets (Hsieh & Shannon, 2005). An initial coding system was developed via the identification of key themes from participant responses. A deductive approach was used in order to develop the themes from existing TAM concepts including; “perceived usefulness”, “usability” and “social approval”. Additional themes also emerged via content analysis of responses. Responses were categorised into these themes, whereby more specific subcategories, related to these broader themes emerged. Responses which were not initially coded were identified and analysed to determine whether they represented new themes or subcategories. After the initial coding, the subcategories were reviewed to determine which subcategories were least represented and needed to be removed or combined, and to examine the subcategories which had a high

representation to determine if further refinement or the subcategory was warranted. This was an iterative process, as the data was reviewed and refined several times before the final coding framework was developed.

## 2.2 Results

The sample produced a total of 807 response statements. Five major themes were identified, including: (1) usefulness, (2) usability, (3) design considerations, (4) social approval/perceptions; and (5) implementation strategies. The most important findings from the interviews are presented in the following sections.

Themes are presented below with supporting quotes. Participants' gender and age are presented after each quote. 'F' identifies a female participant and 'M' identifies a male participant.

### 2.2.1 Usefulness

In the interviews, participants were asked to consider their perceptions towards the usefulness of the 'Do Not Disturb While Driving' app. A total of 69 statements related to the usefulness of this technology. Two benefits of this feature were identified by the participants including limiting phone use and distractions, and increasing road safety.

#### 2.2.1.1 Limiting Phone Use And Distractions

Forty-two statements broadly referred to limiting phone use and driver distraction while driving. A majority of the statements showed that participants thought the app would work well to limit phone use while driving. User recognition of the usefulness of the app is necessary to ensure a successful uptake (Vaezipour et al., 2017). Some examples of the statements include:

*"I think that would be good because people are just so tempted to use their phones and I am guilty of it too so I think it would be really nice to enable that on everyone's phone."* (F, 30)

*"I think it is quite convenient, I think it would be useful to use and utilise. I think it would definitely reduce risks a little bit. The way that it automatically detects that you are driving and shut outs all incoming calls and texts."* (M, 21)

#### 2.2.1.1 Benefits for road safety

Thirty-two statements discussed the broader benefits to society. Generally, participants believed that using the app will reduce road crashes. However, a recurrent concern discussed among participants included the idea that the individuals who would most benefit from the use of this app may not be willing to do so. Participants believed that this would limit the benefits for the community. Some examples of such statements include:

*"I think it is incredibly needed and a really smart thing to do. I don't think that it will work because once again, it is a voluntary thing and I don't believe that people will, I don't think the majority of the population would actually use that, especially now because we are so connected, people need to be connected when they are driving as well. Like I have friends who are real estate agents and they are expected to take phone calls while driving to keep business going. So, I think it is a really smart thing but once again I think we are too far gone with people having too much confidence for people texting and using their phones while driving, even having business pressure to be connected during working hours."* (M, 24)

Themes are presented below with supporting quotes. Participants' gender and age are presented after each quote. 'F' identifies a female participant and 'M' identifies a male participant.

*"If everyone was using a system like that I think accidents would be reduced for sure. So yeah it is safer... that way because I am more focused on the road."* (M, 29)

*"I think it would make it safer. If not necessarily just because people are using that app, but because this will help raise awareness to other drivers about this sort of technology."* (F, 32)

These results suggest that there is a group of drivers who are likely not to benefit from these interventions. The main groups include young drivers or overly connected drivers. More information about this high-risk group is necessary to personalise mobile phone applications to prevent mobile phone distracted driving.

### 2.2.2 Usability

In relation to the usability of the 'do not disturb' feature, participants discussed the degree to which the voluntary apps are able or fit to be used. Two main dimensions were considered: the reliability of the feature would impact their intention to use the app and participants' perceptions of how easy such apps were to use.

### 2.2.2.1 Reliability

Most participants were happy to try the voluntary mobile phone app and acknowledged that some technical issues are likely to impact the reliability. Participants reported that, based on their previous experiences, mobile phone applications typically have bugs and reliability issues. Nonetheless, participants anticipated that developers will fix these issues. Some examples of the statements include:

*“Yeah, I mean this is how apps work, they go to the market, they have some bugs and they again correct the problems and solve the problem and then again have the new version. I think it is fine, it is something usual in the apps.” (M, 28)*

*“Well I think only by using an app you can allow developers to improve it. So yeah, I would certainly keep using it.” (F, 32)*

Some participants expressed concerns that if the frequency of such issues were high, they would find the app less useful. There is a need for app developers to improve reliability of the applications in order to guarantee uptake.

*“If it requires constant maintenance I think it would be annoying personally, but I think if it like a few exceptions now and then it is not the end of the world. The aim is to make driving safer.” (M, 24)*

*“I wouldn't be comfortable using it at all if it had reliability issues. I guess with things like that, it is one of those things, that you would want to be hopefully really up to scratch before launching, because if issues did happen, it could actually have adverse effects and kind of eliminate, sorry cause, what it is trying to eliminate.” (M, 23)*

Another key function identified within the theme of usability is the app's ability to differentiate driving from other forms of road use. Participants were concerned that the app would not be able to identify the difference between using public transport (e.g. bus, train), being the passenger in a vehicle, and being the driver. Automatic identification of the driver is a necessary upgrade in the available applications to improve the reliability of voluntary apps. Examples of such concerns include:

*“...One thing that would annoy me, would the mobile phone recognise the difference between being on a bus or train and being in a car. Because if I am on a bus I want to use my phone, but when I am driving I am not bothered. But I would be annoyed if I had a long bus journey and I could not use my phone, so that is one thing that would have to be right.” (M, 24)*

*“Would it switch off if I was on any kind of transport? Like if it switched off on the bus or the train I would get pretty annoyed.” (M, 29)*

### 2.2.2.2 Perceived ease of use

Seventeen statements related to participants beliefs around the ease of using the “Do-not-Disturb” while driving feature. Eleven participants suggested the technology was simple and convenient to use. Conversely, six participants suggested the set up was difficult and could be simplified. More work is needed to improve the perception of ease of using voluntary apps because this is a major barrier for the acceptance of the technology. Examples of such statements are below:

*“Yeah, my impression is that it is quite understandable and easy to understand.” (F, 42)*

*“I think it is going to be a good thing. I think, the only thing, is that it is a little complicated to go into. There are quite a few steps and stages to get to where you wanted to, and you have to do that every time you got into the car if you were going to do it manually.” (F, 37)*

## 2.2.3 Design considerations

Throughout the interviews, participants considered and discussed the impact of several design characteristics on the usability of this technology. These included: being contacted in emergencies, accessing other apps, loss of phone control, parental control features and operational issues. Further, participants provided a number of design suggestions to improve this technology.

### 2.2.3.1 Driver control over their mobile phone

Thirty-six statements were provided relating to driver control over their mobile phone. Twenty-eight statements suggested that the technology is necessary as it can aid in decreasing distracted driving. Eight statements referred to unfavourable perceptions related to loss of personal control over one's use of the phone. Two participants suggested the loss of control could be situationally inconvenient or become an issue if the feature was not reliable. Examples of both perspectives are included below:



*"I think as long as I am driving and I am responsible for not only my own safety but other people's safety in traffic, I think it should be allowed to limit my interaction with my phone. I think that is the purpose of the app, to increase safety in traffic, and that is the only way that you can do it."* (F, 32)

*"I think that would bother me. I don't like the idea that I can't freely access my phone if I need it for an emergency or something. Like if I get stuck somewhere or I'm on a train and there is a drama and the phone won't let me use it because it thinks I'm driving. No way."* (M, 29)

While unfavourable perceptions towards drivers' loss of control over their mobile phone exist among some participants, this was not considered a problem among many other participants. This suggests that drivers' shared control of the mobile phone with the voluntary application is not a major concern for this technology. Furthermore, most participants recognised that they might not be able to self-regulate mobile phone use by themselves, therefore the shared control was associated with positive perceptions from many participants.

### 2.2.3.2 Performance recording

Thirty-five statements relating to performance recording were identified. Twenty-two statements indicated that participants were happy for performance recording to be a feature, while thirteen statements indicated a concern about privacy related to performance recording and whether the information could be used by police or insurance companies. One participant highlighted the importance of informing individuals that the technology was recording performance.

*"I am not too sure, but I would be interested to see. Personally, it would be interesting to see what you are doing, but I would not be comfortable if it recorded it for other purposes. For example, on android phones on google it records everything, even the places that you visited and how long you parked there, so I turn that off because I don't feel comfortable with that."* (F, 28)

Twenty-one statements highlighted a preference for data remaining confidential, even to family and friends. Meanwhile, nine statements supported open access of data to family and friends. These participants suggested it would: be used for research purposes (3), hold people to account and assist in the event of a crash (3) and could be useful for unexperienced drivers including learners and p-platers (3). Some example statements include:

*"Yeah, I would be fine with that for sure. I think, yeah that is a really interesting one. As in potentially shaming children, with parents finding out how much their children are using it. I think that could be really handy for them, because I don't think that parents really understand, or it would be handy for parents to know that because I feel that parents just assume that their kids are always on their phone, so it would handy to give them a little bit of peace of mind if their child was not, and it would also give them something objective to rouse their kids on if they were."* (M, 24)

*"Yeah I think that would be a good motivator. It would also make you accountable a bit more. Because if it is tracking then you can't say I do this. But I think, like the quit smoking app, it is helpful because it gives you motivation and positive reinforcement and things like that, like positive affirmations."* (F, 37)

### 2.2.3.3 Contact in emergencies

A total of 15 statements related to a concern about being contactable during emergencies. Six participants admitted they would try to cheat the system to use their phones while driving if in an emergency situation. Three participants noted this issue could be avoided by overriding the feature. One participant further raised concern over the feasibility of urgent notifications actually being received by drivers. Examples of such statements include:

*"Yeah, I guess like, just probably not really being notified that you need to be somewhere or something important happening in your life and you not knowing about it I guess would be the only negative thing."* (F, 24)

### 2.2.3.4 Access to driving apps

Participants noted the importance of using their phone to access other driving apps. Ten statements suggested that participants would want to have access to other apps, particularly Maps, as this is used to assist the drive. Four participants admitted they would try to cheat the system to use their phones while driving to access apps such as Maps or Spotify. Finally, one participant raised the question about whether this "do-not-disturb" feature would restrict notifications being received on other devices. Example statements include:

*"I think unintentionally you would. Like oh I really need to find direction to this place now. So unintentionally you would try and use it, but otherwise I don't see why you would voluntarily turn it on and then try and cheat it."* (F, 28)

*"Does it also work with these wearable watches that are notified by vibration? Many of them synchronize with*

the phone, but what if you still get a link with your watch, because there is still the temptation and that has to be factored in. And many more people than I thought actually wear those watches for that purpose and that needs to be taken into account.” (M, 24)

### 2.2.3.5 Parental control

Seven statements were made by participants in relation to the parental control feature of the technology. All participants were in favour of the parental control feature, believing it could be a useful tool to help younger, inexperienced drivers be safe on the roads. However, four participants were unsure about how this feature would be practically effective as these young drivers would want to have control over their phones while driving. Example of such concerns include:

*“I think I mean I am not a parent, so I can’t be too sure how young people are going to feel about it, but I can imagine that if I were a parent I would be really interested in activating that feature that turns Do Not Disturb While Driving for young people while they are learning to drive particularly. Yeah, I thought that that was particularly really important. When I was learning to drive, I did not touch my phone and I made a really big point of trying to not touch my phone while driving because I definitely needed a lot of attention to make sure that I was driving well.” (M, 30)*

### 2.2.3.6 Operational issues

Throughout the interviews a total of 30 statements were made in relation to the operational features of this technology. Eight participants noted that a barrier to their use of this technology was its exclusive availability to iPhones. However, in this report we have identified similar technologies in Android and other platforms. Meanwhile, seven participants indicated they would not use the technology if they had to pay for it. Examples of such statements include:

*“Not everyone has the iPhone, and if it cost money I guess I would not use it.” (F, 35)*

Four participants also raised concerns about using this technology if it drained the phone battery or took up a large amount of phone storage. Mobile phone app developers need to consider energy efficiency as well. Finally, eight participants had no complaint if they had to install a piece of hardware to use the technology while seven participants believed hardware would be unnecessary. Examples of such statements include:

*“Like I said before if it was going to drain my battery and I got out of the car and found my phone was dead I would not be happy.” (M, 21)*

*“Yeah, I don’t really know if that would be necessary really. I don’t really know how that would communicate with your phone and who would be footing the bill for this extra setup. I don’t see it as super necessary.” (F, 24)*

These are issues that designers and road safety practitioners need to consider.

### 2.2.3.7 Design suggestions

Participants were given the opportunity to provide design suggestions to enhance and encourage their use of this technology. Five participants suggested it would be beneficial if it provided feedback or incentives. Three participants suggested that it could be beneficial if the technology could be voice activated. Meanwhile, two participants stated that the technology could have some way to evaluate the importance of the notification to assess whether it should be blocked or received by a driver. Apart from this, remaining participant feedback suggested that design improvements to the technology could be through trial and error of using the “do-not-disturb” feature. Example statements include:

*“I guess if it saved me money on insurance or registration or something. That would be more of a motivator.” (M, 29)*

*“Probably adding some voice commands, so that I can interact with my phone without having to manually deactivate the app. Maybe a text to speech to function that would read me the urgent message from my contact, instead of just telling you that you have a message.” (F, 32)*

*“I think it is a fairly new technology, and so it will learn through trial and error. We might want to add to it. I can’t think of anything at the moment.” (M, 30)*

## 2.2.4 Social approval/perceptions

Throughout the interviews, participants considered how their passengers, and those trying to contact them, might perceive their use of this “do-not-disturb” feature while driving.

### 2.2.4.1 Passengers

Thirty-three responses were recorded relating to perceptions of passengers being aware they are using this technology. Twenty-three responses suggested that participants believed passengers would view the use of this technology positively. Reasons for this positive perception include: making the passenger feel safer (17); and because participants do not like it when they are passengers and a driver uses their phone (6). Examples of statements include:

*"I think they would definitely feel safer, that I am not going to be on my phone while driving."* (M, 21)

*"Safer, I think they would feel safer. I would feel safer."* (M, 24)

In the remaining responses, most participants still acknowledged that passengers might feel safer, however stated that they would be largely unaffected as they are likely to be unaware of their use of the technology (9). The exception where the passenger is trying to use the phone, in which case the use of this technology could be frustrating for a passenger. Three participants stated that if they had passengers in the car, they would be less likely to use the technology. An example statement includes:

*"I guess passengers will be happy that I'm more attentive. Probably feel safer. But they might also be annoyed if they are the one who is using my phone while I'm driving, because that happens."* (M, 29)

### 2.2.4.2 Those contacting you

Twenty-one responses indicated that participants believed family, friends and colleagues would be understanding or unaffected by their use of this technology. Three participants suggested they would be unaffected by others' negative perceptions of their use of this technology, and this would be something that those individuals would need to manage. Example statement below:

*"I don't really see how it is related, because they do not know that my phone has been using it unless I told them."* (F, 27)

Nineteen participants suggested that, while those trying to contact them might be pleased they are prioritising safety, the use of this technology could be inconvenient or frustrating when an urgent response is required. However, three of these responses recognised that the technology setup does allow for notifications to be received. Statement examples include:

*"I think all of my friends and family that would contact me would be supportive and understand. As it stands if I don't get back to them in a couple of hours and said sorry I was driving then people understand. I think people would be supportive and it would be well received."* (F, 36)

*"If you have that automatic reply then they will know that you are driving and using the app, but if you do not have the reply then they might think that you do not want to talk to them. I guess there is a feature to help that."* (F, 35)

*"Probably a little frustrated, like if you are trying to get a hold of someone and they are not picking it up. Maybe a sense of frustration."* (F, 23)

### 2.2.5 Implementation features

Participant responses highlighted three considerations relevant to the setup of this technology, including: (1) automatic setup; (2) manual setup; and (3) combined setup.

Thirty-two statements related to participants' intended setup of the 'Do Not Disturb While Driving' app. There were twenty-one statements referring to participants' preference for having automatic activation, as opposed to the ten statements which noted a preference for manual activation. Examples of such statements include:

*"I would rather put it on automatically because I would not remember to do it every time I got in the car. Yeah, I would send out messages to the person contacting me so they get some sort of response and I would send it to everybody."* (F, 27)

*"Yeah, I think I would just manually turn it on. Not that I would not trust it to turn on automatically, but I would trust myself to turn it on while driving, but I don't think I would use the text message, I think I would just delay responding to any text... No, I think I would just turn off all favourites."* (F, 24)

Other participants stated they would trial both to identify which activation type would suit their personal needs. Examples of such statements include:

*"I would test it on automatic and then I would test it on manual and try both, because if there are some functions that*

*I don't like I might like to customise. I think I would have exceptions but only for emergencies and probably I would just stop and try to answer it if it was a very important call. This would include my parents, they call me only when there is something happening which is really important. Then I don't know. I would have to think about that, they are the first ones that come to mind. And my partner, she usually does not call me, she usually texts me." (M, 32)*

In relation to the message feature, twelve participants would not use it, twelve would send messages to anyone contacting them (with one participant stating this was contingent on the text messages being free), six participants would send messages to favourites, and one participant would not send messages, but would have favourites, so these individuals could contact them anytime. Example statements include:

*"I think I would go for it manually, not automatically, and I think I would text message everybody, just make it for everybody. Everybody is much safer." (F, 30)*

*"In terms of messages I think I would prefer not to use it or to change that one, not the automatic text that are currently on the app. But I would prefer the manual one. (M, 28)"*

## 2.3 Summary

The overall findings of this study are outlined below:

- Perceived benefits of the 'Do Not Disturb While Driving' app included 1) limiting phone use and distractions and 2) increasing road safety. Overall, participants saw limiting phone use positively and as a convenient tool to reduce risk and temptation to look at the phone. Participants believed that the apps could increase safety and awareness for all road users. However, there are concerns that some groups of drivers will not use the voluntary app such as young drivers.
- Perceptions around usability of the app focused on reliability and ease of use. Participants showed mixed responses in regard to how reliability would impact their intention to use an app. Participants recognised that the app is likely to present bugs and therefore it is important for app developers to continuously work on improving their app's reliability. More work is needed to improve the perception of ease of using voluntary apps because this is a major barrier for the acceptance of the technology.
- Participants accepted that loss of a degree of control was necessary to reduce distracted driving, and while some participants saw performance recording as an opportunity to increase accountability, many were concerned with privacy and security.
- Participants reported a number of concerns including the ability to be contacted during emergencies, accessibility of other apps, and excessive battery drainage while the voluntary driving app was active. These issues need to be considered by app developers.
- All participants were in favour of the parental control feature, believing it to be a useful tool to help younger and less experienced drivers to be safer on the roads. However, concerns were raised that younger drivers may feel less supportive of such functions.
- There was a mix of perceptions relating to how social approval could impact intention to use the voluntary mobile phone app. Most participants believed that passengers would feel safer knowing that the driver was using the app, and some participants stated they would be less likely to use technology if there were passengers in the car. However, over half of the participants expressed concerns that people calling them via their phone may get frustrated when unable to make contact. Nonetheless, most of the participants believed that the people trying to contact them will have favourable reactions to their use of the application.
- Considerations regarding implementation features were also brought up by participants, with majority preferring an automated setup of the app, while others preferred a manual setup with the flexibility to customise settings. Such customisations included allowing calls from identified contacts or setting up a custom message which will automatically send to someone trying to contact you while you are driving. Users seem to appreciate a high degree of personalisation.

# 3 Risk analysis with experts

## 3.1 Methods

This study explored experts' concerns and opinions about the use of voluntary apps used to improve road safety through reducing or preventing mobile phone use while driving.

A total of 10 experts were recruited and 3 participants did not complete the interviews (face-to-face or phone) due to logistical reasons (e.g., busy calendars, unexpected trips or cancellations). The group of experts included road safety practitioners, human computer interaction researchers, and developers of apps to prevent mobile phone distracted driving. Typical profiles include:

- An expert software engineer with experience in Human-Computer Interaction, apps development, and road safety.
- A programmer of a popular app to prevent mobile phone distracted driving. The app developed has been downloaded by more than 10,000 users and has been rated 4.1/5.
- Two scientists based in Australian Universities with expertise in mobile phone distracted driving and traffic engineering and with extensive scientific publications.
- A senior researcher specialising in young driver risky behaviour including distracted driving.
- A senior researcher specialising in In-Vehicle Information Systems and road safety.
- An Associate Professor in human-computer interaction with wide experience in road safety apps.

Experts were firstly asked to watch a four-minute YouTube video describing the iPhone 'Do Not Disturb While Driving' technology (link: <https://www.youtube.com/watch?v=A3o-vHnDchY> ). Following this, they participated in an interview featuring questions based on the technology acceptance model and their experiences with mobile phone distracted driving. Some of the general questions included: "What potential misunderstandings could be present related to the use of voluntary workload manager apps?", "What happens if drivers do not have trust in the system?", "What are the potential risks of misuse of the technology", and "Will drivers who use voluntary workload manager apps replace distraction by mobile phones with distraction from some other source?". These questions were just guides; the interviews were directed to the speciality of each one of the experts.

## 3.2 Results

The general discussion confirmed that the experts believed that voluntary apps to prevent mobile phone distracted driving have potential benefits for road safety. Even if a small number of drivers use the apps for short periods of time, a reduction in the exposure to mobile phone use while driving is likely to be positive. As mentioned by one of the experts:

*"Most of these apps have a strong orientation to prevent texting and other visual interactions with the mobile phone which are riskier than just phone conversations."* Research scientist in mobile phone distracted driving

Experts shared their point of view regarding the level of technological development of voluntary apps to prevent mobile phone distracted driving. The general theme in the interviews was that these apps are in the early stages of design and development. The common concern is that the function blocking approach used by these apps may limit their implementation. People are used to having access to their phone at any time and it is likely that many users will not accept losing control over their mobile phones. As mentioned by the experts:

*"An app blocking visual-manual interactions will reduce crashes. However, this is likely not to be accepted because many users do not want to lose their freedom. Blocking functions of the mobile phone will reduce acceptance"* Associate Professor in Human-Computer Interaction

*"Mobile phones are used for a reason. Blocking will only treat the symptom and not cause. Workload management is the solution."* Research scientist in mobile phone distracted driving

The use of voice commands instead of the visual-manual interface is an emergent approach in the apps that could prevent drivers from taking their eyes off the road. However, many of the experts mentioned their concerns with the

reliability with this technology. The lack of reliability of this technology is discouraging users from using the app. A plea for better auditory-voice interfaces was made by the experts. Some examples:

*“The function needs to work, or drivers will not use the app.”* Programmer of workload managers

*“There is balance between forcing people and user freedom. The users like to have the freedom and they will likely turn off the app if it is not working even 10% of the time. Failure of the system is a big thing.”* Associate Professor in Human-Computer Interaction

*“We cannot stop visual interactions until we have better voice interfaces. Siri doesn’t even function correctly for me while connected in my vehicle.”* Research scientist in mobile phone distracted driving

Another important issue that the experts highlighted was the lack of incentives to use the app. They suggested that in general transport stakeholders need to make an effort to create these incentives. An example given involved insurance companies offering a discount for using the apps. Comments included:

*“People do not have incentives for using the apps that block, a good example is insurance companies partnering to offer discounts.”* Senior researcher specialist in In-Vehicle Information

*“Better incentives may also increase acceptance of technology and could help to support implementation of workload manager apps.”* Software engineer with experience in Human-Computer Interaction

Experts also highlighted that there is a need for communication between the mobile phone and the vehicle. New vehicles today have created opportunities to support mobile phone use through vehicle audio systems (also known as integrated hands-free). The vehicle could also serve as a source of information to help activate the app appropriately. Automatic activation of the mobile phone app to prevent distracted driving is more reliable than the driver having to launch the app before every drive.

*“There is a need to achieve better integration between mobile phone and vehicles. They need to be able of interacting in order to offer a more organic solution.”* Associate Professor in Human-Computer Interaction

*“Allowed the app to be completely autonomous, not losing settings.”* Programmer of workload managers

### 3.3 Summary

The main findings of this study are outlined below:

- Experts in the field of road safety and app development believed that the adoption of voluntary apps developed to reduce mobile phone distracted driving, even for a short duration of time, would have positive outcomes. However, a number of concerns were expressed from a variety of experts in the field regarding the implementation and acceptance of such apps.
- The visual-manual blocking function used by the apps was flagged by the experts as a limitation which would decrease widespread acceptance of the app. As the blocking function limits people’s control over their phones, their frustration would lead people to stop using the app.
- The use of voice-commands that shift away from visual-manual interactions with the phone are useful, however the under-developed technology makes reliability an issue. Experts stated that users are likely to cease using the app if it’s unreliable 10% of the time, so future research should be focused on developing better auditory-voice interfaces.
- Another opportunity raised by experts was the use of incentives to encourage drivers to use the app. Transport stakeholders could develop incentives to increase overall acceptance of voluntary apps to reduce distracted driving. An example is insurance companies providing better rates for drivers who use voluntary apps.
- Vehicle data can be used for apps to safely integrate mobile phone use with driving. There are still many opportunities for the development of better apps.

# 4 Case-scenario analysis: an online experiment

## 4.1 Methods

Study 3 involved an online experiment using scenarios identified in Studies 1-3 with a general sample of drivers in Australia. Participants completed a questionnaire. The questionnaire items included mobile phone use history, cognitive interactions with apps (e.g. the TAM questionnaire (Davis et al., 1989) and the Mobile Phone Addiction scale (Bianchi and Phillips, 2005)), self-reported mobile phone use while driving (Oviedo-Trespalcacios et al., 2017c), and driver demographics (i.e., age, gender, previous experience with road crashes, etc.). All these factors have been reported to influence mobile phone distracted driving (Oviedo-Trespalcacios et al., 2016; Oviedo-Trespalcacios et al., 2017a; Oviedo-Trespalcacios et al., 2017b; Oviedo-Trespalcacios et al., 2018a). In addition, the web-based scenario was designed to collect information on behavioural responses based on app features (e.g. if the voluntary app allows texting or browsing) and human factors (e.g. if participants use their mobile phone to listen to music or for driving support such as GPS). Study 3 generalised user practices and preferences regarding interaction with voluntary apps.

Participants were recruited through social networks such as Facebook and by handing out flyers in Victoria. A stratified sampling technique was used to ensure the sample was representative of the driving population with respect to gender and location of residence (metropolitan, non-metropolitan). To attract a good cross section of the driving population participants were offered entry in a draw to win one of 5 x \$100 gift vouchers to acknowledge their time commitment.

## 4.2 Result

### 4.2.1 Characteristics of the sample

#### 4.2.1.1 Demographics

A total of 511 participants completed the online survey. Participants' ages ranged between 18 and 90 years ( $M=47.40, SD=18.03$ ). In total, 52.1% ( $n=266$ ) of participants identified as male, 47.7% ( $n=244$ ) identified as female, and one person identified as other. In relation to level of education, 5.5% of participants had completed Year 10, 10.4% had finished high school, 17.6% had completed or were enrolled in a TAFE course, and 66.5% had completed or were currently enrolled in University.

We asked participants to identify the type of phone operating system they were using: 47.7% used iOS, 45.6% used the Android operating system, 2.5% used the Windows operating system, and 4.1% used another type of software. The Mobile Phone Misuse scale was used to identify participants' overall mobile phone usage levels. Mobile phone misuse is defined by Bianchi (2005) as the continued use of mobile phone devices despite bans on use or knowledge of potential hazards and has strong theoretical links with the addictive behaviour literature. Bianchi (2005) used a 10-point scale ranging from 'Not true at all' to 'Totally true' and the average summed score from the Australian participants sampled by Bianchi was 64.86 ( $SD = 31.60$ ). Participants of this study reported larger mobile phone misuse ( $M = 73.99, SD = 41.12, Min = 27.00, Max = 270.00$ ). This can be explained due to an increase in popularity of the mobile phone or sample differences' i.e. education or income.

#### 4.2.1.2 License and Vehicle Information

The licence and vehicle descriptive statistics for participants are presented in table 4.1. The average number of years holding a valid licence (including learner licence) was 28.68 years ( $SD=17.68$ ).

**Table 4.1**  
**Descriptive statistics for licence and vehicle information**

	<b>Frequency</b>
<b>Licence Type</b>	
Open	470 (92%)
Provisional	41 (8%)
Average years holding valid licence	28.68
<b>Driving Purpose</b>	
Work	107 (20.9%)
Personal	180 (35.2%)
Work and Personal	224 (43.8%)
<b>Vehicle Type</b>	
Small/medium car	313 (61.3%)
Large/SUV/utility car	191 (37.4%)
Other	7 (1.4%)
<b>Transmission Type</b>	
Automatic	391 (76.5%)
Manual	120 (23.5%)
<b>Average Driving Hours in the Last 12 Months</b>	
Up to 5 hrs/weeks	157 (30.7%)
6-10 hrs/week	223 (43.6%)
11-20 hrs/week	104 (20.4%)
21 or more hrs/week	27 (5.3%)

### 4.2.2 Prior crash prevalence

Crash involvement was reported by 75% of participants as occurring at some stage during their driving history. Of that 75%, 25.3% were involved in one crash and 74.7% were involved in 2 crashes or more. During the past 3 years, 75.1% of participants had not been involved in a car crash.

### 4.2.3 Mobile phone use while driving

In addition to understanding which software participants were using, it was also important to get an understanding of participants' current mobile phone use while driving. We used a 7-point scale from "never" to "always" to measure mobile phone use over a range of different behaviours. Table 4.2 outlines how frequently participants engaged in such behaviours.



**Table 4.2**

**Self-reported frequency of mobile phone use behaviours while driving a moving vehicle**

Behaviour	Response					
	Never	Rarely	Occasionally	Sometimes	Frequently	Usually
<b>Visual-manual Interactions</b>						
You performed a visual-manual task on your mobile phone (e.g., texting, browsing, or emailing)	301 (58.9%)	104 (20.4%)	48 (9.4%)	33 (6.5%)	20 (3.9%)	3 (0.6%)
You looked continually at the phone for more than two seconds	281 (55.0%)	139 (27.2%)	47 (9.2%)	27 (5.3%)	10 (2.0%)	6 (1.2%)
You monitored/read conversations without writing back	295 (57.7%)	75 (14.7%)	56 (11.0%)	40 (7.8%)	24 (4.7%)	13 (2.5%)
<b>Handheld Conversations</b>						
You had handheld phone conversations (ear or speaker)	336 (65.8%)	96 (18.8%)	47 (9.2%)	17 (3.3%)	12 (2.3%)	2 (0.4%)
You reacted without delay (e.g. searched, reached, or picked up mobile phone) to a ringing phone (audio or vibration)	321 (62.8%)	114 (22.3%)	38 (7.4%)	22 (4.3%)	9 (1.8%)	3 (0.6%)
You dialed a phone number using your hand	399 (78.1%)	74 (14.5%)	24 (4.7%)	8 (1.6%)	4 (0.8%)	0 (0.0%)
<b>Hands-Free Conversations</b>						
You had a phone conversation using a hands-free device	162 (31.7%)	73 (14.3%)	74 (14.5%)	82 (16.0%)	79 (15.5%)	19 (3.7%)
You had a phone conversation using an in-car audio system or Bluetooth	164 (32.1%)	56 (11.0%)	75 (14.7%)	83 (16.2%)	67 (13.1%)	32 (6.3%)
You had a phone conversation without using your hands (hands-free device, earphones, etc.)	201 (39.3%)	69 (13.5%)	42 (8.3%)	70 (13.7%)	44 (8.6%)	42 (8.2%)
<b>Other Mobile Phone Uses</b>						
You initiated a music app	348 (68.1%)	36 (7.0%)	40 (7.8%)	38 (7.4%)	23 (4.5%)	12 (2.3%)
You used your phone as a GPS device	160 (31.3%)	64 (12.5%)	69 (13.5%)	79 (15.5%)	80 (15.7%)	30 (5.9%)
You used your phone to get urgent information required for your journey (e.g. weather, addresses, opening hours, etc.)	299 (58.5%)	75 (14.7%)	64 (12.5%)	42 (8.2%)	19 (3.7%)	8 (1.6%)

After item level analysis, we grouped similar items into 4 categories to study four dimensions of mobile phone use while driving: visual-manual interactions, handheld conversations, hands-free conversations, and other mobile phone uses, the last of which was not specific about the particular kind of interaction undertaken to gain urgent information. Means, standard deviations and Cronbach's alpha scores for these dimensions are presented in Table 4.3. Reliability analysis (using Cronbach's alpha) revealed that the items within each dimension of mobile phone use were suitably intercorrelated with all values above 0.7 (see Table 4.3). From the descriptive statistics, it can be seen that participants used their mobile phone more frequently for hands-free conversation (see Table 4.3). Participants reported using their mobile phone less frequently when it required them to look at or touch their screen or keyboard except for situations when doing so would support their drive, such as using the GPS.

**Table 4.3**

**Descriptive statistics for four dimensions of mobile phone use while driving**

	M	SD	$\alpha$
Visual-manual Interactions	1.76	1.01	0.81
Handheld Conversations	1.53	0.79	0.74
Hands-free Conversations	3.02	1.57	0.74
Other Mobile Phone Uses	2.31	1.31	0.73

Next the responses for the dimensions of mobile phone use while driving were compared between young drivers (aged 17-25) and experienced drivers. The means and standard deviations of these variables for both young and experienced drivers are presented in Table 4.4. A number of independent sample *t*-tests were conducted to identify if the four different dimensions of mobile phone use while driving were different between younger or experienced drivers. Younger drivers were more likely to engage in visual-manual interactions with their phone ( $t(98.73) = 3.95, p < .001$ ) than experienced drivers, and were more likely to use their mobile phone for other mobile phone uses ( $t(98.96) = 8.18, p < .001$ ). Both young and experienced drivers reported similar levels of engagement in mobile phone use for handheld and hands-free conversations. Handheld conversations ( $t(102.13) = 1.76, p = .082$ ; Hands-free conversations ( $t(509) = -.31, p = .757$ ). The results from these analyses continue to demonstrate the age differences seen in mobile phone use while driving.

**Table 4.4**

**Descriptive statistics comparing mobile phone use while driving across experience levels**

	Young Drivers		Experienced Drivers	
	M	SD	M	SD
Visual-manual Interactions	2.24	1.25	1.67	0.94
Handheld Conversations	1.69	0.94	1.5	0.76
Hands-free Conversations	2.98	1.54	3.03	1.57
Other Mobile Phone Uses	3.34	1.56	2.12	1.16

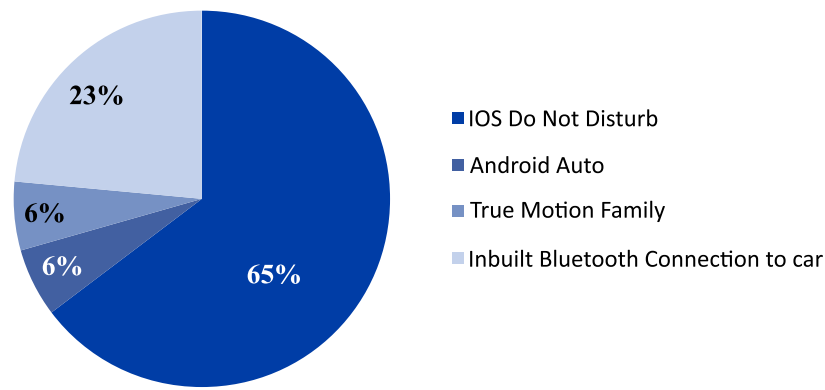
Finally, comparisons were made to determine if the dimensions of mobile phone use while driving had different levels for those who had used voluntary apps to prevent mobile phone distracted driving previously and either continued or ceased using them. Analyses revealed that those who had continued using the voluntary apps while driving had significantly lower reported levels of visual-manual interactions ( $M = 1.56, SD = 0.96$ ) than those who ceased using the app ( $M = 2.24, SD = 1.25$ ), ( $t(40.49) = 1.95, p = 0.04$ ). Participants who had continued using the app were also less likely to use their mobile phone for other mobile phone uses ( $M = 2.16, SD = 1.28$ ) than participants who had stopped ( $M = 3.16, SD = 1.37$ ), ( $t(98.73) = 3.95, p < .001$ ). As noted above, “other mobile phone uses” included unspecified use of the phone to gain urgent information, while other items throughout the analysis were more specific; although this does not appear to affect the overall pattern of results, a more specific item would have been desirable.

#### 4.2.4 Use of voluntary apps to prevent distracted driving

We asked participants about their exposure to mobile phone blocking apps and if they had known about or used any in the past. In order to encourage honesty, the following paragraph was included in the survey:

*“It is not a secret that cell phones and mobile phones have played a big role in the increase of distracted driving incidents. What you might not know is that several app developers are working to create ways to help make your phone a tool to fight against distracted driving, rather than a cause of it. With this research we want to understand what you think about such apps.”*

While 206 (40.3%) participants had heard about voluntary apps designed to reduce mobile phone distracted driving, only 51 (10%) participants had experienced driving while using them. Of that 10%, only a third of users were using the app on the day of the study. For the participants who were still using the app, we asked them what app they were using (See Figure 4.1). It was revealed that 65% were using the iOS ‘Do Not Disturb While Driving’ feature built into the operating software on most Apple phones. The second-largest group were utilising the inbuilt Bluetooth connection in the car. These results demonstrate that people are most likely to use a phone blocking app when it is easily accessible for them.



**Figure 4.1**  
Voluntary Apps used by participants to reduce distracted driving

Those participants who stated they were not using the voluntary app on the day of the study were asked to provide a reason or explanation why; 36% reported that either the app or specific functions did not work well, 20% forgot to activate the app, 12% mentioned that it consumed large amounts of battery power, and the remaining 32% did not specify.

### 4.2.5 Preferred app functions

Participants were asked to identify which app functions they would feel comfortable using. The question allowed participants to tick as many functions as they wanted from the list provided. Table 4.5 shows the total support for each function in addition to a breakdown by age group.

**Table 4.5**  
Age differences in preferences for different functions of voluntary apps used to reduce driver distraction.

Preferred Functions	Age Groups						Total
	18-24	25-34	35-44	45-54	55-64	65+	
Block texting, browsing, social media, and other non-driving apps that require vision	48 (64.0%)	46 (57.5%)	41 (64.1%)	59 (76.6%)	74 (72.5%)	87 (77.0%)	355 (69.5%)
Allow other driving apps such as GPS	67 (69.5%)	73 (91.3%)	57 (98.1%)	57 (74.0%)	76 (74.5%)	68 (60.2%)	398 (77.9%)
Allow music apps	63 (84.0%)	59 (73.8%)	35 (54.7%)	38 (49.4%)	45 (44.1%)	38 (33.6%)	278 (54.4%)
Send messages to people trying to contact you letting them know that you are not available (customised by you)	35 (46.7%)	44 (55.0%)	30 (46.9%)	50 (64.9%)	56 (54.9%)	71 (62.8%)	286 (56.0%)
Block notifications so you don't know that someone has sent you a message or tried to call you while the vehicle was moving	35 (46.7%)	26 (32.5%)	30 (46.9%)	32 (41.6%)	41 (40.2%)	51 (45.1%)	215 (42.1%)
Automatically detect when the vehicle is moving	37 (49.3%)	45 (56.3%)	39 (60.9%)	51 (66.2%)	68 (66.7%)	80 (70.8%)	320 (62.6%)
Record your performance so you can see your level of distraction	26 (34.7%)	29 (36.3%)	21 (32.8%)	21 (27.3%)	32 (31.4%)	43 (38.1%)	172 (33.7%)
Make exceptions for people predefined by you so you can receive their notifications when they text you	39 (52.0%)	27 (33.8%)	16 (25.0%)	15 (19.5%)	21 (20.6%)	18 (15.9%)	135 (26.4%)
Allow people to decide if the message is urgent or not so they can contact you	25 (33.3%)	27 (33.8%)	16 (25.0%)	13 (16.9%)	18 (17.6%)	22 (13.7%)	121 (23.7%)
Let you stop using the app at any moment	36 (48%)	27 (33.8%)	25 (39.1%)	20 (26.0%)	24 (23.5%)	26 (20.0%)	158 (30.9%)
Require you to fix a small piece of additional equipment to your vehicle	13 (17.3%)	13 (16.3%)	11 (17.2%)	11 (14.3%)	25 (24.5%)	26 (20.0%)	99 (19.4%)
Share your performance with your family, friends, etc	9 (12%)	8 (10%)	4 (6.3%)	5 (6.5%)	10 (9.8%)	12 (8.4%)	48 (9.4%)
Allow you to give commands to the phone exclusively through audio using a hands-free device or Bluetooth. The phone will read you text messages and write a response that you dictate	44 (58.6%)	45 (56.3%)	34 (53.2%)	50 (64.9%)	54 (52.9%)	54 (45.3%)	281 (55.0%)
Select where or when is safe to use a phone for a task	15 (20%)	20 (25%)	13 (20.3%)	16 (20.8%)	31 (30.4%)	33 (27.4%)	128 (25.0%)
Allow conversations and incoming calls only through Bluetooth or an in-vehicle audio system	50 (66.7%)	47 (58.8%)	49 (76.6%)	58 (75.3%)	71 (69.6%)	83 (72.6%)	358 (70.1%)

Overall, the most supported function was blocking of apps that required visual-manual interaction. Participants wanted to retain the functionality of apps that supported their drive, such as GPS and Bluetooth calls. Another popular function included the automatic detection of movement.

A number of age differences were evident when looking at the preferred functions. Younger drivers were more interested in using music apps while driving than older drivers. Younger drivers were also more interested than older drivers in setting exceptions and allowing notifications for predetermined people. Older drivers were more supportive of the automatic functions in the app, with greater support for automatically detecting when the vehicle was moving, while younger drivers wanted to be able to cease using the app at any time. The least popular function was sharing your driving performance with family and friends, implying that participants did not want an additional level of accountability. Interestingly, this function was supported more in the younger participants than the older participants.

#### **4.2.6 Constructs to measure acceptance of voluntary apps aimed at preventing mobile phone distracted driving**

In this section, we showed the participants one kind of workload manager which simulates the most popular app currently available on the market, which is the 'Do Not Disturb' feature on iOS. A description of the app was provided to give the participants insight into how the app would work:

##### **The Mobile Phone Blocker**

- Must be initiated voluntarily once and then will detect driving automatically.
- If you are a passenger, it will let you deactivate the app in the first five minutes of the trip only.
- Blocks texting and all other mobile phone tasks that require you to look at the screen such as browsing, social media, chats, dialling, etc whilst the vehicle is moving.
- Does not allow notifications (audio or vibration) whilst the vehicle is moving. Incoming calls are allowed if the phone is connected to Bluetooth and hands-free device calls, in that case, the app will read who is calling so you can decide to answer or not.
- Bluetooth or hands-free device calls are allowed including emergency services.
- Automatically responds to messages to let your contact know that you are driving (if you prefer). If you do not answer a phone call, your phone will send a text to the caller explaining that you are driving (if you prefer).
- Record your performance so you can monitor how much you use or try to use your phone while driving.
- If desired, it shares your performance with family and friends when you want to work together to reduce mobile phone distracted driving. Allows you to use GPS and music apps.
- Otherwise, the phone cannot be used and if needed you will need to pull over.

In this study, we used the Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB) to identify how different cognitive factors would influence participants' acceptance of the Mobile Phone Blocker described above. The TAM is a measure that explains the cognitive instrumental processes and the social influences which determine the perceived usefulness and usage intentions of technology. Similarly, the TPB is a well-supported theory that shows how attitudes, subjective norms, and perceived behavioural control are associated with person's intention and engagement in behaviour. Attitudes were measured on a 7-point scale ranging between two dichotomous attitudes (e.g. bad – good). Perceived usefulness, perceived ease of use, subjective norms, and perceived behavioural control were all measured on a 7-point scale ranging from strongly disagree to strongly agree. Means, standard deviations and Cronbach's alpha reliability tests of these variables are presented in Table 4.6, where all subscales showed strong internal reliability. Drivers consider that the voluntary app will be useful to a large extent (M = 5.04), and they believed they would be able to utilise the app (M = 5.08). However, participants believed their family and friends would have lower perceptions of acceptance towards the app (M = 3.84).

**Table 4.6****Descriptive statistics for TAM and TPB subscales**

	<b>M</b>	<b>SD</b>	<b>α</b>
Perceived Usefulness	5.04	1.62	0.93
Perceived Ease of Use	4.80	1.42	0.84
Attitude	4.81	1.24	0.96
Subjective Norm	3.84	1.96	0.90
Perceived Behavioural Control	5.08	1.51	0.89
Behavioural Intentions	4.28	1.90	0.96

Note: Scales adapted from Mahmudur Rahman, Lesch, Horrey, and Strawderman (2017), Venkatesh and Davis (2000), and Venkatesh, Morris, Davis, and Davis (2003).

### 4.2.7 Correlations among personal characteristics, mobile phone use while driving, and acceptance of the voluntary apps

To study interactions between the personal characteristics, mobile phone use while driving and the acceptance of the voluntary apps aimed at preventing mobile phone distracted driving, we conducted a correlational study. The correlations are presented in Table 4.7 Intention to use voluntary apps to reduce distracted driving was correlated with a number of factors. Of the personal characteristics studied, only age was a significant predictor, with older participants being more likely to show greater intention to adopt the voluntary apps while driving.

**Table 4.7****Correlation table of personal characteristics, dimensions of mobile phone use while driving, and acceptance of voluntary mobile phone apps**

	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>13</b>
1. Age													
2. Experience Level	.64*												
3. Gender	-.27*	-.90*											
4. Visual-manual Interaction	-.41*	-.21*	.11*										
5. Handheld Conversations	-.27*	-.09*	.05	.73*									
6. Hands-free Conversations	-.03	-.01	.03	.30*	.30*								
7. Other Mobile Phone Uses	-.57*	-.34*	.12*	.68-	.52*	.28*							
8. Perceived Usefulness	-.04	-.01	.08	.18*	.12*	.06	.08						
9. Perceived Ease of Use	-.04	-.04	.09-	.07	.01	.02	.03	.67*					
10. Attitude	.16*	.13*	.06	-.07	-.04	-.06	-.17*	.63*	.53*				
11. Subjective Norms	-.03	-.04	-.02	.26*	.19*	.09*	.11*	.65*	.47*	.44*			
12. Perceived Behavioural Control	-.05	-.04	.07	.08	.01	.08	.07	.53*	.77*	.38*	.39*		
13. Behavioural Intention	.09*	.08	.03	.09*	.09	.06	-.02	.78*	.61*	.68*	.64*	.54*	
14. Mobile Phone Misuse	-.57*	-.42*	.16*	.49*	.44*	.12*	.51*	.15*	.06	-.04	.20*	.06	.06

Note: \* Correlation is significant with  $p < 0.05$

Age was negatively correlated with three of the dimensions of mobile phone use, indicating that visual-manual behaviours, handheld conversations and other mobile phone uses were more common among younger drivers.

Of the four dimensions of mobile phone use while driving, visual-manual interaction was positively correlated with behavioural intention, possibly indicating that participants who engaged in such behaviour saw a need to change those behaviours and intended to use a voluntary app to support such change. Visual-manual interaction was negatively correlated with experience level, indicating that the behaviour was more common among less experienced drivers, and was positively correlated with gender, indicating that female participants engaged in the behaviour more frequently than male participants. While none of the other dimensions of mobile phone use were significantly correlated with behavioural intention, both handheld and hands-free conversations were positively correlated with visual-manual interactions. This result indicates that if a participant engages in one form of mobile phone use while driving, they are more likely to engage in other forms of mobile phone use.

The subscales for both the TAM and the TPB were positively correlated with behavioural intentions. These findings provide support for the use of the TAM and TPB as theoretical tools to predict participants' acceptance of the voluntary apps. The items of the TAM included in the current study constituted two subscales: perceived usefulness and perceived ease of use. The degree to which participants perceived the app as useful was positively correlated with their visual-manual and handheld mobile phone use behaviour. Therefore, participants who engaged in more mobile phone use while driving were more likely to see the app as useful. Perceived ease of use was significantly positively correlated with perceptions of usefulness and other predictors from the TPB.

The predictors included from the TPB include attitude, social norms, and perceived behavioural norms, and each subscale was significantly positively correlated with the others. Attitude was positively correlated with age and experience level meaning that older, more experienced participants had more positive attitudes towards the acceptance of the voluntary apps. However, attitude was negatively correlated with other mobile phone uses, therefore participants who were using their phone for GPS, weather, and music had less favourable attitudes towards the voluntary apps. Subjective norms were positively correlated with all four dimensions of mobile phone use while driving. Perceived behavioural control was significantly correlated with the predictors from the TAM and the TPB, but not significantly correlated with any other personal characteristics or dimensions of mobile phone use while driving.

The Mobile Phone Misuse scale was also included in the correlational analysis. As could be expected, the mobile phone misuse scale was positively correlated with all four dimensions of phone use while driving. Mobile phone misuse was positively correlated with gender, indicating that females reported higher levels of mobile phone misuse than males, and supporting the similar correlation found for the visual-manual interaction dimension. Finally, mobile phone misuse was negatively correlated with age and experience level, further demonstrating the greater reporting of problematic mobile phone use among younger, less experienced drivers.

#### 4.2.8 Factors affecting the willingness of installing and activating voluntary apps to reduce distracted driving

To further explore the factors affecting participants' acceptance of voluntary apps to reduce distracted driving, participants were asked to read 12 different app descriptions and to specify if they would install and activate the app. The 12 variations described mobile phone apps with a variety of functions that were enabled, blocked, or permitted under specific exceptions. The 12 descriptions and frequency statistics are displayed in Table 4.8.

**Table 4.8**

**Factors affecting the willingness of installing and activating the voluntary apps**

	<b>Yes</b>	<b>No</b>
Text messages, browsing, and mail (including notifications) are blocked. Calls (dialled or incoming) are blocked	184 (36.0%)	327 (64.0%)
Text messages, browsing, and mail (including notifications) are blocked. Calls (dialled or incoming) are enabled using a Bluetooth or hands-free device only	339 (66.3%)	172 (33.7%)
Text messages, browsing, and mail (including notifications) are blocked, however the phone automatically responds to messages to let your contacts know that you are driving. Calls (dialled or incoming) are blocked	235 (46.0%)	276 (54.0%)
Text messages, browsing, and mail (including notifications) are blocked, however the phone automatically responds to messages to let your contacts know that you are driving. Calls (dialled or incoming) are enabled using a Bluetooth or hands-free device only	329 (64.6%)	182 (35.6%)
Text messages, browsing, and mail (including notifications) from your favourite contacts are enabled. Calls (dialled or incoming) are blocked	108 (21.1%)	403 (78.9%)
Text messages, browsing, and mail (including notifications) from your favourite contacts are enabled. Calls (dialled or incoming) are enabled using a Bluetooth or hands-free device only	215 (42.1%)	296 (57.9%)
Text messages, browsing, and mail (including notifications) from your favourite contacts are enabled and your phone automatically responds to messages from non-favourite contacts to let them know that you are driving. Calls (dialled or incoming) are blocked	119 (23.3%)	392 (76.7%)
Text messages, browsing, and mail (including notifications) from your favourite contacts are enabled and your phone automatically responds to messages from non-favourite contacts to let them know that you are driving. Calls (dialled or incoming) are enabled using a Bluetooth or hands-free device only	207 (40.5%)	304 (59.5%)
Text messages, browsing, and mail (including notifications) from your favourite contacts are enabled but a screen advising not to interact with the phone is displayed. Calls (dialled or incoming) are blocked	100 (19.6%)	411 (80.4%)
Text messages, browsing, and mail (including notifications) from your favourite contacts are enabled but a screen advising not to interact with the phone is displayed. Calls (dialled or incoming) are enabled using a Bluetooth or hands-free device only	206 (40.3%)	305 (59.7%)
Text messages, browsing, and mail are enabled, however notifications are blocked. Calls (dialled or incoming) are blocked	96 (18.8%)	415 (81.2%)
Text messages, browsing, and mail are enabled, however notifications are blocked. Calls (dialled or incoming) are enabled using a Bluetooth or hands-free device only	216 (42.3%)	295 (57.7%)

Overall, participants showed more willingness to install and activate the voluntary apps where calls (dialled or incoming) were enabled using a Bluetooth or hands-free device. This function, when combined with blocking of text messages, browsing, and mail (including notifications) had the highest frequency with 66.3% of participants stating that they would install and activate such an app. The inclusion of functions where favourite contacts are exempted from blocking or messages are sent to people who try and contact you negatively impacted willingness to install and activate apps, possibly because participants saw such an app as less useful as the others listed. Participants showed the least willingness to download an app where notifications and calls were blocked, yet texting, browsing, and mail were still enabled.

Advanced statistical analysis was conducted to analyse the impact of the different potential app functions on the declared participants' decision to install and activate the app. A random-effects logistic regression model was fitted to control for participant-level correlation. The variables included in the model included personal characteristics (age, gender, and driving experience), self-reported mobile phone use (visual-manual interaction, handheld conversations, hands-free conversations, and other mobile phone uses), voluntary app call-related functions (whether dialled or incoming calls are allowed using a Bluetooth or hands-free device or not), and voluntary app visual-manual-related functions. These visual-manual functions consisted of either 1) drivers can make exceptions and interact or receive notifications from favourites, 2) same as 1 but the application also automatically responds to messages from non-favourite contacts to let them know that you are driving, 3) visual-manual tasks are allowed and the driver receives all notifications, 4) visual-manual tasks are allowed but the driver does not receive notifications, 5) visual-manual tasks and their notifications are disabled, or 6) same as 5, however, the application also automatically responds to messages to let your contacts know that you are driving. The parsimonious model is reported in Table 4.9. The model was statistically significant at 0.001, which suggests that the five variables included are able to explain participants' decision to install and activate the app.

**Table 4.9**

**Random effects logistic regression model for participants' decisions of install and activate the app**

Variables	Odds Ratio	P> z	CI 95%
<b>Constant</b>	0.04	< 0.001	[0.03, 0.07]
Visual-manual-related functions			
Visual-manual tasks and their notifications are disabled	4.1	< 0.001	[3.40, 4.93]
Visual-manual tasks and their notifications are disabled. However, the phone automatically responds to messages to let your contacts know that you are driving	5.3	< 0.001	[4.44, 6.48]
Reference±	-	-	-
Call-related functions			
Dialled or incoming calls are allowed using a Bluetooth or hands-free device (Yes = 1)	4.78	< 0.001	[4.13, 5.53]
Actual Mobile phone use while driving			
Visual-manual tasks	1.35	0.002	[1.11, 1.63]
Hands-free conversations	1.18	0.007	[1.04, 1.34]

±Reference category: (1) Drivers can make exceptions and interact or receive notifications from favourites OR (2) drivers can make exceptions and interact or receive notifications from favourites. However, the phone automatically responds to messages from non-favourite contacts to let them know that you are driving, OR (3) Visual-manual tasks are allowed, and the driver receives all notifications OR Visual-manual tasks are allowed but the driver does not receive notifications.

The random-effects logistic regression analysis confirms that demographic characteristics of the participants do not influence their decision to install and activate the app. In addition, mobile phone use for handheld conversations and other mobile phone use were not predictors of the decision to install and activate the app. Another important finding is that four types of visual-manual functionalities seem to have the same level of preference among participants. These four types of visual functionality in voluntary apps were merged and became the reference category:

- Drivers can make exceptions and interact or receive notifications from favourites
- Drivers can make exceptions and interact or receive notifications from favourites. However, the phone automatically responds to messages from non-favourite contacts to let them know that you are driving
- Visual-manual tasks are allowed, and the driver receives all notifications
- Visual-manual tasks are allowed but the driver does not receive notifications.

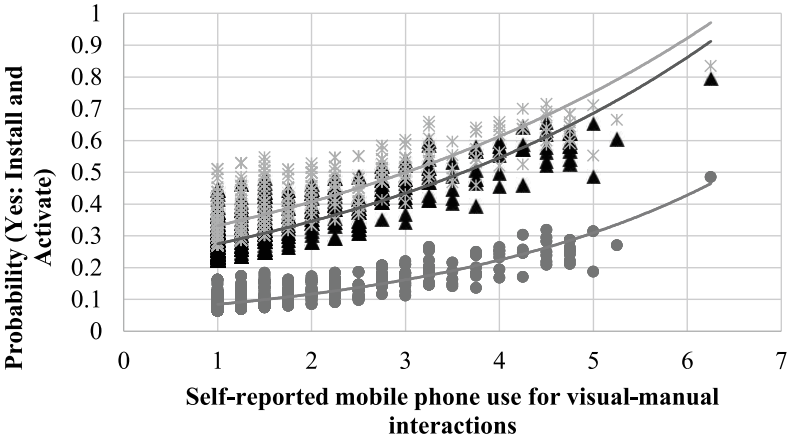
Two of the hypothetical voluntary apps' visual-manual functions were preferred by the participants, i.e. applications with a function of disabling visual-manual tasks and their notifications are disabled, both with and without the

phone automatically responding to messages to let the contacts know that you are driving. Participants were at least four times more likely to report installing and activating a voluntary app if this disabled visual-manual tasks and notifications compared to the apps in the reference categories. However, the odds of reporting to install and activate were increased if the phone automatically responds to messages from non-favourite contacts to let them know that you are driving. In addition, voluntary apps that allow hands-free conversations using a hands-free device or Bluetooth were associated with a larger preference from participants to install and activate (OR 4.78).

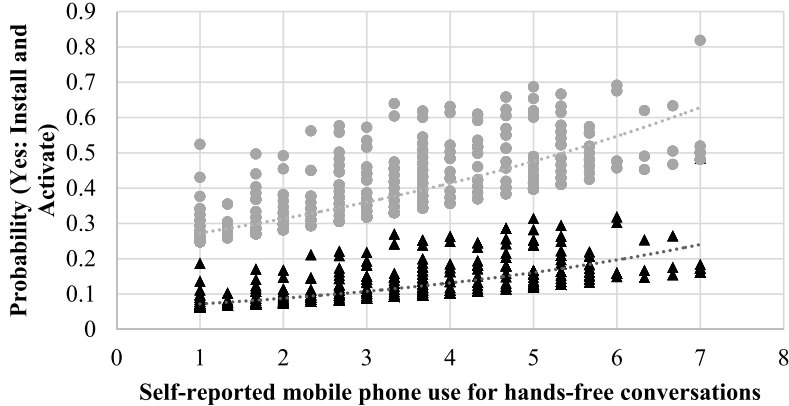
Mobile phone use while driving self-reports were predictors of participants' willingness to install and activate voluntary apps. For every additional unit the odds of selecting and installing a voluntary app are 1.35 for visual-manual tasks and 1.18 for hands-free conversations. These results show that generally, drivers who use the phone more seem more likely to install and activate voluntary applications. This is encouraging given that these apps might offer a solution to target high-risk groups such as young drivers. Figures 4.2 and 4.3 show the interactions between mobile phone and voluntary apps functionality.

Note: ▲ Visual-manual tasks and their notifications are disabled. However, the phone automatically responds to messages to let your contacts know that you are driving; □ Visual-manual tasks and their notifications are disabled; and ● Reference group.

**Figure 4.2**  
 Predicted probabilities for self-reported installation and activation of voluntary apps by level of mobile phone use for visual-manual interactions.



**Figure 4.3**  
 Predicted probabilities for self-reported installation and activation of voluntary apps by level of mobile phone use for hands-free conversations for visual-manual interactions





## 4.3 Summary

The overall findings of this study are outlined below:

- Four dimensions of mobile phone use while driving were measured: visual-manual interactions, handheld conversations, hands-free conversations, and other mobile phone use. Overall, hands-free conversation was the most frequently reported use of mobile phones while driving, closely followed by other mobile phone use such as music or GPS.
- Young drivers were identified as a high-risk group. Young drivers (aged 17-25) were significantly more likely than experienced drivers to engage in visual-manual interactions with their phone and use their mobile phone to listen to music or for driving support (e.g. GPS).
- Participants who had experienced using a voluntary app while driving and continued using it reported fewer visual-manual interactions with their phone while driving and less use of other mobile phone use than those who stopped using the app.
- Participants stated a number of voluntary apps that they had used in an attempt to reduce mobile phone distracted driving. The most common was the 'Do Not Disturb' feature built-in to iOS software on all Apple devices, while other apps included Android Auto, and True Motion Family. Of the participants who had used a voluntary app, only a third had continued using the app at the time of the survey.
- Participants identified a number of functions they would feel comfortable using in a voluntary app, the most popular being the blocking of apps that required visual-manual interaction. The automatic detection of movement was also identified as a favourite function, as well as the ability to retain the functionality of apps such as GPS which support the driving task.
- The Technology Acceptance Model and the Theory of Planned Behaviour were identified as suitable theoretical models through which to determine drivers' acceptance of voluntary apps. Participants had positive results on both scales demonstrating that participants found the app to be useful, easy to use, held positive attitudes and subjective norms towards the app, and had high levels of perceived behavioural control. Furthermore, subscales of the TAM and TPB were significantly correlated with participants' intention to use the voluntary app.
- Other factors predicting intention to use voluntary apps included age and the visual-manual interaction dimension of mobile phone use while driving. Older drivers were more likely to have greater intention to use voluntary apps to reduce distracted driving. Interestingly, participants who reported more visual-manual interactions with their phone while driving showed higher levels of behavioural intention. This may indicate that those who engage in such behaviour are aware of a need to change their behaviour and are willing to use voluntary apps to reduce their mobile phone misuse.
- A voluntary app that blocks text messages, browsing, and mail (including notifications) while enabling calls (dialled or incoming) through a Bluetooth or hands-free device showed the greatest support from participants. Two-thirds of participants indicated that they would be willing to install and activate a voluntary app to prevent distracted driving based on such a description.
- Drivers who use their phones for visual-manual tasks and hands-free conversations seem more likely to install and activate voluntary applications. This is encouraging given that these apps might offer a solution to target high-risk groups such as young drivers.

# 5 In-vehicle study

## 5.1 Method

This study examines the usability of the 'Do Not Disturb While Driving' app and the 'Android Auto' app.

A longitudinal quantitative survey (before and after questionnaires) approach paired with three qualitative diary entries was utilised to address the following objectives:

- Examine the level of acceptance of voluntary apps to prevent mobile phone distracted driving among motorists and identify potential facilitators of, and barriers to, successful implementation;
- Explore motorists' intentions to use (and misuse) voluntary apps to prevent mobile phone distracted driving, and examine whether these intentions influence effectiveness;
- Identify design and situational parameters that contribute to the effectiveness or ineffectiveness of voluntary apps to prevent mobile phone distracted driving

Participants were recruited online via email and snowball sampling. All data collection components of the study were completed online. Before completing the study, participants who signed up were asked to download and familiarise themselves with the 'Do Not Disturb While Driving' or 'Android Auto' phone application, depending on their phone's operating system. Instructions on the use of the application were also provided to participants at this time.

The first questionnaire was emailed to participants before they started the diary-based component of the study while the second questionnaire was emailed to participants with the last diary entry. The questionnaire items include mobile phone use history, cognitive interactions with apps (i.e. the Technology Acceptance Model questionnaire (Davis et al., 1989) and the Theory of Planned Behaviour Questionnaire (Rahman et al., 2017)), and human-machine interaction workload (i.e. NASA TLX to measure perceived workload (Hart, 2016)). These factors have been reported to influence use of mobile phone interfaces (Oviedo-Trespalacios et al., 2016; Oviedo-Trespalacios et al., 2017a; Oviedo-Trespalacios et al., 2017b; Oviedo-Trespalacios et al., 2017c; Vaezipour et al., 2017).

The diary component of the study was emailed to participants at three different time points (two days after the completion of the previous study component). A diary was considered to be the most appropriate method for this component of the study as it allowed drivers to report on their normal use of the application in an everyday setting. It involved a series of open-ended questions targeted at the app use. As there is very limited research in this area, the open-ended question design was most suitable because it allowed unanticipated responses and concepts to be recorded, rather than constraining participants' responses to predefined categories, e.g. as with a Likert type scale. Meanwhile, the questionnaires complemented the diary components of the study, recording quantitative data on the acceptance of technology, and any changes in acceptance over a week of experience with the app.

## 5.2 Overview of findings: Longitudinal survey

### 5.2.1 Characteristics of the sample

#### 5.2.1.1 Demographics

A total of 33 participants completed the study. Ages of participants ranged between 18 and 56 years ( $M = 31.24$  years,  $SD = 8.71$ ). In total, 42.4% ( $n = 14$ ) of participants were male while 57.6% ( $n = 19$ ) were female. In relation to education level, 6.1% of participants had finished high school (year 12), a further 6.1% had either completed or were currently enrolled in a TAFE course or equivalent, while the remaining 87.9% had completed or were currently enrolled in a university degree.

### 5.2.1.2 License and vehicle information

The majority of participants held an open Australian drivers licence (85.3%,  $n = 29$ ), while 11.8% ( $n = 4$ ) of participants held a provisional drivers licence. The average number of years holding a licence (including learner licence) was 13.21 years ( $SD = 8.74$ ). The reported purposes of driving included mostly for work/commute to work (30.3%,  $n = 10$ ), mostly personal (9.1%,  $n = 3$ ) and a mixture of work and personal (60.6%,  $n = 20$ ).

The majority of participants (76.5%,  $n = 26$ ) drove a small/medium car while the remaining participants (20.6%,  $n = 7$ ) drove a large/SUV/utility vehicle. Most participants drove an automatic vehicle (70.6%,  $n = 24$ ) while the remaining participants drove a manual vehicle (26.5%,  $n = 9$ ).

When asked about driving in the last 12 months, 38.2% of participants stated they drove up to 5 hours per week, 47.1% drove 6-10 hours per week, 8.8% drove 11-20 hours per week and 2.9% drove 21-30 hours per week.

### 5.2.2 Prior crash prevalence

In total, 58.8% of the sample reported that they have been involved in a crash at some point in their driving history. A total of 20.6% of participants have been involved in one crash, a further 79.4% were involved in two crashes or more. Of the participants who have been involved in a crash, 67.6% were not involved in a crash in the past three years.

### 5.2.3 Mobile phone use while driving

In total, 53% of participants had an iOS phone operating system, meaning they used the 'Do Not Disturb While Driving' application in the study, while 47% of participants had an Android phone operating system, meaning they used the 'Android Auto' application in the study. Participants' current mobile phone use while driving behaviour was explored over a range of different phone behaviours. A 7-point scale ranging from never (1) to always (7) was used to measure these behaviours. The means and standard deviations of these behaviours from this scale are presented in Table 5.1.

**Table 5.1**

**Descriptive statistics for four dimensions of mobile phone use while driving**

	Survey 1 M	Survey 1 SD	Survey 2 M	Survey 2 SD
Visual-manual Interactions	2.81	1.29	1.97	1.07
Handheld Conversations	1.92	1.04	1.38	0.68
Hands-free Conversations	3.69	1.39	2.79	1.57
Other Mobile Phone Uses	3.81	1.40	2.62	1.48

A number of repeated measures  $t$ -tests were conducted to identify if the four different measures of mobile phone use while driving behaviours change over the course of the study. Drivers were less likely to engage in visual-manual interactions with their phone ( $t(32) = 3.64, p = 0.001$ ), have handheld conversations, ( $t(32) = 2.69, p < .05$ ) and hands-free conversations ( $t(32) = 3.99, p < .001$ ) after they have completed the study using the phone application while driving. Interestingly, after the study, participants were also less likely to use the other mobile phone functions, including the use of GPS and weather applications which supports driving as well as music ( $t(32) = 4.62, p < .001$ ).

### 5.2.4 Use of voluntary apps to prevent distracted driving

In total, 15 (45.5%) participants had heard about voluntary applications designed to prevent distracted driving before this study and only five (15.2%) participants had experience using such an application while driving. Of those five participants, four (80%) were still using the application at the time of the survey completion. Out of those participants, two were using the iOS 'Do Not Disturb While Driving' function, one participant was using 'Android Auto' and the remaining participant was using 'Waze'.

### 5.2.5 Constructs to measure acceptance of voluntary apps

The Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB) were also used in this study. The items were measured on a 7-point scale ranging from strongly disagree (1) to strongly agree (7). The subscales from these models and their descriptive statistics are presented in Table 5.2.

**Table 5.2****Descriptive statistics for TAM and TPB subscales**

	Survey 1 M	Survey 2 SD	Survey 2 M	Survey 2 SD
Perceived Usefulness	5.01	1.35	4.79	1.69
Perceived Ease of Use	5.19	1.11	5.26	1.20
Subjective Norm	4.62	1.70	4.36	1.96
Perceived Behavioural Control	5.75	1.21	5.87	0.93
Behavioural Intentions	4.99	1.19	4.45	1.83
Attitudes	5.09	1.00	4.84	1.40

Note: Scales adapted from Mahmudur Rahman, Lesch, Horrey, and Strawderman (2017), Venkatesh and Davis (2000), and Venkatesh, Morris, Davis, and Davis (2003).

Interestingly, there were no significant changes in the perceived usefulness, ease of use, subjective norm, perceived behavioural control or attitudes between the first and last survey. However, behavioural intentions did have a significant change over time ( $t(32) = 2.75, p < 0.05$ ), meaning participants' intentions to use the voluntary application decreased after they completed the study using the application.

### 5.2.6 Change in perceived driving difficulty

Participants were asked to complete the NASA Task Load Index (TLX) scale (NASA, 1986) in relation to their driving behaviour. The purpose of this was to determine if participants' perceptions of driving difficulty changed over time. It included six components of task demand, including mental demand, physical demand, temporal demand, performance, effort and frustration level. Participants were asked to respond to each item on a scale of 1 (low) to 100 (high). Descriptive statistics of the items in the scale are presented in Table 5.3.

**Table 5.3****Descriptive statistics for the NASA TLX scale**

	Survey 1 M	Survey 1 SD	Survey 2 M	Survey 2 SD
Mental Demand	66.85	22.04	52.40	25.57
Physical Demand	34.91	23.93	29.73	18.18
Temporal Demand	46.61	23.44	46.42	23.20
Performance	84.06	12.62	85.64	10.42
Effort	47.03	25.25	49.91	23.13
Frustration Levels	32.85	26.02	33.21	24.45

It was found that physical demand, temporal demand, performance, effort and frustration levels relating to the driving task exhibited no significant change after the completion of the study compared with baseline. However, participants' perceived mental demand from the driving task significantly decreased after the completion of the study ( $t(32) = 3.99, p < .001$ ). This suggests that participants found the mental demand associated with driving to be lower after they started using the voluntary application.

### 5.2.7 Susceptibility to involuntary mobile phone distraction

Participants' susceptibility to involuntary mobile phone distraction was measured using the Susceptibility to Driver Distraction Questionnaire (Feng, Marlunda & Donmez, 2014). The purpose of this was to determine if participants' involuntary phone behaviours changed over time, after the use of the voluntary application during the study. These items were measured on a 5-point scale ranging from strongly disagree to strongly agree. The items of this scale and their descriptive statistics are presented in Table 5.4.

**Table 5.4**

**Self-reported susceptibility to involuntary mobile phone distraction**

Behaviour	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<b>Questionnaire 1</b>					
<b>While Driving, you find it distracting when:</b>					
Your phone is ringing	3 (9.1%)	4 (12.1%)	2 (6.1%)	13 (39.4%)	11 (33.3%)
You receive an alert from your phone (e.g. incoming text message)	2 (6.1%)	4 (12.1%)	4 (12.1%)	16 (48.5%)	7 (21.2%)
You are listening to music	18 (54.5%)	11 (33.3%)	2 (6.1%)	2 (6.1%)	0
You are listening to talk radio	13 (39.4%)	10 (30.3%)	4 (12.1%)	5 (15.2%)	1 (3%)
There are roadside advertisements	8 (24.2%)	11 (33.3%)	9 (27.3%)	5 (15.2%)	0
There are roadside accident scenes	3 (9.1%)	3 (9.1%)	6 (18.2%)	15 (45.5%)	6 (18.2%)
A passenger speaks to you	12 (36.4%)	12 (36.4%)	5 (15.2%)	3 (9.1%)	1 (3%)
You are daydreaming	3 (9.1%)	7 (21.2%)	10 (30.3%)	12 (36.4%)	1 (3%)
<b>Questionnaire 2</b>					
<b>While Driving, you find it distracting when:</b>					
Your phone is ringing	2 (6.1%)	2 (6.1%)	6 (18.2%)	15 (45.5%)	8 (24.2%)
You receive an alert from your phone (e.g. incoming text message)	2 (6.1%)	1 (3%)	8 (24.2%)	13 (39.4%)	9 (27.3%)
You are listening to music	19 (57.6%)	11 (33.3%)	2 (6.1%)	0	1 (3%)
You are listening to talk radio	15 (45.5%)	11 (33.3%)	2 (6.1%)	4 (12.1%)	1 (3%)
There are roadside advertisements	5 (15.2%)	17 (51.5%)	7 (21.2%)	4 (12.1%)	0
There are roadside accident scenes	2 (6.1%)	8 (24.2%)	4 (12.1%)	14 (42.4%)	5 (15.2%)
A passenger speaks to you	7 (21.2%)	20 (60.6%)	4 (12.1%)	2 (6.1%)	0
You are daydreaming	5 (15.2%)	8 (24.2%)	8 (24.2%)	10 (30.3%)	2 (6.1%)

No differences were found in items related to susceptibility to involuntary mobile phone distraction. The mean of the combined items for susceptibility to involuntary mobile phone distraction was 3.47 (SD = 0.75) for questionnaire 1 and 3.36 (SD = 0.71) for questionnaire 2. There was no significant change in participant’s perceived involuntary phone distraction after the completion of the study.

### 5.3 Overview of findings: Diary entries

Diary entries were utilised to obtain an understanding of participants’ perceptions of the voluntary application and their usability. A deductive thematic analysis approach was used to analyse the diary entries. Themes were developed based on ideas that were mentioned in more than 20% of responses. Overall, there were 7 themes which consisted of:

- 1) positive experiences activating/deactivating the application,
- 2) negative experiences activating/deactivating the application,
- 3) positive experiences with the application; it worked as required,
- 4) negative experiences associated with using the application,
- 5) Android Auto vs Do Not Disturb While Driving,
- 6) usability problems and opportunities for improvement,
- 7) the application can be associated with risky phone use behaviours while driving.

Themes are presented below with supporting quotes. Participants’ gender and age are presented after each quote. ‘F’ identifies a female participant and ‘M’ identifies a male participant.

On average, participants drove 4.34 hours (SD = 6.86) between the completion of the first questionnaire and the first diary entry, 4.56 hours (SD = 5.54) between the first diary entry and second diary entry and 4.59 hours (SD = 4.76) between the second and third diary entry.

### 5.3.1 Positive experiences activating/deactivating the application

The majority of responses from all three diary entries (n = 60) indicated a positive experience with activating or deactivating the application. Most positive responses (n = 33) were associated with ease of use and experiences with the application working as it is supposed to without any issues. Interestingly, many positive responses were also associated with the ability to automatically activate the application (n = 25). This had clear connections to ease of use, as these participants did not have to always remember to activate the application before driving. Comments related to these positive experiences are expressed below:

*“Easy to activate, no issues.” (F, 18)*

*“The automatic activation is good. I would completely forget to do it otherwise.” (M, 32)*

*“I have found the app activates very quickly when I start driving and I appreciate it does it automatically.” (M, 32)*

### 5.3.2 Negative experiences activating/deactivating the application

Conversely, while the majority of responses indicated a positive experience activating the application, a large proportion of responses instead indicated negative experiences. Many participants who stated they had a negative experience activating the application associated this with not being able to automatically start the application (n = 15). The most common reason for this was due to their car not supporting the system. This is demonstrated in the comments below:

*“I have to activate the app manually since I don’t have a car that supports the apps automated activation feature as soon as it connects to your cars audio system. Therefore sometimes I just forget or don’t bother to turn it on because I already started driving.” (M, 32)*

*“Hassle to active and deactivate, forgot many times to activate.” (F, 18)*

Other negative responses associated with activation were also connected to the application not working as it should (n = 10). For example, some participants noted the application activated when they were a passenger and have clicked ‘I am not driving’. This is demonstrated below:

*“As a passenger I clicked on not driving. And I had 2 text messages that sent the ‘I am driving’ auto text.” (F, 56)*

Additionally, some participants noted they liked to use their phone functions (e.g., texting or talking) in stopped heavy traffic, so they would have to continually deactivate then activate the application in these conditions. This is concerning because it means that drivers are not using the apps during the whole drive. An example of this is demonstrated below:

*“I’ve been activating and de-activating the app depending on how heavy the traffic is when I’ve been driving.” (F, 27)*

### 5.3.3 Positive experience with application; it worked as required

A large proportion of responses indicated a positive experience using the application without any problems. A number of these positive experiences were associated with being less tempted to use their phone while driving, especially to check notifications (n = 26). This is demonstrated in the following comments:

*“No notifications, didn’t tempt me to look at my phone to see if any notifications when I’m traffic, stopped at lights; because knew there wouldn’t be any.” (F, 22)*

*“It was great. I wasn’t distracted with texts coming through” (F, 35)*

Other positive experiences were associated with enjoying features which make using the phone while driving easier (n = 19). For example, using voice control to make a call, large text on the application. A number of participants also stated the use of the application was intuitive (n = 14). This is demonstrated in the comments below:

*“It also give me a more user-friendly experience, since the font and feature looks larger and simple make me easy to see during the driving.” (M, 35)*

*“It’s simple to use and intuitive so it has been pleasant to have.” (M, 21)*

Meanwhile some participants did not associate any positive connotations with experience of the application, but they did note that the application worked as expected (n = 24). This is demonstrated in the following comment:

*“I received a text while driving but didn’t receive it until I was at my destination, so it is working as described.” (F, 28)*

### 5.3.4 Negative experiences associated with using the application

Conversely, while a number of responses indicated a positive experience with the application, several responses instead indicated they experienced problems using the application (n = 22). Some of these problems included specific phone functions which are desirable to use while driving cannot be accessed via the applications, e.g. limited access to Google Maps, limited ability to change songs and difficulty with connecting application to vehicle. This is demonstrated in the following comments:

*“Some more advanced settings, for example ability to unlock the phone without stopping the app to run Google Maps and Spotify.” (F, 33)*

*“The app is still annoying me with the connection to my car, and then also trying to switch songs.” (F, 27)*

### 5.3.5 Android auto versus do not disturb while driving

While there were many similarities between the two applications used in this study; ‘Android Auto’ for Android phones and ‘Do Not Disturb While Driving’ for iOS phones, a number of differences were also noted. Interestingly, despite the widespread nature of the ‘Do Not Disturb While Driving’ function, more problems appeared to be noted for this function compared to the ‘Android Auto’ function. Specifically, a large negative experience with this application which was frequently noted included the reduction in usability of ‘Siri’ functions (n = 13). Examples are demonstrated in the comments below:

*“It can add an extra hurdle because some of Siri’s Functionality is turned off.” (M, 32)*

*“I attempted to use Siri to send a text but the function didn’t work.”(M, 30)*

As Android phones do not have the ‘Siri’ function, this was not an issue for ‘Android Auto’ users. Instead, Android phone users have the ‘Google Assistant’ function which acts similarly to the ‘Siri’ function on iOS phones. This was commonly noted by participants with Android phones to work well and influenced their positive perceptions towards the application. This is demonstrated in the comment below:

*“The app give me more convenience way as a simple version of my phone during the driving. Recently I am trying to access the google assistant from the app to help me to locate the place I need to go, it is very helpful and easy to do. Approaching the new season, the app gave me an accurate information about the weather prediction and temperature information in a very simple format.” (M, 35)*

### 5.3.6 Usability problems and opportunities for improvement

A suggestion for improvement of the application included improved access to navigation applications while driving (n = 4). While a number of participants did note that they were able to access navigation functions via the application while driving, and this was associated with a positive perception of the application, many other participants noted this was not the case. Specifically, several participants commented that they had to exit the application while driving to access their preferred navigation application. This meant once they exited the application, its functions no longer worked. Comments of these perceptions are demonstrated below:

*“Being able to start a new navigation without having to stop the app.” (M, 32)*

*“Maybe a button allowing me to access a navigation tool.” (M, 32)*

An additional suggestion for improvement included the ability to integrate the application functions into the car system (n = 3). Specifically, access to phone functions via the steering wheel was suggested as a method to further improve the usability of phone functions while driving. This is demonstrated in the comments below:

*“I think this app can be modified to compatible with car system. So when I want to use the Google map through car steering wheel.” (M, 28)*

*“Maybe provide some operation through the buttons on steering wheel.” (M, 28)*

Another opportunity for improvement which was commonly stated among participants included improved integration of the ‘automatic activation’ function of the application (n = 9). This was especially noted among participants who had car systems which were not compatible with the phone, which made automatic activation very difficult, or impossible for some people. This suggestion is demonstrated in the comments below:

*“I would like my version of the app to activate without me having to think about it.” (F, 47)*

*“Didn’t seem to sync to my car system, so had to manually turn it on and off.” (F, 22)*

### 5.3.7 The application can be associated with risky phone use behaviours while driving

While the applications do support safer phone use behaviour while driving, as demonstrated in the above themes, some responses indicated that the application can make driving riskier (n = 12). For example, if messages have been set as an exception, receiving messages while driving can be more distracting if the driver is using the application. This is demonstrated in the comment below:

*"I just used my phone with the app activated once when I had to use GPS navigation to a restaurant. It's good experience in general, however I found the msg notification popping out on the screen, which was much larger than the original notification, and it distracted my attention." (F, 28)*

In addition, some participants have also stated that they require the use of applications which they cannot access via the voluntary driving application (n = 3). This means they would exit the application to use their other, desired application which would require looking at the phone longer. An example of this is demonstrated below:

*"Not convenient to use Google map. If this app was activated and I want to use Google map to go to a place I have saved, I have to exit this app." (M, 28)*

## 5.4 Summary

The overall findings of this study are outlined below:

- Self-reported mobile phone use behaviours while driving, including visual-manual phone interactions, handheld conversations, hands-free conversations and even the use of phone functions which support driving (e.g. GPS applications) significantly decreased during the course of the study, while participants were using the voluntary app.
- There were no significant changes in perceived usefulness, ease of use, behavioural control or subjective norm of the voluntary applications to prevent mobile phone distracted driving after the completion of the study. Behavioural intentions related to the use of the application significantly decreased over time, meaning participants' intentions to use the application decreased after experience with the application.
- The only change in perceived driving difficulty was a decrease in mental demand. This suggests participants perceive the mental demand of their driving task to be easier while using the application.
- There were no significant changes in participants' perceived susceptibility to involuntary phone distraction while driving. This suggests the use of the application did not impact involuntary phone distraction behaviours while driving. More research into involuntary distraction is needed.
- Positive experiences related to using the voluntary phone application while driving were related to the application working as outlined and starting automatically when the car started moving. In addition, the ability to access music and GPS functions of the phone and take calls via Bluetooth further contributed to positive experiences with the application. Most participants with positive experiences felt safer while driving when using the application, especially if they were in the habit of using their phone.
- Negative experiences with using the voluntary application while driving were related to the application not working as it was supposed to, especially if it could not start automatically. Additional problems with the application included the automatic start when the participant was a passenger and the 'I am not driving' function did not disable this, as well as difficulties with automatic activation if a passenger of the car also owns the application. Some participants also acknowledged problems with accessing some GPS functions and changing songs while the application was activated.
- Some risky phone behaviours were associated with the application. This was mostly noted if the participant wanted to use an application on their phone which the voluntary app does not support, or they set exceptions, especially if they set message exceptions.
- The 'Android Auto' application and the 'Do Not Disturb While Driving' function were very similar but a notable difference included problems experienced with the 'Siri' function with 'Do Not Disturb While Driving' which was not experienced with 'Google Assistant' with the 'Android Auto' application.
- Suggested improvements to the application included improved access to navigation applications as well as integrating some functions of the application into the vehicle system, for example buttons on the steering wheel controlling certain phone functions. Additionally, usability of the voluntary application could be improved with integration of automatic activation in more vehicle models.





# 6 Conclusion

## 6.1 General discussion

This research addressed a large gap in the literature by investigating the use of voluntary apps to prevent mobile phone distracted driving. Firstly, the five most popular apps were identified and explored. Most of these applications focus on blocking phone functions, e.g. calls, texts, and other visual-manual interactions, with limited focus on workload management. The iOS 'Do Not Disturb While Driving' app was the most popular as it comes pre-installed in Apple iPhones, therefore, this app was focused on in the subsequent studies. In the driver acceptance qualitative analysis study, participants had an overall positive perception of the app and identified several benefits associated with its use including limiting phone use, limiting distractions and increasing road safety. While many participants also had positive perceptions towards the app sharing control of the phone as well as usability of the app, including reliability and ease of use, other participants had concerns and negative perceptions towards these factors. These negative perceptions are supported by previous research which identifies concerns surrounding the reliability of such apps (Sousa, 2015; Tchankue et al., 2012). Additional concerns included the ability to be contacted during emergencies, accessibility of other apps, and excessive battery drainage while the voluntary driving app was active. These results suggest that overall, this technology has the potential to be utilised by a large proportion of drivers, yet a number of concerns need to be met before this can be widely adopted.

The risk analysis with experts study resulted in similar conclusions to the above. The experts noted that the voluntary app has a strong potential to reduce distracted driving and improve road safety. However, a number of considerations need to be made to ensure the technology is effective and drivers would accept and use the voluntary app. Firstly, reliability of the app is a concern and the experts in this study addressed the issue that drivers are unlikely to continue using the voluntary app if it is unreliable more than 10% of the time. Noted improvements to this technology which may increase driver acceptance included the integration of workload management of the phone functions as opposed to simply blocking specific phone functions, as well as the use of incentives to encourage safe driving. This study provided an important addition to research on the development of apps to reduce mobile phone distracted driving, as the scant literature which has begun to explore this (e.g. McGinn, 2014; Sousa, 2015; Tchankue et al., 2012) has only examined drivers' perceptions. Meanwhile, this study took this a step further by examining experts' opinions on this topic. These results suggest that the voluntary apps to reduce phone use while driving show great potential in improving road safety, yet there is still a long way to go in 1) the development of the applications and 2) increasing drivers' acceptance of these applications and subsequently increasing the use of these applications among drivers.

The case scenario analysis backed up the aforementioned qualitative results via a quantitative analysis and provided further information in relation to user practices and preferences regarding interaction with voluntary apps. Use of the phone for hands-free conversations, using GPS and music applications were the most common reported phone uses while driving. Encouragingly, drivers that continued using a voluntary app aimed at reducing mobile phone distracted driving reported less phone use while driving, including both visual-manual phone interactions and the use of music and GPS applications, compared to those who stopped using the app. However only a third of participants who started using a voluntary app reported still using it at the time of the survey. This study also identified that young drivers were more likely to engage in phone use while driving behaviours, especially via visual-manual phone interactions and the use of music and GPS apps. These results support previous findings which identify young drivers to be the most frequent users of mobile phones while driving (Ismeik, Al-Kaisy, & Al-Ansari, 2015; Walsh, White, Hyde & Watson, 2008). However, of concern, young drivers were also less likely to utilise the voluntary app aimed at preventing phone use while driving compared to more experienced drivers. These results further highlight the problem associated with the voluntary nature of the application and the need to increase drivers' acceptance and their subsequent long-term use of the application. Additionally, future research needs to also focus specifically on increasing use of these applications among the young driver population.

The safety benefits of voluntary apps aimed at reducing mobile phone distracted driving are further supported by the final, in-vehicle study. It was found that, during the course of the study while participants were using the application, reported phone use while driving, including visual manual interactions, handheld and hands-free calls and even the use of applications which are supported by the app including music and GPS functions, significantly decreased. These results support previous literature which identified drivers' reported texting while driving

behaviour significantly decreased after using the 'DriveSafe.ly' app (McGinn, 2014), which is a similar voluntary application designed to reduce mobile phone distracted driving (see Table 1.1. and 1.2 for further information on this app). However, the participants' reported behavioural intentions in relation to use of the app decreased over time, suggesting drivers are less likely to use the app after experiencing it. A number of areas for further development were identified in this study, most of which surrounded improving the apps to ensure they work as they are supposed to, as most negative perceptions towards the apps were based on this problem.

Overall, the results from these studies support the idea that use of a voluntary application such as 'Do Not Disturb While Driving' can effectively reduce exposure to mobile phone distracted driving activities if used properly and continuously. Mobile phone use while driving is a pervasive issue, with 223 people hospitalised in Victoria during the 2014/2015 financial year alone as a result of distraction related crashes, and this figure is likely to be much larger due to under reporting (King et al., 2017). The prevalence of phone use while driving behaviours is supported by the in-vehicle study, in which the phone functions of GPS and music were the most prevalent, followed by hands-free conversations, visual-manual interactions and finally handheld conversations. Additionally, it is expected that mobile phone use while driving behaviour is expected to increase in the ensuing years (World Health Organisation, 2018). Therefore, if voluntary applications designed to reduce mobile phone distracted driving were to be utilised by the driving population, phone use while driving behaviour and the subsequent crash rates may be avoided.

The role of the voluntary app designers as well as mobile phone companies should be considered further from a policy and practice perspective. Currently, interventions that focus on preventing phone use while driving focus on the driver yet ignore mobile phone manufacturers and software developers (Young & Salmon, 2015). The apps reported in this literature review demonstrate some progress in this area. Nonetheless, it is imperative that research is conducted that identifies the safety benefits of these voluntary apps as well as the specific features of such apps that could influence drivers to utilise them.

## 6.2 Conclusion

This section discusses how the findings addressed the objectives of the project.

### 6.2.1 Level of acceptance of voluntary apps aimed at preventing mobile phone distracted driving

Through a number of analyses, several potential facilitators and barriers to the successful implementation and acceptance of voluntary apps to reduce mobile phone use while driving were identified. Of the participants in this study, 66.3% said they would be willing to install and activate an app based on the following description:

Text messages, browsing, and mail (including notifications) are blocked. Calls (dialled or incoming) are enabled using a Bluetooth or hands-free device only

Furthermore, the type of mobile phone use that participants reported also influenced the acceptance and effectiveness of voluntary apps to reduce mobile phone use while driving. Participants who reported more visual-manual interactions with their phone while driving showed greater intention to use the voluntary app. This may indicate that those who engage in such behaviour are aware of a need to change their behaviour and are willing to use voluntary apps to reduce their mobile phone misuse. The use of such apps also produced significantly less mobile phone use while driving. Participants who continued using the app reported fewer visual-manual interactions and less use of their phone for other mobile phone use than those who had ceased using the app. These promising findings show the facilitators to the acceptance and impact of voluntary apps on reducing mobile phone use while driving.

A number of barriers were identified that could limit the acceptance of voluntary apps. Participants consistently raised concerns around the functionality and reliability of such apps, and experts stated that people will stop using such apps if they are unreliable even 10% of the time. These issues with reliability and participants wanting the app to work effortlessly place significant demands of the designers of such apps, and technology will need to improve to meet the users' requests. Another barrier includes the increased levels of reported mobile phone misuse, meaning that people continue to use their mobile phones despite bans on use or knowledge of potential hazards.

Maladaptive attachment to mobile phones has also been identified within a subset of mobile phone users. Such attachments may influence the driver's willingness to use voluntary apps. Future research needs to consider the complexity of mobile phone use while driving and assess drivers' perceptions of such apps. The voluntary nature of these apps means their success is dependent on drivers' acceptance of their functions. The current 'blocking' functions that are used in voluntary apps currently available on the market simply block functionality and are unlikely to be widely accepted. Therefore, drivers should be included in the identification of key features and design

process of future voluntary apps.

Finally, there are currently limited incentives for drivers to use voluntary apps to reduce mobile phone use while driving. Transport bodies can build on this opportunity to create incentives (e.g. with insurance companies) to increase acceptance of voluntary apps. In summary, stakeholders can use the barriers identified in this study to target future developments and increase the acceptance of voluntary apps to reduce mobile phone use while driving.

### **6.2.2 Drivers' intentions to use (and misuse) voluntary apps aimed at preventing mobile phone distracted driving**

The Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB) were supported as strong theoretical models through which to measure drivers' acceptance of voluntary apps. Participants had positive results on both scales demonstrating that participants found the app to be useful, easy to use, held positive attitudes and subjective norms towards the app, and had high levels of perceived behavioural control. Subscales of the TAM and TPB were significantly correlated with participants' intention to use the voluntary app.

Other factors predicting intention to use voluntary apps included age and the visual-manual interaction dimension of mobile phone use while driving. Older drivers were more likely to have greater intention to use voluntary apps to reduce distracted driving. Interestingly, participants who reported more visual-manual interactions with their phone while driving showed higher levels of behavioural intention. This may indicate that those who engage in such behaviour are aware of a need to change their behaviour and are willing to use voluntary apps to reduce their mobile phone misuse.

Mobile phone misuse was positively correlated with gender, with females reporting higher levels of mobile phone misuse than males. Finally, mobile phone misuse was negatively correlated with age and experience level, further demonstrating higher problematic mobile phone use in younger, less experienced drivers.

### **6.2.3 Design and situational parameters that contribute to the effectiveness or ineffectiveness of voluntary apps aimed at preventing mobile phone distracted driving**

Design considerations identified through participant interviews included driver control, performance recording, contact in emergencies, access to other driving related apps, parental control and functionality. Participants accepted that loss of a degree of control was necessary to reduce distracted driving, and while some participants saw performance recording as an opportunity to increase accountability, many were concerned with privacy and security. All participants interviewed were in support of including a parental control feature in voluntary apps specifically to reduce mobile phone use in younger drivers. However, concerns were raised that younger drivers may feel less supportive of such functions, so incentives should be developed which encourage and increase acceptance of voluntary apps for younger drivers.

Finally, the use of voice commands instead of the visual-manual interface is an emergent approach in the apps to prevent drivers from taking their eyes off the road. Many of the experts interviewed mentioned their concerns with the reliability with this technology. However, less than 20% of participants wanted to use an app that required them to attach a small piece of additional equipment to their vehicle. This, in addition to the lack of reliability of voice-command technology, is discouraging drivers from using the app. A plea for better auditory-voice interfaces was made by the experts and car manufacturers should be engaged in the design of in-vehicle interfaces to support safe mobile phone use while driving.

### **6.2.4 Propose good practices for driver use of voluntary apps to address the distracted driving problem**

The results of this research were used to build a set of recommendations for stakeholders, and drivers who want to use voluntary apps to decrease their mobile phone use while driving. These guidelines and recommendations are presented in Section 6.3.

### **6.2.5 Investigate potential risks of the use of these apps including transference of risky behaviour to other potential distractions**

It was identified that some risky behaviours are associated with the voluntary application use while driving. In the diary entries study component, several participants noted the application provided more of a distraction while

driving than originally provided by their phone without the application. This was primarily noted if participants set exceptions to the application, especially exceptions to messages, or if they required the use of additional applications which were not supported by the voluntary application they would need to do longer interactions. This is demonstrated in the comments below:

*“I just used my phone with the app activated once when I had to use GPS navigation to a restaurant. It’s good experience in general, however I found the message notification popping out on the screen, which was much larger than the original notification, and it distracted my attention.” (F, 28)*

*“Not convenient to use Google map. If this app was activated and I want to use Google map to go to a place I have saved, I have to exit this app.” (M, 28)*

### **6.2.6 Identify high-risk groups who are unlikely to benefit from the use of voluntary apps**

A number of high-risk groups were identified including younger adults and women. Young drivers (aged 17-25) were significantly more likely than experienced drivers to engage in visual-manual interactions with their phone and use other mobile phone functions, e.g. music and GPS. Women were also identified as an at-risk group, as they were significantly more likely to engage in visual-manual interactions with their phone and use their phone more frequently for other mobile phone use. Future research should target strategies to increase acceptance of voluntary apps within these high-risk groups to reduce their mobile phone use while driving.

## **6.3 Guidelines and recommendations for use of voluntary applications aimed at preventing mobile phone distracted driving**

### **6.3.1 Guidelines and recommendations for users**

- Take some time to learn about the app and the importance of using it.
- Remember to activate the app before starting to drive as well as the GPS and Music.
- The recommended setting is to allow the app to automatically detect driving.
- Always keep your eyes focused on the road as the app will not help if you continue looking at your phone. Even looking at your phone to change a song will take your eyes off the road and can be dangerous.
- Only allow phone calls from family members who might need you in an emergency. Inform them to only contact you through phone calls in the case of an emergency instead of text.
- Remember that the phone can ring at any moment, regardless of what driving demands you are experiencing, so don’t try to reach for it immediately, wait until you can safely stop the vehicle and always use hands-free methods of communication (e.g. Bluetooth).
- Do not make exceptions to allow you to receive messages. If someone needs to contact you urgently, they can contact you through a phone call.
- Young drivers (25 years or less) should always turn their phones off before they drive.
- The main incentive for using the app is to ensure the safety of yourself and others.
- Remember that the apps do not always activate automatically. Please make sure that the app is working before starting to drive.
- If a different application on your phone is not supported by the voluntary application, it is best not to use it while driving; your focus should be on the road, not the phone.

### **6.3.2 Guidelines and recommendations for stakeholders**

- Insurance companies can explore the opportunity to implement apps with their own insurance schemes, which will provide further incentives to encourage drivers to use the voluntary apps.
- There is a need to develop apps that are better integrated with driving in order to avoid the blocking approach which is very unlikely to be widely accepted by drivers.
- Advocacy groups could advocate for the engagement of car manufacturers in the design of in-vehicle interfaces to support safe mobile phone use while driving.

- There is a need to improve the reliability of the current applications on the market. Users frequently complain that the apps are not reliable, and this severely impacts their acceptance and continued use of voluntary apps.
- Voluntary apps developers can use the suggested improvements given by the participants, e.g., improved access to navigation applications as well as integrating some functions of the application into the vehicle system, for example buttons on the steering wheel controlling certain phone functions. Additionally, usability of the voluntary application could be improved with integration of automatic activation in more vehicle models.

# 7 References

- Asbridge, M., Brubacher, J. R., & Chan, H. (2012). Cell phone use and traffic crash risk: a culpability analysis. *International journal of epidemiology*, 42(1), 259-267.
- Bianchi, A., & Phillips, J. G. (2005). Psychological predictors of problem mobile phone use. *CyberPsychology & Behavior*, 8(1), 39-51.
- Clark, B., Parkhurst, G. and Ricci, M. (2016) Understanding the socioeconomic adoption scenarios for autonomous vehicles: A literature review. Project Report. University of the West of England, Bristol, UK. Available from: <http://eprints.uwe.ac.uk/29134>
- Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, 319-340.
- 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.
- François, M., Osiurak, F., Fort, A., Crave, P., & Navarro, J. (2017). Automotive HMI design and participatory user involvement: review and perspectives. *Ergonomics*, 60(4), 541-552.
- Hart, S. G. (2006, October). NASA-task load index (NASA-TLX); 20 years later. In *Proceedings of the human factors and ergonomics society annual meeting* (Vol. 50, No. 9, pp. 904-908). Sage CA: Los Angeles, CA: Sage Publications.
- Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative health research*, 15(9), 1277-1288.
- Hong, F. Y., Chiu, S. I., & Huang, D. H. (2012). A model of the relationship between psychological characteristics, mobile phone addiction and use of mobile phones by Taiwanese university female students. *Computers in Human Behavior*, 28(6), 2152-2159.
- Horberry, T., Stevens, A., & Regan, M. A. (Eds.). (2014). Driver acceptance of new technology: *Theory, measurement and optimisation*. Ashgate Publishing, Ltd.
- Ismeik, M., Al-Kaisy, A., & Al-Ansari, K. (2015). Perceived risk of phoning while driving: A case study from Jordan. *Safety Science*, 78, 1-10. doi:10.1016/j.ssci.2015.02.011
- King, M., Legge, M., Oviedo-Trespalacios, O., Rakotonirainy, A., & Reagan, M. (2017): "Mobile phone use while driving scoping study". Commonwealth of Australia, Department of Infrastructure and regional Development, Reference ID: 10015067.
- Kyriakidis, M., Happee, R., & de Winter, J. C. (2015). Public opinion on automated driving: Results of an international questionnaire among 5000 respondents. *Transportation research part F: traffic psychology and behaviour*, 32, 127-140.
- McGinn, M. C. (2014). Predicting Factors for Use of Texting and Driving Applications and the Effect on Changing Behaviors (Doctoral dissertation, Southern Illinois University at Edwardsville).
- Overton, T. L., Rives, T. E., Hecht, C., Shafi, S., & Gandhi, R. R. (2015). Distracted driving: prevalence, problems, and prevention. *International journal of injury control and safety promotion*, 22(3), 187-192.
- Oviedo-Trespalacios, O., Haque, M. M., King, M. J., & Washington, S. (2015, November). Influence of road traffic environment and mobile phone distraction on the speed selection behaviour of young drivers. In *International Conference on Driver Distraction and Inattention, 4th, 2015, Sydney, New South Wales, Australia* (No. 15325).
- Oviedo-Trespalacios, O., Haque, M. M., King, M., & Washington, S. (2016). Understanding the impacts of mobile phone distraction on driving performance: A systematic review. *Transportation research part C: emerging technologies*, 72, 360-380.
- Oviedo-Trespalacios, O., Haque, M. M., King, M., & Washington, S. (2017a). Effects of road infrastructure and traffic complexity in speed adaptation behaviour of distracted drivers. *Accident Analysis & Prevention*, 101, 67-77.

- Oviedo-Trespalacios, O., Haque, M. M., King, M., & Washington, S. (2017b). Self-regulation of driving speed among distracted drivers: An application of driver behavioral adaptation theory. *Traffic injury prevention*, 18(6), 599-605.
- Oviedo-Trespalacios, O., King, M., Haque, M. M., & Washington, S. (2017c). Risk factors of mobile phone use while driving in Queensland: Prevalence, attitudes, crash risk perception, and task-management strategies. *PLoS one*, 12(9), e0183361.
- Oviedo-Trespalacios, O., Haque, M. M., King, M., & Demmel, S. (2018a). Driving behaviour while self-regulating mobile phone interactions: A human-machine system approach. *Accident Analysis & Prevention*. In Press
- Oviedo-Trespalacios, O., Haque, M. M., King, M., & Washington, S. (2018b). Should I Text or Call Here? A Situation-Based Analysis of Drivers' Perceived Likelihood of Engaging in Mobile Phone Multitasking. *Risk Analysis*. In Press
- Oviedo-Trespalacios, O. (2018). Getting away with texting: Behavioural adaptation of drivers engaging in visual-manual tasks while driving. *Transportation Research Part A: Policy and Practice*, 116, 112-121.
- Petroulias T. Community Attitudes to Road Safety—2013 Survey Report. Department of Infrastructure and Regional Development; 2014. [http://www.infrastructure.gov.au/roads/safety/publications/2013/pdf/ community\\_att\\_13.pdf](http://www.infrastructure.gov.au/roads/safety/publications/2013/pdf/community_att_13.pdf).
- Rahman, M. M., Lesch, M. F., Horrey, W. J., & Strawderman, L. (2017). Assessing the utility of TAM, TPB, and UTAUT for advanced driver assistance systems. *Accident Analysis & Prevention*, 108, 361-373.
- Siuhi, S., & Mwakalonge, J. (2016). Opportunities and challenges of smart mobile applications in transportation. *Journal of Traffic and Transportation Engineering (English Edition)*, 3(6), 582-592.
- Simmons, S. M., Hicks, A., & Caird, J. K. (2016). Safety-critical event risk associated with cell phone tasks as measured in naturalistic driving studies: A systematic review and meta-analysis. *Accident Analysis & Prevention*, 87, 161-169.
- Smith, B. W. (2016). Automated Driving Policy. In *Road Vehicle Automation 3* (pp. 53-58). Springer, Cham.
- Sousa, J. P. C. D. (2015, September). Study and Implementation of advanced mechanisms for improving safety driving in teh use of messaging applications. In *Study and Implementation of advanced mechanisms for improving safety driving in teh use of messaging applications*.
- Tchankue, P., Wesson, J., & Vogts, D. (2011, November). The impact of an adaptive user interface on reducing driver distraction. In *Proceedings of the 3rd International Conference on Automotive User Interfaces and Interactive Vehicular Applications* (pp. 87-94). ACM.
- Vaezipour, A., Rakotonirainy, A., Haworth, N., & Delhomme, P. (2017). Enhancing eco-safe driving behaviour through the use of in-vehicle human-machine interface: A qualitative study. *Transportation Research Part A: Policy and Practice*, 100, 247-263.
- Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management science*, 46(2), 186-204.
- Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS quarterly*, 425-478.
- 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 and Prevention*, 40(6), 1893-1900.
- Weller, J. A., Shackelford, C., Dieckmann, N., & Slovic, P. (2013). Possession attachment predicts cell phone use while driving. *Health psychology*, 32(4), 379.
- World Health Organization. (2012). World Health Statistics 2012. *World Health Statistics 2012*.
- Zheng, P. & Ni, L. (2010). *Smart Phone and Next Generation Mobile Computing*. Burlington: Elsevier Science.



# Appendix I

Scale items used to measure factors associated with intentions for using voluntary apps aimed at preventing mobile phone distracted driving. The response scale ranged from 1 (strongly disagree) to 7 (strongly agree).

## Perceived Usefulness

Using the system would improve my driving performance
Using the system while driving increases my safety
Using the system enhances the effectiveness of my driving
I would find the system useful in my driving

## Perceived Ease of Use

How I would interact with the system would be clear and understandable
Interacting with the system would not require a lot of mental effort
I would find it easy to get the system to do what I want it to do

## Theory of Planned Behaviour

### Subjective Norm

People who influence my behaviour would think that I should use the system
People who are important to me would not think that I should use the system

### Perceived Behavioural Control

I have control over using the system
I have the resources necessary to use the system
I do have the knowledge necessary to use the system
Given the resources, opportunities and knowledge it takes to use the system, it would be easy for me to use the system

### Behavioural Intention

If the system is available in the market at an affordable price, I intend to purchase the system
If my phone is equipped with a similar system, I expect that I would use the system when driving
Assuming that the system is available, I intend to use the system regularly when I am driving
If the system is available for free, I intend to install the system in my phone
I would rather have this technology than trying to manage my mobile phone use while driving
I intend to use a system like this in the future