FINAL REPORT

What is known about distracted driving?

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Summary

The Australian Automobile Association (AAA) commissioned the Griffith Criminology Institute to undertake a review of the distracted driving literature and a related policy scan. This report contains three main parts: a narrative review of distracted driving, a scoping review of the research in this field from 2015-2020 and a policy scan including a review of legislation within Australia and a selection of comparable jurisdictions and interviews with stakeholders.

Distracted driving is a key factor in road crashes. 'Distraction' occurs when a driver engages in a secondary activity that removes attention from the primary task of driving safely. Distractions can be both inside (e.g., using a mobile phone or wearable technology, eating, drinking, talking with passengers) or outside a vehicle (e.g., looking at roadside advertising or navigating complex road contexts). Individual influences on driver distraction include the ability to self-regulate as well as sociodemographic factors like age and gender and psychosocial influences including personality, mental health and cultural background. Likewise, normative factors, which are a type of social influence that encourages conformity, can both encourage or discourage distracted driving behaviours.

A significant amount of research has focused on technological distractions including human machine interactions and driver assistance systems. The recent research suggests that limiting technology based secondary tasks will reduce driver distraction. There is a suggestion that higher levels of vehicle automation can induce boredom and, consequently, cause drivers to divert their attention towards competing secondary tasks.

The most common secondary task examined in the research was mobile phone use. Mobile phone use while driving is common, with nearly half of the drivers in the USA reported sending texts while driving. Research suggests that the reaction time of drivers who speak on a mobile phone while driving increases by approximately 18%. Within a workplace context, supervisors, cultural norms and workforce attitudes influence individual's intentions to engage with work-related human machine interaction technologies and mobile phones.

The research on roadside signage and driver distraction is inconclusive. Some research suggests that billboards and road signage are distracting while other research suggests that they have a limited effect on driver attention.

Intrapersonal factors impact distracted driving in several ways. For instance, individuals with traumatic brain injuries have longer and more frequent glances towards secondary tasks while driving when compared with a control group. Personality factors may also be important predictors of distracted driving

although the specific traits associated with distracted driving may vary across groups. For example, extraversion was found to be associated with higher levels of driver distraction in younger drivers.

Several studies have considered the effects of age and gender on distracted driving with differing results. However, it appears that older drivers are more likely to self-regulate the type and timing of secondary tasks. For instance, older drivers tend to consistently reduce their speed when engaging with HMI navigation systems and only text when the vehicle is stationary.

A range of theories have been applied to understand and describe distracted driving. The Theory of Planned Behaviour (a psychological theory focused on understanding the ways behaviours can be predicted) appears to be able to predict the different intentions people have to drive while talking on a mobile phone or sending or receiving text messages.

Systems thinking (or sociotechnical systems) is a new and promising area of distracted driving research. Researchers using this approach explore and build explanatory models that map contextual factors like regulatory systems, workplace/cultural norms, and manufacturing standards that may contribute to distracted driving behaviours. Understanding systemic contributing factors will help develop more effective policy interventions. For instance, instead of attempting to regulate driver behaviour to stop the use of particular in-vehicle technology, it may be more effective to regulate the manufacturer of the equipment.

Several studies considered interventions to reduce distracted driving. While education programs may reduce the incidence of distracted driving, the impact of these programs may be uneven, or their efficacy may reduce over time. For instance, there is evidence to suggest that recent mobile phone laws and associated education campaigns have reduced the incidence of drivers' talking on their phone however drivers continue to text while driving, often obscuring their phone from view to avoid detection. Moreover, 'phone blocking while driving' settings, although effective, are often not used or are turned off after a period of time. Other interventions are showing more promise. For professional and fleet drivers, improving the organisational safety climate or culture, more effective time management strategies and the provision of safety training may make individuals less likely to use mobile phone or other HMI technologies while driving.

Research suggests that legislation to limit mobile phone use while driving does reduce their use for some groups of drivers. However, interviews with stakeholders suggest that enforcing laws prohibiting mobile phone use while driving is resource-intensive and therefore may not be an effective deterrent. Industry stakeholders, law enforcement professionals and road safety experts suggest preventing distracted driving requires a multi-faceted approach. This could include targeted enforcement strategies, public education campaigns, and work health and road safety policies. There is also an opportunity to address distracted driving with motor vehicle manufacturers and retailers or other entities such as insurance companies who form part of the wider sociotechnical road safety system. For example, insurance companies could offer lower premiums for customers who use in-vehicles mobile phone blocking technologies or driver monitoring systems.

There are several areas where research in distracted driving can focus in the future. This includes (1) other forms of distraction apart from mobile phones, (2) the effect of infotainment as well as the position of these systems and technologies within the vehicle, and (3) improving the design of roadside advertising to limit distraction. There is also a need to better understand the effect of driver distraction on particular sub-populations such as those with attention deficit hyperactivity disorder, brain injuries, those with particular personality factors and professional drivers. When considering the root cause of driver distraction, research exploring ‘mind wandering’ requires further investigation. Additionally, interventions could consider the best way to involve third parties and apply legal levers to reduce driver distraction. In conclusion, future research studies should consider more holistic and system-wide approaches that include the entire road safety sociotechnical system.

List of abbreviations

Acronyms and terms	Explanation
'5 categories' of distraction	Mobile phone distraction, cognitive distraction, passenger distraction, outside of vehicle distraction, in vehicle activities distractions
AAA	Australian Automobile Association
ACC	Adaptive cruise control or longitudinal control
Accimap	Systems based technique for analysing the causes of incidents within sociotechnical systems
ACT	Australian Capital Territory
Adaptive automation	Level of automation can be modified in real time by either the human or the system
ADHD	Attention Deficit Hyperactivity Disorder
ADS	Automated Driving Systems
ANDS	The Australian Naturalistic Driving Study
ALKA	Adaptive Lane Keeping Assist
ANN	Artificial neural network – the ANN model can predict if SCEs have occurred
AR	Augmented reality – in vehicle displays that integrate information displays with the driver's forward view. To draw attention to outside of vehicle environmental or infrastructure features
AttenD	AttendD algorithm measures the attentional management of the driver through real-time glance analysis
BSSS	Brief Sensation Seeking Scale
BYNDS	Behaviour of Novice Young Drivers Scale
CB radio	Citizens band radio
CITS	Cooperative Intelligent Transport Systems
CMF	Crash modification factors
CNC	Crash and near crash rates
Counter-balanced design	Counterbalancing refers to the systematic variation of the order of conditions in a study, which enhances the study's interval validity.
CPWD	Cell phone use while driving
CV	Connected vehicles
CWD	Calling while driving
CWIT	Colour-word interference test used to measure executive control capacity (goal maintenance, working memory)
DAS or ADAS	Driver assistance systems or Advance driver assistance systems

Acronyms and terms	Explanation
DBQ	Driver behaviour questionnaire
Decision Tree	A predictive model used to show a statistical probability. Each branch of the decision tree represents a possible decision, outcome, or reaction
Default mode network	A brain network associated with mind wandering.
DI	Distraction level Index
Dispatch software	Variety of HMI hardware and software used by fleets to plan, assign and track work tasks, deliveries, and consignments.
DLE	Duration of lateral excursion
DRT	Detection response task
DSCR	Dedicated Short Range Communications (DSRC) transmit information between vehicles and infrastructure.
DWI	Driving while impaired (e.g., alcohol, drugs, fatigue, distraction)
Ecological validity	A measure of how test performance predicts behaviours in real world settings. Simulators are relatively low in ecological validity compared to naturalistic driving studies. However, some simulator studies using naturalistic settings have higher ecological validity
EDA	Electrodermal Activity measures
EEG	Electroencephalography
EFA	Exploratory factor analysis
EGDS	Eye Glance Measurement using Driving Simulator Testing A test that measures eye glance time necessary for performing secondary visual-manual tasks.
Emergent properties	Emergent properties in *systems research* are performance outcomes arising within and between system components
ES	Experience sampling
ESRA 1	E-Survey of Road Users' Attitudes (2015-2016) conducted in 25 countries
Executive control	A cognitive mechanism that directs attention to goal-relevant thought and behaviour
FCW	Forward collision warning systems make use of auditory, visual, and haptic Human Machine Interfaces (HMIs)
FoMO	Fear of missing out
Forward roadway	Term used to describe driver looking towards the road ahead. Different studies measure how far the driver looks ahead or if the driver deviates from looking at the forward roadway
Gap acceptance measure	Assessment of gap size between vehicles. Gap acceptance is a fundamental safety-critical task that drivers perform daily

Acronyms and terms	Explanation
GPS	Global Positions Systems
Haptic shared control	A continuum between manual control and full automation
HDD	Head Down Display
Headway	Normally described in meters
High fidelity / low fidelity simulators	Lower fidelity can be used for training while higher fidelity (realistic) replicates real life context
HMD	Head-mounted display – e.g. Google Glass
HMI	Human Machine Interface OR Human Machine Interaction
HUD	Heads-up display
Injunctive norm	The perception of what is disapproved or approved by society (or a subset of society)
ISO	International organisation for standardisation • ISO 9241-210:2010 Ergonomics of human-system interaction • ISO 15007-1:2014 and 2020 Measurement and analysis of driver visual behaviour with respect to transport information and control systems
IVIS	In vehicle information systems
IVT	In vehicle technology
L licence	Learner licence
LDWS	Lane departure warning systems
Levels of vehicle automation	Level 0 (no automation), level 1 (driver assistance), level 2 (partial driving automation), level 3 (conditional driving automation), level 4 (high driving automation)
LoHA	Level of haptic authority defines the sharing of control authority between the system and the driver (e.g. fixed, shared,
MAD	Multiple-Additional-to-Driving tasks
MCT or MDT	Mobile Computer Terminals or Mobile Data Terminals used in emergency response services vehicles
MDC	Mobile Data Computer (used in police vehicles)
MW	Mind wandering: an internal (cognitive) form of distraction. Encompasses thoughts and feelings unrelated to ongoing primary tasks
MR	Monitoring Request: an auditory or visual HMI request to monitor the road with their eyes only or to place hands on steering wheel. MRs rely on vehicle cameras or other sensors as well as basic localization (e.g. GPS, HD maps). For example, MRs could be used when approaching intersection, zebra crossing, or construction works)
MPUWD	Mobile phone use while driving

Acronyms and terms	Explanation
MUARC	Monash University Accident Research Centre
MVC	Motor Vehicle Crashes
NDRTs	Non-driving related tasks
NDS	Naturalistic driving study (direct observations of driving)
NEST	Naturalistic Engagement in Secondary Tasks dataset – developed from Strategic Highway Research Program 2 (SHRP2)
NHTSA	National Highway Traffic Safety Administration
Nomadic devices	Portable technology. For example, smartphones, smart watches, tablets
NRC	The number of renewal cycles per event
NSW	New South Wales
NT	Northern Territory
NTC	National Transport Commission of Australia
OEM	Original equipment manufacturers
OOTL	Out of the loop phenomenon. A driver can be removed from two primary control loops, (1) operational vehicle control and (2) cognitive control or situational awareness (SA)
OSPAN	Operation span task. Used to assess working memory capacity. Participants attempt to remember sequentially presented words while solving maths problems
OVM	Original vehicle manufacturer
P licence	Provisional licence
Parallel processing	Alternative tasks require multitasking
PARs	Police accident reports
PARRC systems model	Priority, Adapt, Resource, Regulate, Conflict (PARRC) systems model developed by Parnell, Stanton, and Plant (2016)
Perceptual load	The amount of external information an individual has to process during a task. Perceptual load plays an important role in driving.
Performance measures	Methods that examine performance measures like lateral/horizontal position, speed control, gap acceptance etc.
Physiological measures	Methods designed to measure eye glance distance, visual occlusion etc. in relation to distracted driving
PLD & FLD	Partial lane departure and full lane departure
Propensity weighting	Propensity scores estimate the treatment or exposure effect in an unbiased way
PWB	Psychological well-being
QLD	Queensland

Acronyms and terms	Explanation
RDB	Risky driving behaviour
RF model	Random Forest modelling
Risk ratios	Estimates of the associated change in risk
SA	South Australia
SART	Sustained Attention to Response Task
SCEs	Safety Critical Events
SDDQ	Susceptibility to Driver Distraction Questionnaire
SDLP	Standard deviation of lane position measure
Self-determined nudging	Describes a process of determining a goal and using a 'nudging' method to remind the individual of that goals
Serial processing	Frequently switch between task
SHRP (NDS)	Strategic Highway Research Program is a naturalistic driving study that was conducted in six locations in the U.S. from 2012 to 2013. Approximately 3,400 vehicles were monitored with Data Acquisition Systems (DASs), which collected video and kinematic data continuously while the vehicles were driven
SHRP2 (NDS)	Second Strategic Highway Research Program (2012-2015) was created to find strategic solutions to three national transportation challenges: improving highway safety, reducing congestion, and improving methods for renewing roads and bridges. The study tracked 3,500 drivers across a 3-year period
SRT	Steering reaction time
STC	Sociotechnical approach
STS	Sociotechnical systems approach
SV ROR	Single vehicle run off road crashes
Systems thinking	Analysis grounded in a broad range of contextual and systemic factors. Systems thinking is a term used within the sociotechnical systems approach
TOR	Take Over Request: an auditory or visual HMI request to take over control of the vehicles controls in automated driving scenarios
TAS	Tasmania
TBI	Traumatic Brain Injury
Technological distraction countermeasures	Mobile phone blockers, driver monitoring systems, and vehicle or smartphone settings that prevent cell-phone use during driving
TEORT	Total eyes-off-road time
Time budget	The available time between an automated take over request (TOR) and colliding with an obstacle or crossing a safety boundary
Time headway	The measure (in time) between two vehicles travelling at particular speeds

Acronyms and terms	Explanation
TWD	Texting while driving
UFOV	Useful field of view
UI	User interface (e.g., on smartphones or IVT)
UK	United Kingdom
USA	United States of America
V2E	Vehicle to everything
V2I	Vehicle to infrastructure technologies
V2V	Vehicle to vehicle technologies
V2X	Vehicle to everything technologies
VCS	Visual control system
VDU	Visual display units
VIC	Victoria
Visual spare capacity	Amount of visual attentional capacity that drivers allocated to non-driving tasks
VM	Visual manual displays
VR	Voice recognition systems
WA	Western Australia
WHS	Workplace Health and Safety
Within-subjects experiment	All participants are exposed to every treatment or condition
WMC	Working memory capacity

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1. Introduction

1.1 Background

This report was commissioned by the Australian Automobile Association (AAA) and reviews the 'Distracted Driving' literature. Broadly, the Griffith University research team was asked to consider what is currently known about the field of distracted driving in relation to four predetermined themes: (1) human behaviour, (2) policy and regulations, (3) the technology landscape, and (4) enforcement and compliance with legal frameworks.

Road crashes are a leading cause of death globally resulting in more than 1.35 million deaths and up to 50 million injuries per year (World Health Organisation, 2018). While there are several factors that contribute to road crashes, this report is focused on distracted driving.

Distracted driving is difficult to define as driving involves constant 'distractions' or switching between driving and non-driving tasks (Rogers & Monsell, 1995; Strayer, 2015). For example, drivers must continuously scan the environment for potential threats as well as monitor and engage with vehicle controls. Moreover, the ability to switch between the driving task and other tasks (distractions) is moderated by a range of intrapersonal (person specific) and non-personal or 'external' factors (both inside and outside of the vehicle). Intrapersonal factors include cognitive capacity, knowledge, skills, and attitudes. External factors *inside the vehicle* include interactions with passengers, eating, drinking, and using in-vehicle and wearable/portable technologies. External factors *outside of vehicle* include the weather, road infrastructure (including advertising billboards), other vehicles, and other road users (e.g., pedestrians and cyclists). Additionally, underlying contextual factors that influence whether or not drivers chose to engage with non-driving distractions include societal contexts/structures, behavioural norms and social relationships. Therefore, distracted driving is a multifaceted concept, encompassing inside and outside of vehicle activities/tasks, individual capacities, a range of social contexts, and the wider transport sociotechnical system (Shinar, 2019; Strayer & Cooper, 2015; Young & Salmon, 2015).

Notwithstanding the multifaceted nature of driving distractions, on the whole recent research is more focused on technological distractions, particularly those that involve a human machine interface (HMI, see for example: Oviedo-Trespalacios, Briant, Kaye, & King, 2020; Stavrinos, Pope, Shen, & Schwebel, 2018; Steinberger, 2018). HMI technologies include handheld and wearable devices like mobile phones or watches, in vehicle telematics (IVT) used by vehicle fleets that gather data on driver behaviour and vehicle activity, and driver assist systems (DAS) like vehicle automation and global positions systems (GPS) for navigation.

The exact contribution of distracted driving to road crashes is difficult to quantify due to limited data collection in many countries. For instance, only 64 countries routinely collect information regarding mobile phone use as part of regular police crash reports or through observational studies (World Health Organisation, 2018).

1.2 Objectives, inclusion criteria, and methods

The objectives, inclusion criteria and methods for this review were specified in advance in a protocol document (see Appendix I). A search for existing scoping reviews was conducted through a comprehensive database search including Web of Science, Scopus, Proquest, Informit, Google Scholar, and TRID. No existing scoping reviews for the study period (2000-2020) were found. However, the searches located a series of other literature reviews, mostly from the time period 2010-2020. A recent study reviewed the literature relating to known countermeasures (Arnold et al., 2019) while another was limited to engineering factors contributing to distracted driving and possible solutions (Chand & Bhasi, 2019). Two very recent reviews of the literature were located; however, these were selective in scope (Goodsell, Cunningham, & Chevalier, 2019; Qi, Vennu, & Pokhrel, 2020).

Goodsell et al's report (2019) was prepared for the Australian Government's National Transport Commission (NTC) and examined the scientific literature on driver distraction affected by in-vehicle and mobile devices. The report answered four questions: (1) how does technologically related distraction affect safety, (2) to what extent does technologically based distraction contribute to road trauma in Australia, (3) how is technologically based distraction identified and measured and (4) what guidelines have been developed to reduce the impact of these technologies. Thus, the report centres primarily on human-machine interface (HMI) technologies and examines moderating factors like driver characteristics and driving demand. Qi, Venuu, & Pochrel's report (2020) was commissioned by the Illinois Center for Transportation and summarises distracted driving research in the USA. The report includes discussion on research methodologies used to detect distracted driving, factor analysis, impact on road safety, current laws and enforcement countermeasures in use within the USA, and mitigation technologies for personal and enforcement practice use.

The preliminary search for existing reviews was encouraging as it indicates a large body of work exists in this area. However, no international scoping review of the literature has been completed to date. Of the two recent reviews, Qi, Venuu & Pockrel's review (2020) is limited to the USA context while Godsell et al's

Australian report (2019) is primarily concerned with detection methods (physiological indicators that measure cognitive load) and corresponding technological countermeasures. In contrast to these two reports, our intent is to follow a stepped overarching scoping review methodology using a detailed extraction form, category output tables, and a narrative summary that thematically describes the international research in view of the research questions (Arksey & O'Malley, 2005; Peters et al., 2020).

The research team was asked to provide:

- a thematic scoping review of the literature (2000-2020)
- a summary of any distracted driving legislative/regulatory/policy frameworks within Australia or comparable jurisdiction (for heavy and light vehicles).
- a summary and evaluation of recent (2015-2020) distracted driving countermeasures in Australia.
- a list of key researchers/research organisations within Australia and comparable jurisdictions that work in the field of distracted driving. The list should include the researcher's affiliations and areas of expertise.

1.3 Research questions

The review was guided by one main research question and three supplementary questions.

1. *How has the concept of Distracted Driving developed in the timeframe 2000-2020*?
   a) *How does the research literature represent the problem of Distracted Driving?*
   b) *Does the more recent literature (2015-2020) provide novel insights to the problem of Distracted Driving and, if so, are any added factors, concepts, or theories identified?*
   c) *Does the more recent literature (2015-2020) provide examples of successful countermeasures, laws and policy interventions that address distracted driving? Have these measures been evaluated?*

In addition to the literature review, this report contains a policy scan. To conduct this scan and compile the list of legislative/regulatory/policy frameworks, a series of semi-structured interviews was conducted with road safety professionals, government officials, and academics who work in the field of distracted driving.

1.4 Progression of report

The report is divided into four sections. Section 1 (Introduction) provides the rationale, background, and objectives for the report together with a list of guiding research questions. Section 2 (Narrative review) is an overview of the distracted driving field of enquiry and sets the scene for the next two sections. The Narrative review describes the two main approaches to distracted driving research found in the literature and a discussion about their methodological limitations. Section 3 (Recent trends in distracted driving: 2015-2020) provides a scoping review of the recent literature. Section 4 (Legislation and policy: consultation with stakeholders) presents the opinions, concerns, and suggestions of key industry professionals regarding the problem of distracted driving. A list of references is included at the end of the report.

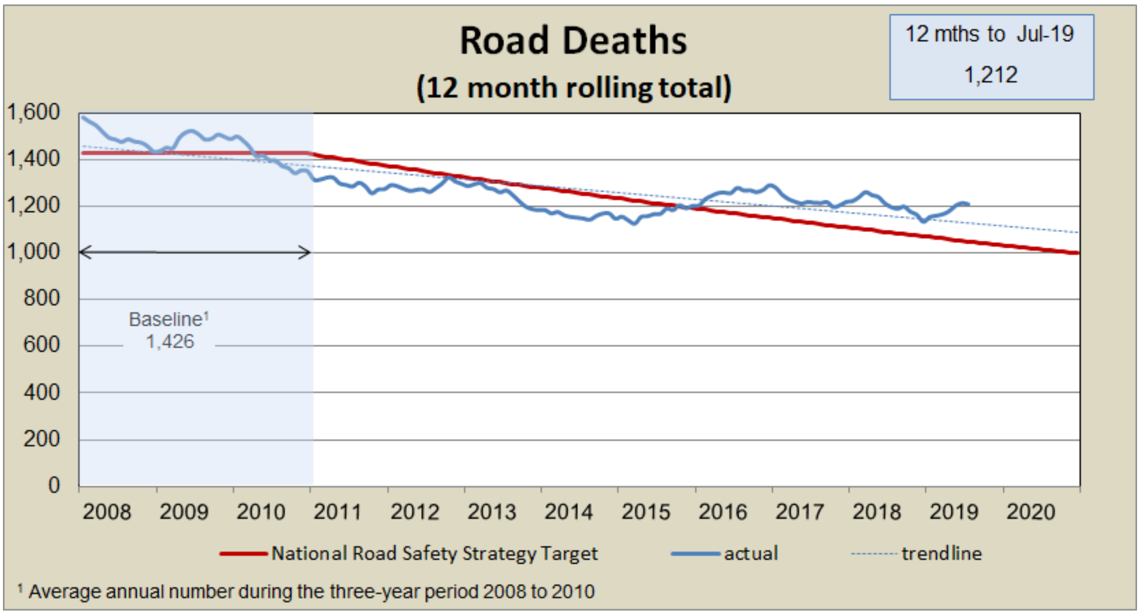
A supplementary document 'Appendices' contains a number of appendices that pertain to some sections within the report. For example, one of the appendices lists the guiding questions used within the consultation with stakeholders (Section 4 in this report). Thus, the reader can read the main report while referring to the supplementary document when necessary.

2. Narrative review of early literature

2.1 Road crashes in Australia

As noted above, there are more than 1.35 million deaths and up to 50 million injuries per year worldwide are attributable to road crashes (World Health Organisation, 2018). Within Australia, the number of individuals dying from road crashes is falling. Despite this, it is still not at the target outlined in the National Road Safety Strategy (see Figure 2.1). Moreover, the number of those who are seriously injured as the result of a crash appears to be increasing. For instance, Henley and Harrison (2015) state that there was an average annual increase in serious injury crashes within Australia over the 10-year period from 2001 to 2010.

Figure 2.1: Annual Road Deaths, Australia



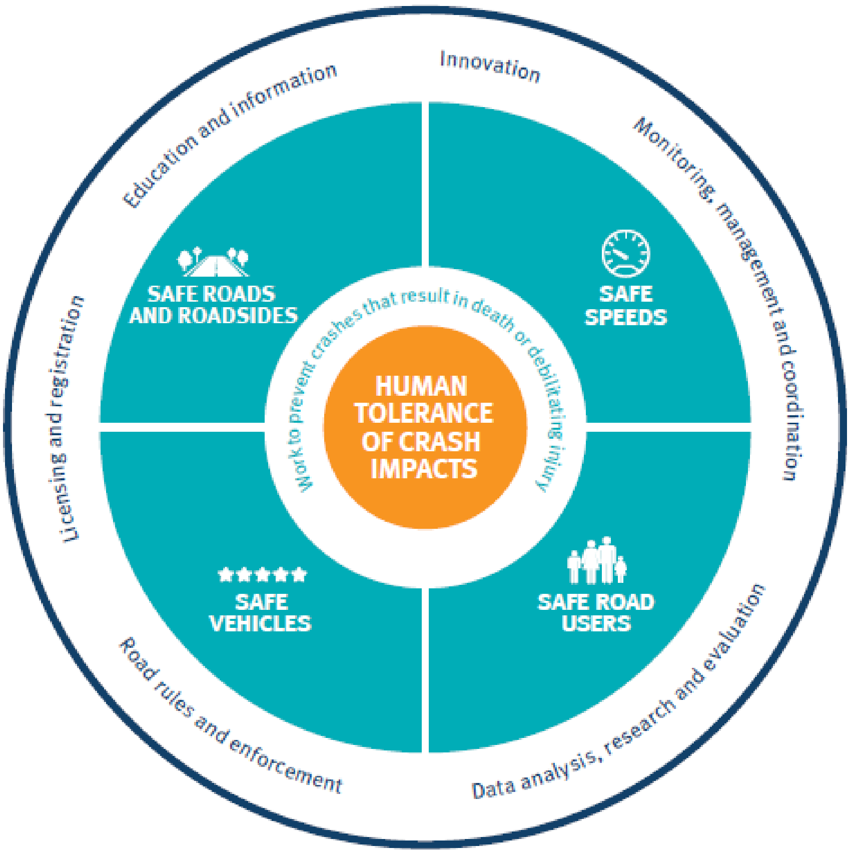
Source: (National Road Safety Strategy, 2019)

The factors that contribute to road crashes are diverse and include, but are not limited to, factors such as drink driving, fatigue, environmental and road factors, age, gender, personality, skills, hazard perception abilities (e.g. Bates, Davey, Watson, King, & Armstrong, 2014; T. Dingus et al., 2016; Papadimitriou et al., 2019; Siskind, Steinhardt, Sheehan, O'Connor, & Hanks, 2011). The World Health Organisation (2018) lists various road user behaviours (speed, drink driving, motorcycle helmet use, seat-belt use, child restraint use, distracted driving and drug driving) as well as road, vehicle and post-crash care as factors that influence death and injury rates from road crashes.

The dominant policy model applied by roads authorities and road safety advocates in Australia is the Safe System Approach. The Safe System Approach is focused on developing a road transport system that can more effectively accommodate human mistakes, incorporate strategies that better manage crash forces and embrace the idea of 'shared responsibility' for road safety. A core underlying factor in the Safe System Approach is the acknowledgement that humans are not perfect and will therefore make mistakes while using the road. The Safe System Approach has been adopted in a range of countries including Sweden (as Vision Zero), the Netherlands (as Sustainable Safety), New Zealand and various jurisdictions within Australia.

As shown in Figure 2.2, there are four main components of the Safe Systems Approach. These are: safe roads and roadsides, safe vehicles, safe speeds and safe road users. The combination of these elements helps to increase the likelihood that individuals will survive a crash or experience debilitating injury.

Figure 2.2: Safe System Approach



Source: (Department of Transport and Main Roads, 2015)

2.2 Approaches to distracted driving and inattention research

Driver distraction is considered a key contributing factor in road crashes (T. Dingus et al., 2016; World Health Organisation, 2018) and falls within the safe road users element of the Safe Systems Approach. Despite this, driver distraction is a developing research field addressing a range of secondary tasks that affect the primary task of driving. The term 'distracted driving' is often used as a synonym for 'inattentive driving' however the concepts are not interchangeable. Regan, Hallett and Gordon's (2011) definition of distracted driving is commonly cited in the literature and states a *distraction* is any secondary activity that results in '*diversion of attention away from activities critical for safe driving toward a competing activity, resulting in insufficient or no attention to activities critical for safety driving'*. Inattentive driving behaviour, in turn, results in increased crash risk (Strayer, 2015). In the last few decades the use of portable/nomadic devices, in-vehicle technologies (IVT), and driver assist systems (DAS) have increased, leading to more technology-based distractions that take attention away from the driving task and increase crash risk (Caird, Simmons, Wiley, Johnston, & Horrey, 2018; Oviedo-Trespalacios, Haque, King, & Washington, 2016; Simmons, Hicks, & Caird, 2016). While past road safety measures (e.g., mandatory seatbelt use and lower speed limits) have lowered crash rates internationally, new technologies add complexity to the driving task, create new distractions, and potentially increase crash risk (World Health Organisation, 2018).

Two interrelated methodologies are commonly used in recent driver distraction research; the *human factors approach* and the *sociotechnical systems approach* (Parnell, Stanton, & Plant, 2018d; Shinar, 2019). Human factors researchers investigate psychosocial, socioeconomic, and biomechanical factors that affect how individuals respond to secondary tasks (distractions) when performing the primary task of driving. The methods used by conventional human factors researchers place emphasis on cause-and-effect relationships using observational techniques and quantitative measures. Confounding variables like cultural and environmental context, political systems, legislation, gender, and age are acknowledged but often controlled for (removed) to clarify the effect of a particular distraction on a particular population or group (Shinar, 2019).

The second methodology –the sociotechnical systems (STC) approach - is a relatively new and ascending field in distracted driving research (Salmon, Read, & Stevens, 2016; Shinar, 2019). Systems researchers, in contrast to traditional human factors researchers, are interested in mapping *complexity* within the transport systems (Parnell, Stanton, & Plant, 2019). Thus, the task of systems researchers is to examine interdependencies, or relationships, between different systems, driving conditions, and motorists. The emphasis is, therefore, less on finding error in human behaviour and more on understanding what needs to change in the entire sociotechnical system to reduce road crashes (Cunningham & Regan, 2016; Parnell, Stanton, & Plant, 2017; Shinar, 2019; Young, Osborne, et al., 2019b).

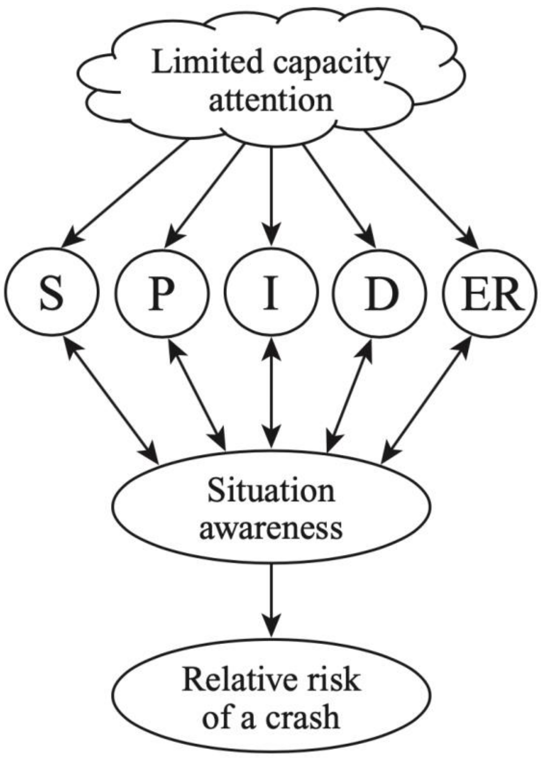
The following subsections provide a brief summary of key researchers and principles within the human factors field and the STS approach. Notwithstanding these different approaches, more recent research in the driver distraction field (and road safety generally) is trending towards combining human factor analysis with the broader contextual elements of STC practices. Moreover, road safety policy internationally (Larsson, Dekker, & Tingvall, 2010; World Health Organisation, 2018) and in Australia (Department of Transport and Main Roads, 2017) are based of the STS approach.

2.2.1 Human factors approach - inattention research

David Strayer is a prolific human factors researcher in the field of distracted driving (See for example: Strayer et al., 2017; Strayer & Drews, 2004; Strayer, Watson, & Drews, 2011). Together with his colleagues, Strayer compares a range of 'old standard' distractions like talking with passengers, eating and drinking, grooming, or listening to music and contrasts these with newer, in vehicle and wearable HMI technologies. Strayer argues that each types of distraction has a particular *cognitive load* on attention and therefore effects crash risk. Moreover, the level of inattentiveness (caused by each distraction) is mediated by a person's *ability* to multitask leading to differences in *situation awareness* (Strayer, Cooper, Turrill, Coleman, & Hopman, 2015a).

Situation awareness is produced by a series of dynamic mental processes that combine to make sense of a constantly changing environment. In a driving context, situation awareness is produced by <u>scanning</u> the environment, <u>predicting</u> threats, <u>identifying</u> threats, <u>deciding</u> when/how to act, and <u>executing</u> an appropriate <u>response</u> or 'SPIDER' for short (Strayer & Cooper, 2015). Distractions can lower levels of visual scanning, resulting in less situational awareness and a higher risk of missing potential threats (crash risk). Very low levels of situational awareness are described as 'inattentional blindness' (Strayer, 2015). A large proportion of distracted driving research attempts to measure inattentional blindness using simulator and naturalistic driving studies (NDSs). Strayer's SPIDER model of attention is visualised below (see Figure 2.3).

Figure 2.3: The SPIDER model of attention in driving



Source: (Strayer, 2015)

However, on its own the SPIDER model lacks explanatory power – i.e., the ability to predict why different types of distraction (performing a dual task) cause higher levels of inattentive driving. Strayer suggests three possible explanatory pathways. *Domain-general* models propose that humans have limited mental resources and any cognitive overloading, or multitasking, results in reduced performance (Kahneman, 1973). In contrast, *multiple resource theory* (C. Wickens, 1991) suggests that visual, verbal and auditory inputs require separate pools of processing resources (or *domains*). Dual processing is possible providing tasks do not overburden specific combinations of resource domains. Similarly, the concept of 'code conflict' proposes that if two tasks use similar mental pathways 'cross-talk' occurs leading to reduced performance for one or both competing tasks (Pashler, 1994 in Strayer, 2015).

Situation awareness is also negatively affected by the amount of *time* a process takes to occur. Strayer (2015) contrasts the shorter task of changing channels on a radio or glancing at a vehicle speed monitor (a couple of seconds), with the longer task of engaging in a mobile phone conversation (minutes). Thus, actions that take longer have a larger detrimental impact on attention than shorter distractions. Moreover, Bergen and colleagues (2013) suggests that a longer verbal or written activity (language-mediated interaction) also causes an overlap of cognitive processes or *domain-specific interference*. Domain-specific interference explains common dual task difficulties (e.g., participating in a conversation while attempting to work on a crossword or puzzle) although individual capabilities mediate the effect. Individual difference (cognitive capacity) is a key mediating factor in distracted driving research (Engström, Markkula, Victor, & Merat, 2017).

Interestingly, research shows major differences in attention levels between drivers who are speaking on the phone and drivers who are talking with vehicle passengers. Strayer refers to epidemiological studies that indicate a fourfold increase (McEvoy et al., 2005) in crash risk when drivers speak on the phone compared to drop in crash risk (below 1) when talking with an adult passenger (Rueda-Domingo et al., 2004). This finding suggests that another "pair of eyes" in the vehicle is helpful as the passenger may assist in pointing out risks and/or helps with general navigation tasks. Moreover, video produced in simulator studies show that passengers often stop talking to the driver of the vehicle during difficult navigation tasks (Drews, Pasupathi, & Strayer, 2008) suggesting they have assessed the situation as too risky to continue talking.

As discussed above, the relationship between driving distractions and inattentive driving is mediated by cognitive ability. Likewise, "mind wandering", where a driver becomes lost in thought while driving, negatively affects some individuals more than others. Again, research suggests the ability to drive safely while daydreaming (mind wandering) is mediated by practice, requiring less 'cross-talk' within and between mental domains (Engström et al., 2017; Smallwood, McSpadden, & Schooler, 2008; Strayer, 2015). Interestingly, 'mind wandering' can result in drivers following a familiar route out of habit, rather the route they planned. Mind wandering is a new field in recent distracted driving research (see Section 3 of this report).

2.2.2 Sociotechnical systems and modern systems theory

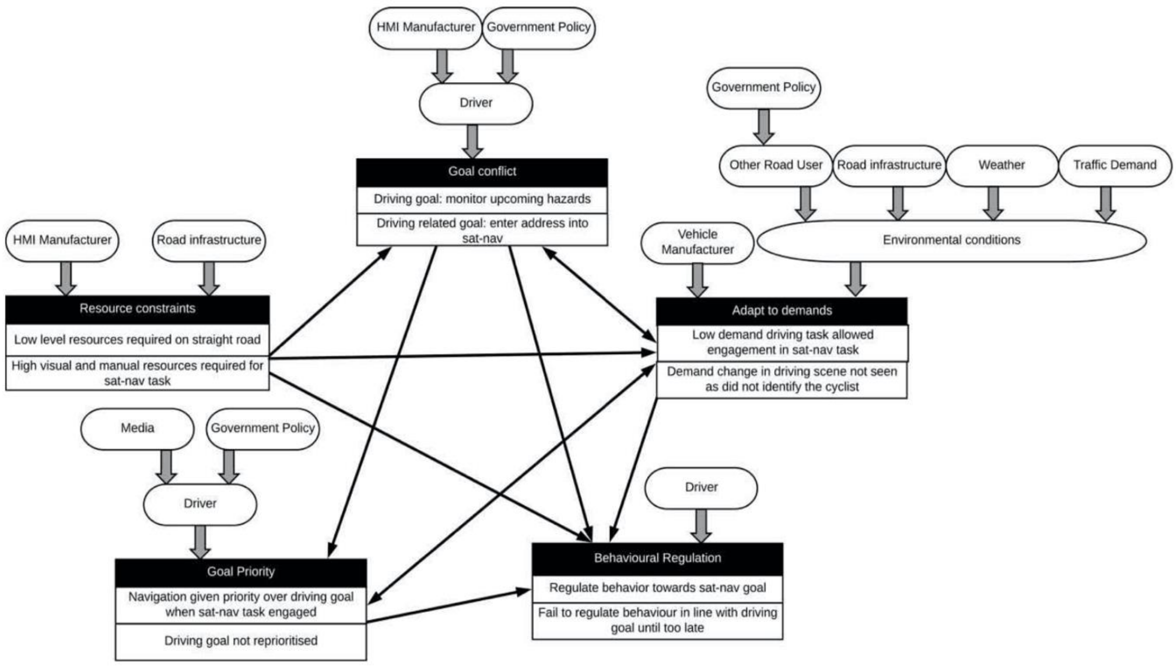
As discussed above, the term *sociotechnical system* is an amalgam of 'social system' and 'technological system' describing the interaction between human behaviour, communities, organisations, governance, and technological systems. This field of enquiry is not new, emanating from work by researchers in the 1950's who investigated productivity declines in English coal mines following the adoption of new technologies (Trist & Bamforth, 2016). Trist and Bamforth (2016) suggested that new technologies change established processes in work groups and, paradoxically, increased work-related cognitive demands . In short, work tasks became more, rather than less, complex. Although this seminal piece of research focused on a closed workplace, future researchers introduced the concepts of *complex systems* leading to Bertalanffy's general *systems theory* (Weckowicz, 2000)and the principle of *systems thinking*.

Claes Tingvall from Sweden introduced the concept of systems thinking to the field of road safety with the policy of 'Vision Zero' (Tingvall, 1998), a philosophy that states no loss of life is acceptable in road systems. Tingvall's main contribution to Australian road safety laws (in conjunction with Australian researchers led by Narelle Haworth) was the introduction of lower speed limits within the Australian Road Rules (Haworth, Ungers, Vulcan, & Corben, 2001). Tingvall argued that because human error (and therefore road crashes) is an expected part of the road system, *systems designers* (governments, road engineers, vehicle manufacturers) must change the road system to account for these human errors. This thinking led to the adoption of the Safe Systems Approach within Australia.

Kristie Young and Paul Salmon from Australia and Katie Parnell and colleagues from the United Kingdom are key systems thinking researchers in the field of driver distraction. Parnell and colleagues' recent book *'Driver Distraction: A Sociotechnical Systems Approach'* (Parnell et al., 2019) provides a summary of how systems thinking can be used in distracted driving research. The major contribution of the book is the development of the Priority, Adapt, Resource, Regulate, Conflict (PARRC) systems model that maps five interconnected causal factors for distracted driving behaviour (adaption to demands; behavioural regulation; goal conflict; goal prioritisation; resource constraints) and how these factors are impacted by the wider transport system (See Figure 2.4). Parnell et al. (2019) find that although some causal factors of driver distraction are attributed to the individual, others result from transport policy, the advent and regulation of new technologies, or life and work contexts.

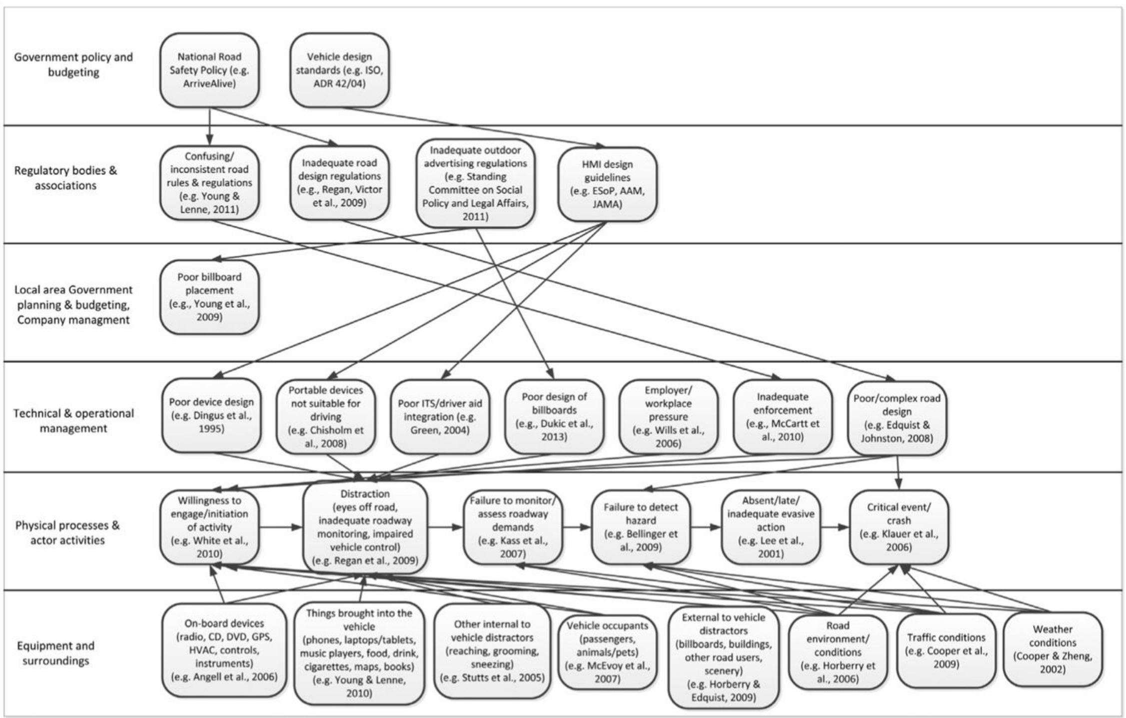
Likewise, Young and Salmon (2015) discuss the limitations of traditional human factors research. Their work maps complex relationships and interactions that occur between hierarchical levels in the transport system and argue that responsibility for distraction is a shared responsibility between road designers and road users. While lower hierarchical levels (the road users) are responsible for following road rules, the higher levels (policy makers and regulators) are responsible for overseeing systemic risks (particularly in view of new technology) and developing targeted regulatory frameworks (see Figure 2.5). Moreover, Young and Salmon demonstrate that information flows (communication between the hierarchical levels) are integral to designing safer systems through application of the STAMP framework. STAMP (Systems-Theoretical Accident Model and Processes) is a systems causality modelling tool developed by Nancy Leveson (2004) initially used in the aeronautical industry and later implemented across a range of engineering and industry fields to map systemic factors of sociotechnical systems. Similarly, Young and Salmon (2015) and Salmon et al. (2016) apply the STAMP framework to map the wider sociotechnical road safety system.

Figure 2.4: PARRC model of distraction



Source: (Parnell et al., 2016)

Figure 2.5: The STAMP modelling tool



Source: (Young & Salmon, 2015)

In the United Kingdom, Parell and colleagues (Parnell et al., 2017; Parnell, Stanton, & Plant, 2018a; Parnell et al., 2018d, 2019) have also worked with a variety of analysis tools and research methods to systemically map the UK transport system. For example, AcciMap was used to map key actors and processes within a UK transportation system (Parnell et al., 2019). However, Parnell et al. caution that AcciMap, and other system analysis tools (e.g. STAMP mentioned above) are of limited use if not supplemented with exploratory qualitative research methods – for example *grounded theory*. Qualitative research methods help to answer questions about *why, what and how* individuals interpret and respond to particular constraints and risks within an entire system. Within the distracted driving field questions include; '*what* motivations push drivers to break traffic laws in regard to mobile phone use?', '*why* do regulators and policy makers ban one technology (e.g. mobile phones) but not another (e.g. wearable devices or interactive GPS systems)' or '*how* do legislators gain insights (feedback) about the efficacy of certain rules and regulations?'.

2.3 Types of driver distraction

As noted above, distracted driving describes any secondary activity or task that interferes with the primary task of driving a vehicle (Strayer, 2015). Secondary activities and tasks occur both inside and outside of the vehicle and are shaped by societal, political, and regulatory contexts (Parnell et al., 2019). An important field in distracted driving research are *person specific* factors that determine individual capacity to resist engaging with secondary tasks. Person specific factors include *psychosocial* and *socioeconomic* influences that impact individual choice and self-regulation (Atchley & Strayer, 2017; Gauld, Lewis, & White, 2014; Oviedo-Trespalacios, Haque, King, & Washington, 2019). The various components of distracted driving investigation (types of distractions, contextual factors, individual capacity, individual choice) are described below.

2.3.1 Inside of vehicle

Distractions that occur inside of the vehicle include using mobile or wearable technology as well as non-technology based everyday distractions like eating, drinking, and talking with passengers. A limited number of studies investigate no technology-based distractions, often with contradictory findings. For example, one study found vehicle control measures (e.g., lane keeping, and reaction time) when eating or drinking while driving was similar to technological distractions (Irwin, Monement, & Desbrow, 2014). While another study found eating and drinking caused higher decrements in vehicle control than in-vehicle technologies (Choudhary & Velaga, 2019). Likewise, other technology-based studies are often contradictory. Some studies suggest that both hands-free and handheld technologies have similar crash risk profiles (Desmet & Diependaele, 2019; Haque & Washington, 2015; Yan et al., 2018) while others found that hands-free voice based interactions are less distracting than more manual modes (Mehler et al., 2016; Tippey, Sivaraj, & Ferris, 2017).

A recent review of distracted driving literature by Stephan (2020) from the Monash University Accident Research Centre (MUARC) suggests contradictory findings may be explained by differing study methodologies. For example, naturalistic driving studies (NDS) that include specific surrogate outcome measures and/or remove 'confounding' variables, may produce conflicting results to similar studies that do not include these measures (see pages 11, 14-17, 24, 30, 34 of Stephan's report). Nevertheless, some confounding variables may, in retrospect, become an interesting (and determining) factor within a study. For instance, drivers who listen to music or conduct a lengthy hands-free phone conversation may do so primarily on longer drives. Longer drives usually occur in suburban environments with less complex road systems. Less complex road systems are less distracting than city environments. If more study participants in the group using hands-free devices are from suburban areas this extra *confounding variable* could potentially skew the observed crash risk effect. Conversely, an example of a surrogate outcome measure is using a tyre strike or other "near miss" as a surrogate for crash risk, potentially exaggerating the effect of certain distractions. In other words, weaknesses in study design may skew or exaggerate findings.

Wijayaratna, Cunningham, Regan, Jian, Chand & Vinayak (2019) contrasts mobile phone distraction studies from two different methodological approaches; real world naturalistic driving studies (NDSs) and driving simulators studies. NDS studies typically use *risk ratios* (measure of the risk of a certain event within one group compared to the risk of the same event within another group) to calculate the likelihood of a crash occurring using different conditions and one outcome measures (crash risk). In contrast, simulator studies measure driver performance as a level of distraction (Strayer & Drews, 2004). For example, measuring the lane keeping ability (performance) of drivers who are distracted by a competing secondary task compared to drivers who are not distracted. NDS studies provide greater realism (and more complexity) but study variables may be unknown or unaccounted for. Sometimes variables are purposely removed as they may 'muddy the waters' when presenting findings (confounding variables). Likewise, simulator-based studies are often designed to limit or control environmental factors (lessen complexity) to more precisely measure driver performance. For example, NDS studies may not include vehicle passengers, varying weather conditions, or everyday 'mind wandering' that may occur due to observed environmental factors (see discussion on mind wandering in Section 3 of this report).

Notwithstanding these methodological issues, Stephan's review suggests that in-vehicle secondary tasks involving visual or manual distractions are associated with higher crash risk than verbal distractions. Moreover, the review found using *in vehicle technology* (IVT), had similar levels of crash risk for all drivers, rather than for particular demographic groups (Stephan, 2020). Nonetheless, young drivers' relatively high levels of *exposure to technology* (e.g. how often a driver engages with their phone while driving) was much higher than older drivers (page 33-34 of Stephan's review). Interestingly, the most common in-vehicle driving distraction for younger drivers was talking/interacting with vehicle passengers (a non-technological distraction. Again, these findings are related to exposure, i.e. younger drivers generally carry more passengers, leading to more distractions per trip compared with older drivers.

Conversely, other studies suggest that drivers (regardless of age) may benefit from carrying a passenger as they provide 'an extra pair of eyes' that help with navigation tasks and/or scanning the road environment for possible crash risks (Rueda-Domingo et al., 2004; Stephan, 2020: page 35). Other distractions like reading, writing, reaching for objects within the vehicle, were all associated with higher crash risk, again particularly for younger drivers. However, tasks like eating or drinking did not show consistent distraction effects. This is, perhaps, not surprising as these activities do not combine complex visual, verbal and auditory resources or 'cross-talk' between these cognitive 'domains' (see discussion in Strayer, 2015; C. Wickens, 1991).

2.3.2 Outside of vehicle

Distractions that are caused from outside of the vehicle include looking at billboards and navigating complex road infrastructure (traffic complexity). As discussed above, *situation awareness* is produced by scanning the environment, predicting threats, identifying threats, deciding how to act, and executing an appropriate response (SPIDER: Strayer, 2015). Nonetheless, *multiple resource theory* (C. Wickens, 1991) holds that, while multitasking is a common and necessary driving task, it is more difficult under the condition of 'code conflict'. As explained above, code conflict occurs when specific mental processes are overburdened, reducing the efficacy of each task (Strayer, 2015).

Research based on simulator studies suggest that digital/dynamic billboards are correlated with higher crash risk as they overload visual/cognitive pathways and take away attention from the driving task for extended periods of time (Belyusar, Reimer, Mehler, & Coughlin, 2016; Oviedo-Trespalacios, Truelove, Watson, & Hinton, 2019; Stavrinos, Mosley, et al., 2016). See also section 3.4.6 of this report. More complex secondary tasks take longer to process and therefore are more distracting than simpler secondary tasks (Bergen et al., 2013). By way of compensation, drivers often select lower speeds when confronted with complex visual distractions outside of the vehicle, for example, complex road infrastructure (Lewis-Evans & Rothengatter, 2009; Oviedo-Trespalacios, Haque, King, Washington, & Transportation Research Board, 2017). Again, this behavioural adaptation is age related, i.e., adapting speed to limit the effect of distractions is more often performed by older, experienced drivers than younger drivers (Cao et al., 2020; Oviedo-Trespalacios, Haque, King, Washington, et al., 2017). However, other research suggests that most people (regardless of age) somewhat reduce their speed as a coping mechanism when multitasking while driving (Engström et al., 2017; Schneidereit, Petzoldt, Keinath, & Krems, 2017). As discussed above, this contradictory finding perhaps suggests methodological limitations in study design which, in turn, influence study findings. For example, researchers may not account for confounding or other variables and/or may rely on study metrics that use surrogate outcome measures, like tyre strikes or lane keeping measures, for crash risk (see discussion in Section 2.3.1).

2.3.3 Intrapersonal factors and behavioural theories

Intrapersonal or person specific influences moderate an individual's ability to multitask and self-regulate (Strayer, 2015) and include *sociodemographic factors* like age, gender, education and income, as well as *psychosocial influences* like personality, mental health, and normative or cultural backgrounds. Although personal characteristics are central to intention to comply (self-regulation) with laws and regulations, this area of study is relatively underrepresented in distracted driving research (Oviedo-Trespalacios, Haque, et al., 2019). Nonetheless, a range of theoretical frameworks are used to understand why, how, and under what conditions individuals engage with distracting technologies or other behaviours. These include general behavioural theories like the theory of planned behaviour (TPB) and the theory of reasoned action (TRA) as well as frameworks that address conditions related to particular HMI technologies like *facilitating expectancy*, *performance expectancy*, *effort expectancy*, and *social influence* (Venkatesh, Morris, & Davis, 2003). Social influences include cultural and societal approval or disapproval for a particular behaviour. Technology specific theories are also emerging, for example, the technology acceptance model (TAM) and the unified theory of acceptance and use of technology (UTAUT). These various theories and models are discussed in Section 3 of this report.

Behavioural choices include whether or not to, for example, use prohibited technologies like handheld mobile phones, drive while fatigued, while under the influence of alcohol or other drugs, or while experiencing emotional stress (Strayer, 2015). In a recent combined driving simulator and self-report survey study, Oviedo-Trespalacios and colleagues found that personality and attitudinal characteristics influenced whether or not an individual pulled over to make a phone call, i.e. took precautionary steps to avoid driving while distracted (Oviedo-Trespalacios, Haque, et al., 2019). Although the authors did not recommend complete deregulation of mobile phone use while driving (see page 141 of the report) findings suggest that drivers self-regulate (e.g., choose not to use the phone) under certain operational or strategic contexts. Therefore, a 'context-aware' technology enabled workload management systems (page 141 of the report) could be used to communicate with drivers about where and when they could safely engage with in vehicle HMI technologies (e.g. navigations systems).

Research that tracks behavioural choices often use self-report methods, questionnaires and/or comparative scales, together with quantitative metrics. For example, the driver behaviour questionnaire (DBQ) and the behaviour of novice young drivers scale (BYNDS) are used in exploratory factor analysis (EFA) to estimate when, and under which conditions, driving behaviours change (Al Reesi, Freeman, Davey, Al Adawi, & Al Maniri, 2018). Study findings from self-report methods (and associated scales) have potential to inform the design and implementation of public education and information campaigns as well as gain an understanding of why and how driver distraction occurs.

2.3.4 Contextual factors

As discussed above, another stream in the distracted driving literature is concerned with sociotechnical systems (Parnell et al., 2019; Salmon et al., 2019). Early sociotechnical systems authors proposed that as human error is inevitable, research and intervention studies should focus less on human factors, or 'the old view', and more on systemic/contextual factors, or 'the new view' (see discussion in Dekker, 2001). Examples of systemic factors in road safety research include traffic infrastructure, laws and regulations, societal/cultural expectations, HMI technologies, and more vulnerable road users like pedestrians and cyclists (Shinar, 2019; Tingvall, 1998; Young & Salmon, 2015).

Contextual factors are both limiters and enablers of safe driving. For example, societal norms (cultural expectations) may discourage dangerous driving behaviours while, at the same time, may place expectations on an individual to be at a certain place at a certain time. These time expectations could lead to speeding or other behaviours like running red lights, ignoring risks, or other safety shortcuts. Likewise, development in the technology landscape place time and productivity expectations on fleet workers (James, 2015; Jonasson, Holgersson, Nytomt, & Josefsson, 2017). On the other hand, new technologies used by professional fleets may alert workers to potential risks thereby increasing safety. Drivers may also adapt their behaviour to traffic infrastructure and weather conditions. For example, some drivers reduce speed to counteract reduced vision due to rain, fog, or snow (Tivesten & Dozza, 2015). Other drivers increase their speed when the road is straight and wide while reducing their speed at intersections and more complex road systems, particularly while engaging in secondary tasks (Oviedo-Trespalacios, Afghari, & Haque, 2020). Finally, although legislation and enforcement is a key component of encouraging behaviour change to increase road safety (Bates, Soole, & Watson, 2012), enforcement tends to be inconsistent and variable both in terms of funding and implementation (Kyd & Cammiss, 2020). This may be because victims of driving offences are not recognised as a victim of crime. These examples demonstrate that drivers respond to the entire transport sociotechnical system including societal expectations, road infrastructure, environmental factors, and HMI technologies. In short, a range of contextual factors influence driver behaviour in both negative and positive ways.

3. Recent trends in distracted driving research (2015-2020)

3.1 Introduction

While Section 2 of this report provided a general overview of distracted driving research, Section 3 categorises the trends in distracted driving research in the past five years. There has been a significant amount of research in this area during this time. Given the complexity of the field, the review is divided into sub-categories. These include the prevalence of driver distractions, types of distractions (e.g., technological, roadside advertising, multi-tasking and intrapersonal distractions), personal factors (e.g., socio-demographic factors and individual opinions/perceptions), particular populations (e.g., professional and fleet drivers), interventions (including legislation, enforcement, and systemic approaches), and the theoretical underpinnings in this field.

3.2 Method

This report follows Arksey and O'Malley's (2005) original scoping review method. Scoping reviews are designed to map and categorise the literature in relation to broadly set objectives. Project objectives were defined in consultation with AAA through an initial Expression of Interest process followed by a series of collaborative meetings/discussions that refined the scope of the final report.

In general scoping reviews identify key concepts in the field of enquiry and the main sources and types of literature. The four main reasons for conducting a scoping review are: (1) examine the extent, range and nature of research available, (2) determine the value of undertaking a systematic review, (3) summarise and disseminate the findings, (4) summarise and disseminate the findings <u>and</u> identify any research gaps in the literature. This report is aligned with the fourth reason, to summarise the findings and identify gaps in the distracted driving literature.

To meet project objectives the research team followed Arksey and O'Malley's five stage scoping review process: (1) identify the research question, (2) identify relevant studies, (3) study selection, (4) charting the data and (5) collating, summarising and reporting the results. Moreover, a sixth stage, involving a consultation exercise with professionals and experts in the field of distracted driving was also undertaken at the request of AAA. The consultation exercise informed Sections 4 (Legislation and policy – consultation with stakeholders) and Section 5 (Future directions) of this report and helped to identify gaps in the literature and policy landscape from the perspective of industry stakeholders.

In preparation for stage 2 (identify relevant studies) the research team compiled the below list of distracted driving concepts in consultation with the Griffith University subject librarian. The study timeframe was originally set to 2000-2020 however after consultation with AAA this was reduced to 2015-2020. A narrative review of the larger timeframe (2000-20120), addressing studies from key distracted driving authors is provided in Section 2 of the report.

Table 3.1: Distracted driver concepts used within the scoping review

Distracted Driver – concepts Internal/external can be conceptualised differently				
Distraction internal (cognitive triggers remove attention from a task)	**Distraction external** (visual triggers that remove attention from a task)	**Psychosocial** (how social factors influence thought and behaviour)	**Socioeconomic** (the interaction of social and economic factors)	**Countermeasures Interventions**
Cognitive distraction/interruption	Road infrastructure	Mental health	Income	Legal framework
“mind off the road”	Billboards OR advertising	ADHD	Education	Law/regulations
“eyes off the road”	Passenger peer interactions	Depression	Employment occupation	Fines Penalty Sanction Demerit points
Dual task/multitask	Music	Emotional health Wellbeing	Age	Public education campaign Education
Task complexity	Phone Technology		Gender	Advertising
	Human Machine Interface (HMI)			
Fatigue/sleepiness	Visual distraction			Morals/ethics
Anxiety/stress	Weather			Culture
Alcohol/drugs				Shame
Boredom/daydreaming/mind wandering				Occupational, health and safety OHS
Hunger/thirst				

Target databases included Web of Science, Scopus, Informit (including CINCH – Australian Criminology Database), EBSCO host bundle, ProQuest bundle (including ProQuest Criminal Justice), TRID (Transport Research Board) and Google Scholar. Sources included academic research articles, books, book chapters, and conference proceedings. Other relevant grey literature (e.g., industry and government reports) was provided by AAA or sourced through consultation with colleagues in the field of distracted driving. Identified articles/reports/books were added to the project Endnote reference library.

Study selection (stage 3) involved an iterative coding and theme development process. Two project members (LB and MA) individually coded each Endnote reference. The initial codes were based on the distracted driving concepts used in the database searchers (see above table) and were adjusted/amended during the first read through of abstracts/summaries. A series of codes were used to either include or exclude references. For example, the code ELBcountry denoted **E**xcluded by **LB** due to out-of-scope **country**, while IMAtheory denoted **I**ncluded by **MA theory** relevant study. LB and MA collaborated using email/phone/Team meetings to adjust/amend codenames. If the researchers disagreed on codes, further discussion resolved conflict. Codes were eventually collapsed into twelve main themes/categories of research. The 12 theme names were then somewhat adjusted to represent the meaning of the theme more fully. Final theme names are subheadings within Section 3 of the report.

While some of the included articles spanned two or more themes, one main theme was allocated to each reference. However, the report sometimes includes a reference in the discussion of one or more themes for this reason. Once all references were encoded, LB and MA performed a second pass as a final check on inclusion/exclusion. Exclusion criteria included: out of scope country, general road safety study, DUI or drug related studies, other road user articles (cyclist, pedestrians), engineering articles, not applicable technology studies, medical fields, purely methodological studies, fatigue-based studies, and general commentaries.

Stage 4 (charting the data) was performed through a series of extraction tables. See 'Appendix B: Literature Extraction Tables' included in the separate Appendices document. Stage 5 was a collaborative process involving all team members collating, summarising and reporting the results. The sixth stage (consultation with professionals/experts) was performed by one team member (MvF) who is a practised qualitative interviewer with extensive experience in police investigations. A series of interview questions were drafted and adjusted in relation to each interviewee's area of expertise. Regular team meetings were held to collaborate and inform team member of progress. In the second half of the project timeline, two extra researchers were recruited to help chart the data, draft sections of the report, and clean the Endnote library to ensure references within the report were consistently formatted.

3.3 Search diagram

Identification

Records identified through database searching (2000-2020)
(n = 2353)

Duplicates removed
(n = 599)

Screening

Records after duplicates removed
(n =1754)

Removed articles from 2000-2014
(n =736)

Records remaining
(n = 1018)

Records removed - outside of scope
(n = 517) *

Eligibility

Full-text articles assessed for eligibility
(n =501)

Additional articles excluded
(n = 62) **

* Studies relate to NA country, DUI, other road user, engineering/NA tech, medical investigation, fatigue, general commentaries
** Studies relate to NA country, DUI, other road user, engineering/NA tech, medical investigation, fatigue, general commentaries, and same studies by same authors published in different journals/conferences

Included

Studies included in qualitative synthesis
(n = 439)

Additional supplementary references included (n = 105)

Books and book chapters = 19
Cited by review authors = 43
Earlier reviews of literature = 6
Refs in Narrative Review section = 19
Road safety statistics = 9
Other material = 9

Total references included
(n = 544)

3.4 Recent distracted driving literature (2015-2020)

Several of the studies included in the scoping review and discussed in this report use the same datasets. For instance, there are several studies that use the SHRP2 (Second Strategic Highway Research Program) naturalistic dataset (e.g. Calvo, Baldwin, & Philips, 2020; Huisingh et al., 2019; J. Y. Lee, Lee, Bärgman, Lee, & Reimer, 2018). SHRP2 involved over 2,000 participants from six states in the USA. Participants needed to drive a vehicle that was suitable for the data acquisition system that recorded their driving. Most recent model cars that were in good working order were suitable. When the data acquisition system was installed in the vehicle, participants completed a range of tests including cognition, vision, personality, sleep-related and medical conditions. Individuals received a $500 per year incentive for their participation.

3.4.1 Technological distraction – Human Machine Interface (HMI)

What is HMI?

Broadly speaking a HMI is the space or device where humans interact with machines/computers (Arena & Pau, 2019). In the field of road safety, HMI is the interface between the driver and in-vehicle technologies (IVT), in vehicle information systems (IVIS) and portable devices like mobile phone, laptops, tablet computers, smartwatches, and head mounted displays (HMDs). The goal of HMI is to effectively control the 'machine' and to receive communication/feedback that supports a driver's decision making, particularly safety critical information. HMI technologies use a variety of sensory input methods, for example, touch (keyboards/touchscreens), vision (displays or warning lights), and sound (voice or alarms). More recent HMI interfaces involve advanced driver-assistance systems (ADAS or DAS) that incorporate external sensors and cameras. DAS provides information between the vehicle and outside infrastructure (V2I), vehicle and other vehicles (V2V), or vehicle to everything (V2X). V2X systems constantly scan the environment and detect physical infrastructure, pedestrians and other vulnerable road users (Arena & Pau, 2019).

HMI – recent research

Knowledge about HMI technologies and driver distraction generally originates from two streams of research: naturalistic driving studies (NDS) and simulator-based studies (Shinar, 2019; Young & Salmon, 2015). Research in these fields often control for environmental factors like road infrastructure, varying weather patterns, or traffic densities. These methodological limitations have led to criticisms of low ecological validity or real-world application (Parnell et al., 2016; Shinar, 2019). Notwithstanding these limitation, naturalistic driving and simulator studies consider a range of physiological, cognitive, and psychosocial/socioeconomic factors that affect HMI communication (Wu et al., 2016). Physiological factors include visual scanning, steering/braking, and hazard reaction time. Cognition or ‘cognitive load’ measures track ‘task-switching’ ability across modal domains (auditory, vocal, visual, manipulative, cognitive, tactile). The investigation of socioeconomic factors (e.g., age, gender, income, education) are less common in NDS and simulator-based studies, although age and gender are investigated more often. Psychosocial factors will be discussed in the section (Intrapersonal factors) and include personality and other mental conditions (Braitman & Braitman, 2017; Hayley, de Ridder, Stough, Ford, & Downey, 2017; Parr et al., 2016). It is important to note that NDS and naturalistic studies *predict* potential crash risk (through an odds ratio) rather than unequivocally demonstrate crash causation (Parnell et al., 2018d; Shinar, 2019).

Portable technologies include mobile phones, tablets/computers, wearable devices (e.g., watches, fitness trackers), head mounted displays (HMDs), and dedicated global positioning systems (GPS or Sat Nav). IVTs are embedded in vehicles by the original vehicle manufacturers (OVMs), provide similar functions to portable devices and, in some cases, include driver assistance systems (DAS) and/or vehicle performance indicators. DAS are still in the early stages of design in Australia and vary in relation to levels of automation (SAE International, 2020). In general, HMI research either: (1) evaluates a particular device’s distraction potential (secondary task cognitive load) compared to baseline (driving only) or (2) makes cognitive load comparisons within and between devices/systems. Although not all studies use theories, models or frameworks, many HMI researchers relate their findings to Wickens’ (1991) multiple resource theory (MRT) and broader definitions of inattention (Kahneman, 1973; Strayer, Cooper, Turrill, Coleman, & Hopman, 2015b). MRT holds that people have limited mental resources and experience performance decrements when engaged in more than one task, particularly when multitasking across visual/manual/cognitive domains (Strayer, 2015). Although engaging in secondary tasks often results in driving performance decrements, the effect can vary in magnitude based on spatial and temporal considerations (Biondi, Getty, Cooper, & Strayer, 2019; Christoph, Wesseling, & van Nes, 2019; X. Li, Oviedo-Trespalacios, & Rakotonirainy, 2020; Simmons, Caird, & Steel, 2017).

HMI and driver self-regulation

Examples of temporal and spatial considerations include choosing to use a GPS device before embarking on a drive, slowing down to check the GPS display, or choosing to use an HMI device when a stopped at an intersection (Grahn & Kujala, 2020; Knapper, Van Nes, Christoph, Hagenzieker, & Brookhuis, 2016; X. Li, Vaezipour, Rakotonirainy, & Demmel, 2019). These compensator, or self-regulatory, actions imply drivers adjust their driving behaviour to compensate for a perceived risk of collision. Notwithstanding these behavioural modifications, research shows driving performance may be affected due to cognitive ‘switch cost,’ or the time it takes to mentally return to the primary driving task (Strayer et al., 2015b). Strayer et al.

(2015b) found that switch-cost was unexpectedly long after engaging with technology (approximately 18 seconds). This finding is consistent with earlier cognitive experiments (Rogers & Monsell, 1995) however the time delay is much longer after complex technology-based distractions (Suh & Ferris, 2019).

Another important safety concern is how drivers' self-regulatory behaviours affect surrounding traffic flows. A recent study (X. Li et al., 2020) used detection response tasks (DRTs) that tracked physiological effects following engagement with particular technologies (i.e., making a voice call, texting, GPS navigation). The study found drivers often slowed the vehicle too far in advance, waited too long at intersections, and kept an unnecessarily long gap between themselves and the vehicle in front after engaging with technology (X. Li et al., 2020). These exaggerated behaviours may have the unintended effect of impeding efficient traffic flows or causing a rear-end or lane departure crash. Haigwara and colleagues (2016) found that when drivers performed visual/manual tasks with high cognitive complexity their headway distance and laneway deviations were more erratic than the baseline condition. Intuitively, these finding makes sense and confirm the principles within Wickens' Multiple Resource Theory (1991) that suggest overloading a cognitive domain produces efficiency decrements. Interestingly, compensatory behaviours were recorded even when there was no visible hazard or surrounding traffic, suggesting complex secondary tasks may result in 'mind wandering' or longer term cognitive inattention (X. Li et al., 2020).

HMI emerging technologies - Voice recognition (VR) and heads-up displays (HUDs)

To counteract the distraction potential of complex visual/manual tasks, technology manufactures are beginning to use sensory feedback, voice recognition (VR) systems, wearable head mounted displays (HMDs), and in vehicle heads up displays (HUDs). Portable HMDs are designed to reduce total-eyes-off-the-road (TEOTR) time by displaying safety (e.g., speed limits) and navigational information at the driver's eye level (Sun, Wu, & Spence, 2015; Tippey et al., 2017; Wu et al., 2016). In vehicle HUDs effectively function in the same way by projecting information onto the front windscreen, usually at or slightly below, the line of normal forward roadway vision.

In principle, these systems result in less TEOTR, a major safety benefit. However, an increasing body of research argues VR systems and HUDs may increase cognitive load and therefore increase driver distraction (Mehler et al., 2016). A recent meta-analysis of 43 studies found that while VR systems reduce combined visual/manual tasks, system inaccuracies often result in lengthy feedback delays (Suh & Ferris, 2019). Feedback delays occur when driver requests take a longer than expected time to register and give visual, auditory, or tactile feedback. In a study by Simmons et al. (2017), drivers were often asked to repeat information or were 'misheard' by the system requiring the driver to repeatedly glances towards output screens to check system requests, confirm voice commands, and verify system feedback. This visual-auditory overlap or ‘cross-talk’ (Wickens 2003, 2008, 2013 in Simmons et al., 2017) increases cognitive workload, and contributes to ‘inattentional blindness’ (IB) or the so called ‘looked-but-failed-to-see’ driver experience (Desmet & Diependaele, 2019; Sun et al., 2015).

The problem of IB is two-dimensional, i.e., it can occur in both primary and secondary tasks. For example, traffic complexity in the primary visual field (the driving task) may produce IB to the secondary visual task (responding to HMI requests). Nonetheless, when compared with looking down to a GPS mobile phone display, HMDs and VR systems were found to cause less lane departures or potential collisions (Wu et al., 2016). In a slightly more complicated study, Tippey et al. (2017) designed a texting task with four conditions; (1) a voice to text input condition using a Google Glass HMD, (2) a voice activated smartphone condition, (3) a handheld texting condition, and (4) baseline (no texting). Measures included lane deviations, brake reaction time, and eyes of the road glances. Unsurprisingly results showed that the baseline (no texting task) consistently outperformed all other conditions, and handheld touch phones were consistently associated with the worst performance. Interestingly, the head up display (Google Glass) and the voice activated smartphone texting task received similar performance measures.

In short, the recent HMI literature suggests that limiting secondary visual/manual tasks and, therefore, total eyes off the road time (TEORT), will reduce driver distraction to a certain extent (J. He et al., 2018). These findings are in broad agreement with Wickens’ Multiple Resource Theory (MRT) that posits visual, verbal and auditory inputs require separate pools of processing resources (or domains). Overburdening a resource domain or ‘cross-talk’ between resource domains (visual, verbal, auditory) has the potential to increase cognitive load leading to driver inattention. However, other research suggests attention is affected by a range of other socioeconomic, psychosocial and intrapersonal factors (Shinar, 2019). These will be discussed in the following sections.

Summary:

To counteract the distraction potential of complex HMI visual/manual tasks, technology manufactures are beginning to use sensory feedback, voice recognition (VR) systems, wearable head mounted displays (HMDs), and in vehicle heads up displays (HUDs). However, increased cognitive workload and ‘cross-talk’ across cognitive domains associated with HMI technologies continues to produce ‘inattentional blindness’ (IB) or the so called ‘looked-but-failed-to-see’ effect. Research suggests some drivers reduce technology use in more complex driving contexts to compensate for a perceived risk of collision.

3.4.2 Technological distraction – Driver Assist Systems (DAS)

DAS include in-vehicle driver assist systems as well as emerging cooperative intelligent transport systems (CITS) that use vehicle to vehicle, and vehicle to surrounding road infrastructure technologies. In-vehicle

DAS are classified into 6 levels of vehicle automation (SAE International, 2020) ranging from no automation (0) to full automation (5). Early stages of CITS are currently in use within light and heavy vehicle fleets (see Section on Commercial Vehicles) and several trials are underway in Australia and internationally that aim to investigate safety benefits for general use.

DAS recent research

In total 19 studies investigated DAS in the 2015-2020 literature. A majority of studies were from the USA (Chang, Boyle, Lee, & Jenness, 2017; Flannagan, Bärgman, & Balint, 2019; Gaspar & Carney, 2019; Kuehn, Vogelpohl, Vollrath, & National Highway Traffic Safety Administration, 2017; Raddaoui & Ahmed, 2020), six were from Germany (Kohl, Gross, Henning, & Baumgarten, 2020; Lubbe, 2017; Naujoks et al., 2017; Weber, Dangelmaier, Diederichs, & Spath, 2020; Zeeb, Buchner, & Schrauf, 2015, 2016), two were from Australia (Cunningham & Regan, 2018; Vecovski, Wall, Young, & Tyler, 2015), three were from France (Benloucif, Sentouh, Floris, Simon, & Popieul, 2019; Hidalgo-Muñoz et al., 2019; Navarro et al., 2017), two were from the Netherlands (Cabrall, Stapel, Happee, & De Winter, 2020; Lu et al., 2019), and one was from Canada (D. He & Donmez, 2019). Most studies used a simulator-based design (Cabrall et al., 2020; Chang et al., 2017; D. He & Donmez, 2019; Kuehn et al., 2017; Lubbe, 2017; Navarro et al., 2017; Raddaoui & Ahmed, 2020; Zeeb et al., 2015, 2016). Some simulator-based studies incorporated qualitative questionnaires and/or surveys (Benloucif et al., 2019; Hidalgo-Muñoz et al., 2019; Lu et al., 2019; Naujoks et al., 2017; Weber et al., 2020). Two studies used naturalistic driving methodologies (Gaspar & Carney, 2019; Kohl et al., 2020). One study trialled a variety of new technologies (Vecovski et al., 2015). Finally, one study reviewed the recent literature (Cunningham & Regan, 2018).

While theories are not commonly used within the DAS literature, Zeeb et al. (2016) applied Wickens' multiple resource theory and malleable attentional resource theory to explain how different secondary tasks impacted driver cognitive workload. The study found that composing an email did not adversely affect driving performance as the task heightened driver alertness and increased driver attentiveness. Similarly, Kohl et al. (2020) related their findings – that visual displays do not adversely affect drivers more than the baseline – to the filter model of selective attention, the attenuated model of attention, and the SEEV model of attention. In general, these theories of selective attention suggest that secondary stimuli can be filtered (sometimes unconsciously) and prioritised. Hence, the frequency of glance behaviour was moderated in accordance with the needs of the driving task. However, both sets of authors warn the studies used driving simulator based experimental designs and therefore may not apply in real world settings (the problem of ecological validity).

Conversely, in their 2018 literature review of DAS technologies Cunningham and Regan (2018), found that all levels of vehicle automation can cause fatigue (through boredom), driver-misprioritised attention (towards a competing driving function like monitoring fuel efficiency), and driver diverted attention towards secondary tasks. DAS technologies have the potential to induce low levels of situational awareness (Naujoks et al., 2017), slower reaction times (Kuehn et al., 2017), more/ longer glances away from the forward roadway (Gaspar & Carney, 2019; D. He & Donmez, 2019; Zeeb et al., 2015), driver confusion (Naujoks et al., 2017), and lane departures (Zeeb et al., 2016). One study showed that DAS was associated with technological system failures resulting in delayed warning (Navarro et al., 2017) while another study argued that persistent and unnecessary alerts can lead to the so called 'cry wolf' effect where too many system warnings result in drivers ignoring auditory and visual alarms (Cabrall et al., 2020). Moreover, in-vehicle voice information systems (IVIS), like calendar and navigation tasks with higher cognitive workload, were found to have longer response times and associated crash risk, than listening to music or informational visual displays (Chang et al., 2017).

In one US study considering future uptake of DAS, younger drivers were found to be more at risk of distraction/inattention than other age groups. Flannagan and colleagues (2019) used the SHRP2 naturalistic dataset to estimate future propensity to engage in secondary tasks with predicted increases in vehicle automation. They found that while older drivers exhibited the most elevated crash odds ratios (OR) for mobile phone use (higher crash risk) this age group rarely used mobile phones while driving. Middle aged driver had the lowest crash OR (lowest crash risk) for mobile phone use while younger drivers were at the midpoint crash OR (mid-level crash risk). However, younger drivers used mobile phones at a consistently higher rate (higher exposure to technology) than the other age groups, increasing their overall crash OR. One implication that can be drawn from Flannagan et al's study (2019) is that as the Australian vehicle fleet rejuvenates (newer vehicles replace older vehicles) with more HMI and DAS technologies on board, this can potentially lead to more secondary task distractions for all age groups. However, as younger drivers tend to interact more with in-vehicle technologies, this younger age group may experience a higher crash risk than older drivers. Section 4.2.4 of this report provides data on the age of the current Australian vehicle fleet.

While the above studies examined potential decrements in driver performance associated with levels of DAS, other studies used experimental designs to test visual/aural/tactile warning systems. For example, in a study comparing HUDs with audio/visual dashboard alerts, Lubbe (2017) found no difference between the two warning systems. However, brake reaction times were much faster (and therefore presumed safer) when either alert system was combined with a brake pulse (tactile) warning. Although these findings are interesting, the study design (driving simulator with a constant speed limit of 30km/h) may limit the applicability in real world settings. Another autonomous driving study examined the efficacy of monitoring requests (MR) and take over requests (TOR) in view of driver response times (Lu et al., 2019). MRs, as the name suggests, are designed to bring the drivers' attention back to the driving task when the vehicle enters a potentially complex driving context (e.g., approaching a pedestrian crossing). In contrast, a TOR is a formal request for the driver to take over control due to a detected safety critical situation (e.g., a child running onto the road). Overall, the drivers responded faster to TOR when preceded with a MR when compared to a test scenario with only a TOR. However, Lu et al. (2019) found that when used on their own MRs delayed driver response times due to a perceived “cry-wolf” effect. In a similar study investigating the effects of continuous lane keeping assist and adaptive lane keeping assist on the driver's response rate, the adaptive system was both preferred by the driver and demonstrated quicker response rates (Benloucif et al., 2019). In this study, the driver eye gaze, eye lid change, blinking, and head position was monitored and triggered the Adaptive Lane Keeping Assist (ALKA) when necessary. However, the authors warn that questions remain about the intrusiveness of monitoring systems.

With higher levels of automated and connected driving, monitoring systems will require constant surveillance of driver attentiveness in preparation for a possible TOR. Two recent studies, a naturalistic driving study (Gaspar & Carney, 2019) and a simulator study (D. He & Donmez, 2019), investigated how drivers deploy visual attention in partially automated vehicles. Gaspar and Carney (2019) found that drivers chose autopilot 79% of driving time and their total eyes of the road time (TEORT) substantially increased when compared to manual driving. Similarly, D. He and Donmez (2019) compared secondary-task behaviours of novice and experienced drivers in two driving scenarios - non automated (manual driving) and automated driving. Predictably, TEORT increased in both age groups during the automated driving scenarios, however novice drivers engaged more frequently with secondary tasks and recorded longer TEORT overall. In a very recent connected vehicles (CV) study, Raddaoui and Ahmed (2020) aimed to quantify the workload demands from DAS systems and found that while weather warnings did not increase visual/cognitive demand, work zone warnings (that inform drivers about approaching work zones and speed reductions) with visual HMI displays overloaded visual/cognitive workload and increased TEORT. Likewise, Hidalgo-Muñoz et al. (2019) found that operating music/radio systems required minimal processing (less driver attention) compared to more complex visual/cognitive displays (more driver attention). These studies highlight the contradictory aims of vehicle automation and connected driving technologies. While HMI and DAS technologies aim to improve road safety by automating certain driving tasks, they have the potential to also distract the driver by continuously providing information about the wider road context.

Summary:

DAS include in-vehicle driver assist systems and cooperative intelligent transport systems (CITS). Research suggests all levels of vehicle automation can cause fatigue (through boredom) and driver-misprioritised attention, although younger drivers were found to be more at risk of distraction/inattention than other age groups. While some DAS have low distraction potential, those with higher complexity overload visual/cognitive workload and increase total eyes of the road time (TEORT). Some research suggests that drivers respond faster to DAS system take over requests (TORs) when preceded with one or more monitoring requests (MR). Conversely, other research shows drivers sometimes experience a “cry wolf” effect if too many monitoring requests are issued.

3.4.3 Multitasking

While this scoping review is focused on driving distraction which, by its nature, includes multitasking activities while driving, this section focuses on the 87 studies that had multitasking as a primary focus of their study. The majority of studies originated from USA (e.g. Fakhrmoosavi, Kavianipour, Savolainen, & Gates, 2020; Kim, Ghimire, Pant, & Yamashita, 2019; Razi-Ardakani, Kermanshah, Mahmoudzadeh, & Transportation Research Board, 2017), 14 studies were conducted in Australia (e.g. Haque, Oviedo-Trespalacios, Debnath, & Washington, 2016; Onate-Vega, Oviedo-Trespalacios, & King, 2020; Wundersitz, 2019), 14 within Europe (e.g. Kountouriotis & Merat, 2016; Lobo, Ferreira, & Couto, 2020; Wandtner, Schömig, & Schmidt, 2018) and two in Canada (Chen, Hoekstra-Atwood, & Donmez, 2018; Nowosielski, Trick, & Toxopeus, 2018). Studies in this area largely use a driving simulator methodology to examine the impact of multitasking on driving safety (e.g. Bowden, Loft, Wilson, Howard, & Visser, 2019; Mulvihill et al., 2018; Onate-Vega et al., 2020). There were also a considerable number of studies which used variants of an in-field driving methodology. Many of these used the SHRP2 data (e.g. Bálint et al., 2020; Owens et al., 2018; Risteska, Donmez, Chen, & Modi, 2018) or used methodologies similar to SHRP2 to collect their own data (e.g. Lobo et al., 2020; Tivesten & Dozza, 2015; Young, Osborne, et al., 2019a). Some studies used a roadside observer design (e.g. Fakhrmoosavi et al., 2020; Kidd & Chaudhary, 2019).

Of the studies examined, phone use was the most frequently studied (e.g. Ebadi, Fisher, & Roberts, 2019; Owens et al., 2018; Xiong, Bao, Sayer, & Kato, 2015). This was done in several ways. Some studies focused exclusively on phone use to the exclusion of all other distraction such as Žuraulis, Nagurnas, Pečeliūnas, Pumputis, and Skačkauskas (2018). This study used a closed driving circuit with participants controlling a vehicle that was sprayed with a special driving coating part way through which significantly reduced the wheels adhesive coefficient. Participants did this both without and with handheld phone use and the drivers’ responses were compared. The results showed that the reaction time of drivers who were speaking on a mobile phone increased by 18.1%. Watson et al. (2016) similarly, when examining the impact of phone use on driving found a reduced reaction time. Like Watson et al. (2016), Fancello, Adamu, Serra, and Fadda (2020) similarly examined mobile phone use with a simulator. The study found the risk of collision increases for all age groups when using different types of smartphones. Their results also indicated that drivers tend to increase their speed during a phone conversation.

However, all the studies above were tested in contexts which are different to normal driving environments and therefore may not reflect the normal behaviour of drivers on the road. This was addressed by some studies using naturalistic data. Young, Osborne, et al. (2019a) used data from the Australian Naturalistic Driving Study in which 346 privately owned vehicles were equipped with Data Acquisition Systems and driven for a period of four months by 346 primary drivers and 33 additional drivers. The study examined patterns of secondary task engagement during everyday driving trips. The study found that while drivers engage in a secondary task every 96 seconds on average, only 5.9% of the secondary task events were associated with a driving incident. This could be explained by the potential use of strategic decision making indicated by drivers being significantly more likely to initiate a secondary task when stationary. This is supported by the work of Oviedo-Trespalacios, King, Haque, and Washington (2017). Oviedo-Trespalacios, King, et al. (2017) used a survey to collect data about mobile phone use, attitudes and risk perceptions. They reported lowering the driving speed and increasing the distance from the vehicle in front were the most popular task-management strategies for talking and texting/browsing while driving. They also reported high rates of secondary task engagement with at least one of every two motorists surveyed reporting engaging in distracted driving.

There was also a significant number of studies which examined cognitive secondary tasks. T. A. Dingus et al. (2019) examined 19,732 control driving periods in a case-cohort data set including cases (crashes) and selected controls (control driving periods). Cognitive secondary tasks were associated with a significantly increased crash risk and were observed in 20.0% of select driving cases. Ebadi, Pai, Samuel, and Fisher (2020) utilised a driving simulator to similarly examine the impact of cognitive distractions, specifically on glances toward hazardous events. They found that distracted drivers made shorter glances when compared with their non-distracted counterparts, which presumably meant that they did not focus on the road as much. This indicated, like T. A. Dingus et al. (2019)'s results, an increased crash risk.

Other studies examined visual or visual-manual secondary tasks. Kountouriotis and Merat (2016) examined the effects of visual and non-visual distraction tasks on driving performance. Thirty volunteers (50% female) participated in a driving simulation. One study condition involved a lead car which is when a vehicle is front and may provide a focus point for the driver. In conditions without a lead car, visual distraction was found to increase variability in both gaze patterns and steering control. However, when a lead car was present there was no significant difference from the baseline measure. There was some crossover of these types of studies with that of cognitive distractions such as Cvahte Ojsteršek and Topolšek (2019). This study evaluated select visual and cognitive distractions utilising a self-report survey. The most negative impact on drivers' perception of changes in the traffic environment resulted from thinking about personal problems, chores, errands and roadside advertisements as well as looking at advertisements and the natural environment. Some of these studies, such as Perlman et al. (2019), combined visual and manual tasks. They examined driver workload, attention, and performance impact on smartphone visual-manual and auditory-vocal interfaces to initiate phone calls on a smartwatch. When compared to using a primary visual-manual interface, auditory-vocal interfaces are generally associated with lower off-road visual demand, lower self-reported workload ratings, and better remote detection task response than. The study also noted some possible advantages for the voice-based smartphone interface over the voice-based smartwatch interface including a shorter task completion time, fewer off-road glances, and a higher successful call completion rate. Bowden et al. (2019) compared cognitive tasks, cognitive + visual tasks and cognitive + visual + manual tasks to each other. The study found each additional level of distraction slowed detection response task response times and increased speed variability during 0–10 s post-distraction. Lane position maintenance from 0 to 10 s post-distraction was only impaired when the distraction included a manual component. Driver employment of multitask strategies was also seen with some drivers reducing speed during the distraction task. However, only drivers in the cognitive + visual + manual condition reduced their speed during the time when distracted. However, all three conditions exhibited some degree of post-distraction impairment.

Auditory tasks (those that involve listening) are another type of multitasking. These tasks tended to have an explicit or implicit cognitive, visual and/or manual element. The auditory studies could be split into two groups. The first being auditory interfaces with technology. Perlman et al. (2019) is an example of this. The second group of studies focused on the potential level of interest of the secondary task and its potential positive impact on driving. Nowosielski et al. (2018) used a driving simulator to investigate whether an audiobook could be used to improve driving performance in under-stimulating environments. It was found that while the effects of secondary tasks such as audiobooks were especially deleterious on the complex drive, on a simple drive listening to an audiobook lead to a faster response time to hazards. Horrey, Lesch, Garabet, Simmons, and Maikala (2017) produced similar results. Response times to critical braking events were longer in the interesting audio condition compared to the boring or no audio condition. However, drivers perceived the interesting material to be less demanding and less complex than the boring audio condition (although the material was described as "objectively matched for difficulty" by the study authors). The researchers also noted drivers exhibited less variability in lane keeping and headway maintenance for both the interesting and boring auditory conditions compared to no audio.

In-vehicle distractions, apart from mobile phones, were also recognised as a source of multitasking. One example of this is in-vehicle controls. Strayer et al. (2015b) found that the cognitive workload of IVIS were found to be moderate to high and the workload experienced by older drivers was significantly greater than that experienced by younger drivers performing the same operations. The study also noted practice did not eliminate the interference from IVIS interactions. There were also long-lasting residual costs after the IVIS interactions had terminated. J. Y. Lee et al. (2018) similarly investigated IVIS but only considered radio interactions. The glance patterns observed in on-road radio tuning experiment produced 2.85–5.00 times more crashes than baseline driving.

Other studies included a longitudinal study by Kidd and Chaudhary (2019) which replicated a 2014 observational study to examine if the prevalence of distracted driving overall and of individual secondary behaviours had changed. There was a 57% increase in the likelihood of mobile phone manipulation in 2018 relative to 2014. However, there was no evidence that distracted driving has become more common in recent years, despite the prevalence of some secondary behaviours changing. Although mobile phone use was frequently observed in 2014 and 2018, collectively, other non-mobile phone secondary behaviours were more prevalent. Risteska et al. (2018), using SHRP2 data, investigated engagement in single vs. multiple types of secondary tasks. The study found engagement in multiple secondary task types is more prevalent in distraction-affected, safety-critical events than base events suggesting it contributed to crash risk. Sanbonmatsu, Strayer, Biondi, Behrends, and Moore (2016) examined the impact of multitasking on self-awareness of performance. Control participants' assessments of the safeness of their driving and general ability to drive safely while distracted were negatively correlated with the actual number of errors made when driving. However, mobile phone participants' assessments of the safeness of their driving and confidence in their driving abilities were not correlated with their actual errors. Thus, it appears that the prevalence of distracted driving has not changed but the types of distractions have. Additionally, drivers do not appear to be accurately assessing how safe their driving is while they are distracted.

Summary:

Mobile phone use is the most frequently studied multi-tasking activity while driving. Studies suggest that using a mobile phone while driving is detrimental to safety. Visual, visual-manual and auditory tasks also distract drivers. However, there is some evidence that certain types of auditory tasks, when used roads that are considered more boring, may increase alertness and thus driving safety.

3.4.4 Prevalence

Of the studies that examine the prevalence of driving distraction, the vast majority were conducted within the USA (e.g. Eluru & Yasmin, 2016; L. Li et al., 2018; O'Connor, Shain, Whitehill, & Ebel, 2017). The next most frequent geographic locations for studies were the UK followed by Germany (three (Horsman & Conniss, 2015; Parnell, Stanton, & Plant, 2018c; Sullman, Prat, & Tasci, 2015) and two studies (Precht, Keinath, & Krems, 2017; Vollrath, Huemer, Teller, Likhacheva, & Fricke, 2016), respectively). Only one occurred within Australia. Similarly, France, Finland, Italy, Norway and Spain each only had one study. Two studies by Woods-Fry et al. (2018) and Ismaeel, Hibberd, Carsten, and Jamson (2020) occurred in multi-national contexts involving Europe. Ismaeel et al. (2020) examined only European countries including the UK, Germany, France, Poland and the Netherlands. Woods-Fry et al. (2018) coded Europe as one group which included Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Norway, Poland, Portugal, Slovenia, Spain, Sweden, Switzerland, the Netherlands and the UK. Ismaeel et al. (2020) found, second only to age, country was the most constant predictor of percentage of secondary task engagement time. The Polish sample had the highest percentage of secondary task engagement followed by the Netherlands, UK, and France. The lowest was Germany. Woods-Fry et al. (2018) found the USA sample was significantly more likely to report they have talked on handheld device while driving and have sent a text or email while driving (49.7% and 35.3 %, respectively), compared to Europe (37.8% and 27.2%, respectively) and Canada (25% and 24%, respectively).

A significant percentage of the studies had age as a focus in identifying probability of driver distraction (e.g. Parnell et al., 2018c; Prat, Planes, Gras, & Sullman, 2015; Sullman et al., 2015). Most of these studies, such as Dozza, Flannagan, and Sayer (2015), had a varied age sample. Their results showed younger drivers were more likely to use a phone while driving, allowed smaller safety margins while using a phone and did not allow as much distance from the middle of the road when compared with older drivers. Parnell et al. (2018c) is another example of differences in driver distraction based on age. They found younger drivers and the middle age male group reported themselves to be more likely to engage with technologies while driving when compared with the older age group. However, they also noted drivers of all age groups tended to report that they are more likely to engage with technologies when stopped at a junction and generally perceived the consequences of their actions to be reduced if they were not performing the act of “driving:. Alternatively, there were studies that focused on one age group. Beck, McManus, and Stavrinos (2019) is one of these studies. It examined attitudes about distracted driving and associated issues with adolescent drivers. They found that the acceptability of handheld phone use increased by 4.7% for every additional month since obtaining a driving permit, males believed they were better at texting while driving and multitasking, and a higher sensation seeking score was associated with greater acceptance of distracted driving behaviours. L. Li et al. (2018) also examined adolescent drivers. They found 38% reported texting/emailing while driving at least once. L. Li et al. (2018) also found that infrequent seat belt users compared with frequent seat belt users and students who reported drinking and driving were more likely to report texting/emailing while driving. Texting/emailing while driving increased substantially with age.

There were also several studies that attempted to divide the prevalence of distraction by type of distraction. Huisingh, Griffin, and McGwin (2015) used a roadside observational approach to examine the prevalence and characteristics of driver distraction. Among those involved in a distracting activity, the most frequently observed distractions included interacting with another passenger (53.2%, where passengers were present), talking on the phone (31.4%), external-vehicle distractions (20.4%) and texting/dialling a phone (16.6%). Prat et al. (2015) used the same methodology and found the most common types of secondary task were conversing with a passenger (11.1%) and talking on a handheld mobile phone (1.3%). However, smoking (3.7%) was also included. These studies occurred in different places with Huisingh et al. (2015) in the USA while Prat et al. (2015) in Spain. Sullman et al. (2015) conducted a study in the UK which shared the same methodology and aims as the studies above. Their results showed the most common secondary tasks being talking to passengers (8.8%), smoking (1.9%), and talking on a hands-free mobile phone (1.7%).

A small proportion of studies intentionally focused on the probability of distraction at specific times or locations. Ismaeel et al. (2020) explored the prevalence and characteristics of engagement in secondary tasks whilst driving through intersections. Nearly one-quarter of the total driving time at intersections was spent on secondary activities. Drivers were less likely to engage with secondary tasks when their vehicle was moving compared to when stationary. Also, drivers tended to perform secondary tasks less frequently at: (1) intersections managed by traffic signs than those controlled by traffic lights, (2) when they did not have priority compared to when they had priority, (3) and in adverse weather conditions compared to fine weather conditions. These results are consistent with Huth, Sanchez, and Brusque (2015)'s study that investigated how drivers used their phones when stopped at red traffic lights. Strategic phone use behaviour was detected for visual-manual interactions. For example, Visual-manual interactions, compared to voice-based phone calls, were more likely initiated when stationary at red traffic light and were usually stopped before the vehicle moved off. Thus, there appears to be some self-regulation of visual/manual secondary tasks. However, despite these self-regulatory behaviours, Eluru and Yasmin (2016) found that any mobile phone use has a negative impact on driving performance, particularly within the critical 'dilemma zone' (the yellow/amber signal) of signalled intersections. The dilemma zone is characterised by driver indecision and may result in either red-light running or an abrupt stop at the intersection. In summary, mobile phone tasks (secondary tasks) divide the driver's available attention resulting in less attention to critical decisions within the dilemma zone (Eluru & Yasmin, 2016).

Only two studies examined the changes over time in distraction with conflicting results. These studies were both focused on mobile phone use, although they used different methodologies making it difficult to directly compare. Oviedo-Trespalacios, Nandavar, Newton, Demant, and Phillips (2019) using a self-reporting survey and two different samples found problematic mobile phone use in Australia increased from the first data collected in 2005. However, White, Hepworth, and Zidar (2018) reported, despite the exponential growth of mobile phones in America, mobile phone-related crashes have remained stable over time when examining 11 years of crash data from Kentucky. Thus, problematic mobile phone use while driving increased in Australia but remained stable in Kentucky.

Summary:

There are a range of activities that distract drivers including mobile phone use, interacting with a passenger and smoking. Interacting with a passenger appears to be the most prevalent distraction. Drivers tend to engage in distracting activities at particular times or locations such as while stopped at an intersection. Research suggests that young drivers are more likely to use a mobile phone or technologies while driving. Mobile phone use appears to be increasing.

3.4.5 Professional and fleet drivers

While a significant proportion of the research is focused on drivers as individuals, there are some studies that consider distraction for those whom the vehicle is a workplace; such as professional and fleet drivers. The majority of the studies that examined distracted driving among the population of professional drivers were conducted in the USA (Claveria, Hernandez, Anderson, & Jessup, 2019; Fitch, Hanowski, & Guo, 2015; Hammond, Soccolich, & Hanowski, 2019; Harland, Carney, & McGehee, 2016; Hsiao, Chang, & Simeonov, 2018; James, 2015; Stavrinos, Heaton, et al., 2016; Swedler, Pollack, & Agnew, 2015; Wehr, 2015; Zahabi & Kaber, 2018a, 2018b; Zahabi, Razak, Shortz, Mehta, & Manser, 2020). One study was conducted in Australia (Thompson et al., 2016), two in Sweden (Iseland, Johansson, Skoog, & Dåderman, 2018; Jonasson et al., 2017) and one in Israel (Zohar & Lee, 2016). Of these 18 studies, six were naturalistic driving studies (Fitch et al., 2015; Hammond et al., 2019; Harland et al., 2016; Iseland et al., 2018; Thompson et al., 2016; Zohar & Lee, 2016), including one that compared two naturalistic driving studies (Hammond et al., 2019), and four were simulator studies (James, 2015; Lenne et al., 2019; Stavrinos, Heaton, et al., 2016; Zahabi & Kaber, 2018a). While simulator studies allow consistent scenarios for participants, they often do not provide realistic driving scenarios. Therefore, there may be limitations regarding ecological validity or how the results transfer to the 'real world'.

Swedler, Pollack, and Agnew (2015) used a mixed-methods approach and surveyed 277 truck drivers and conducted 11 interviews, while Zahabi and Kaber (2018b) used a mixed-methods approach, including a Goals, Operators, Methods, and Selection Rules (GOMS) analysis. Claveria et al. (2019) conducted surveys among 515 truck drivers. Jonasson et al. (2017) conducted an observational study on seven district nurses who visited patients (and therefore drive as part of their normal working days), and Wehr (2015) interviewed 107 police officers (who again drive as part of their normal working day). Both Hsiao et al. (2018) and Zahabi, Pankok, and Park (2020) conducted literature reviews. Different groups of professional drivers were included in the studies, police officers (James, 2015; Wehr, 2015; Zahabi & Kaber, 2018a, 2018b; Zahabi, Razak, et al., 2020), nurses (Jonasson et al., 2017), and school bus drivers (Zohar & Lee, 2016). The largest group examined were truck drivers (Claveria et al., 2019; Hammond et al., 2019; Iseland et al., 2018; Stavrinos, Heaton, et al., 2016; Swedler, Pollack, & Gielen, 2015; Thompson et al., 2016). Hammond et al. (2019), included bus drivers as well truck drivers within their sample. In summary research regarding distracted driving has occurred with a range of professional driver groups and using different research methodologies.

Two different types of studies focussed on mobile phone use: (1) those that used naturalistic data and (2) those that used simulator data. Both types of studies found that visual-manual tasks (texting and driving) impacted the driving task more negatively than mobile phone conversations (Fitch et al., 2015; Stavrinos, Heaton, et al., 2016). Fitch et al. (2015) analysed two naturalistic driving data sets involving commercial motor vehicle and light vehicle drivers. While Stavrinos, Heaton, et al. (2016) completed a driving simulator study with self-reported questionnaires on 50 commercial truck drivers. In the first study, it was found that the two groups, commercial motor vehicle and light vehicle drivers, varied as to how much they conversed on a mobile device but did not vary their engagement in visual-manual subtasks. Furthermore, commercial motor vehicle drivers conversed less frequently as the driving task demands increased, whereas light vehicle drivers did not. This study also found that most drivers decreased speed to compensate for the extra cognitive task (Fitch et al., 2015). While in Stavrinos, Heaton, et al. (2016) study, self-rated optimism bias was positively associated with more speeding, lane deviations, eye glances off the road, and total violations compared to participants who rated themselves as 'somewhat skilled'. Both studies acknowledged their limitations by the small numbers of visual-manual tasks completed (Fitch et al., 2015), and the small sample size (Stavrinos, Heaton, et al., 2016)

The impact of text-based distraction tasks on driving performance was further explored by James (2015) and Hammond et al. (2019). In James (2015) a driving simulator study with 80 police officers, drivers were tasked to follow a lead vehicle while interacting with a Mobile Data Computer. Using a generalised linear mixed-model analysis of driving performance, James (2015) found that officers' distracted driving performance resulted in significantly greater lane deviation, instances of unintentionally leaving the assigned driving lane and braking latency than during non-distracted drives. Hammond et al. (2019) found similar results in their comparison of distracted driving behaviour (not including mobile phone use) of 203 heavy truck drivers and 65 bus drivers. While bus drivers engage in less distracting behaviours than truck drivers, the length of time 'eyes of the road' measures resulted in similar lane deviations for both truck drivers and bus drivers. The difference between the distracting behaviours could be explained by work commitments. Truck drivers use more computer-based devices, such as dispatch systems and calculators, while bus drivers only use intercom systems to interact with passengers.

Hsiao et al. (2018) and Wehr (2015) both studied distracted driving by police officers and other emergency workers. From his review of academic and grey literature, Hsiao et al. (2018) concluded that 'emergency code' culture influences distracted driving. When emergency vehicles are given an emergency code, it allows the driver to exceed speed limits, cross stop sign and red lights, and use sirens and warning lights. The emergency code, coupled with driver overconfidence, intensifies risky behaviour. This risky behaviour is further associated with dual and multi-tasking involving HMI and phones. These findings were confirmed by Wehr (2015), who asked 107 police officers to complete a self-report questionnaire.

The impact of work culture allowing or even re-enforcing the interaction with a device was also explored by Swedler, Pollack, and Gielen (2015) and Jonasson et al. (2017). Swedler, Pollack, and Gielen (2015) surveyed 277 truck drivers and interviewed 11 supervisors and managers, Jonasson et al. (2017) observed 7 district nurses. Both studies found that supervisors, cultural norms, and workforce attitudes influence intentions to engage with work-related HMI and mobile phones. Despite the limitations of small sample size (Swedler, Pollack, & Gielen, 2015) and being difficult to replicate (Jonasson et al., 2017), they concluded that a change of culture or policy frameworks is necessary to reduce interaction with HMI and mobile phones while driving for work.

Claveria et al. (2019) tried to further understand the factors that influence professional drivers to use mobile phones. In this study, 515 truck drivers participated in an online survey. The study found that time management strategies (e.g. such as planning a route in advance and assessing where to park), reduced the occurrence of mobile phone use while driving, as did management policies (e.g. restricting driving hours and mandated rest stops) decrease mobile phone use. Likewise, individuals who received safety training were less inclined to use mobile phones while driving. These findings were similar to Zohar and Lee (2016)'s findings of their naturalistic driving study of 474 school bus drivers. Results showed that a higher-level safety climate mitigated against the effect of driver distraction. The authors further note that a strong safety climate relies on regular social interaction and shared values. Shared values, in turn, are often implemented through organisational safety policies. Both studies reported limitations: Claveria et al. (2019) noted that the self-report study might not reflect actual factors. Zohar and Lee (2016) reflected on the sample size and that not all buses were equipped with cameras.

Iseland et al. (2018) further explored the reason why drivers, in addition to completing work-related tasks, engage in secondary tasks. Using a small naturalistic driving study, including semi-structured interviews and questionnaires of 13 long-haul truck drivers, they found that the drivers engaged in multi-tasking, including mobile phone and vehicle technology use, or because of boredom and need for social interaction. However, technology does lead to distraction. As Zahabi and Kaber (2018b) found in their small study of five police officers, mobile computer technology was the most frequently used by drivers despite it also being the most cognitively demanding secondary task. It required visual, manual, and cognitive tasks, including scrolling through pages, long term memory tasks, and text input. These technologies significantly increased driver distraction (Zahabi, Pankok, et al., 2020). This was confirmed through a systematic literature review and online survey of 81 police officers conducted by Zahabi, Pankok, et al. (2020). However, this study also found that most concerns were related to the location of technology and proposed further development of the guidelines to improve the design. The design was researched in a driving simulator study of 20 police officers by Zahabi and Kaber (2018a). This study found that the different technology designs, standard versus enhanced, did not impact lane deviation or brake time. However, eye tracking measures and secondary task completion time was significantly lower in the enhanced design. Perceived workload and situation awareness was not different across designs (Zahabi & Kaber, 2018a).

One study explored the driver assistance system “Mobileye” to keep the driver safe. In this naturalist driving study of 122 truck drivers, it was found that the assist system had the potential to reduce the likelihood of a crash. However, the system itself was found to be distracting. The researchers suggested that this could be due to optimism bias or the small sample size (Thompson et al., 2016). That distraction and inattention contributed significantly to increased crash risk, particularly, rear-end crashes were confirmed by Harland et al. (2016) after reviewing 247 crash videos involving fleet services drivers.

Summary:

Supervisors, cultural norms and workplace attitudes affect employee intentions to engage with work-related HMI and mobile phones. Truck drivers may engage in mobile phone and vehicle technology use because of boredom or for social interaction. Improving organisational safety climate, employee time management and safety training may make individuals less likely to use mobile phones while driving.

3.4.6 Road advertising or ‘billboards’

Road advertising or roadside billboards have the potential to distract drivers. Table B.6 (see Appendix B) presents the 14 studies included in this review regarding distracted driving and billboards (in the period 2015 to 2020). While most of the published studies were conducted in the USA (Belyusar et al., 2016; Chrysler, Carlson, Brimley, & Park, 2017; Kaber et al., 2015; Stavrinos, Mosley, et al., 2016; Zahabi et al., 2017), there was also research conducted in Israel (Gitelman, Doveh, & Zaidel, 2019; Marciano, 2020; Marciano & Setter, 2017), Australia (Samsa, 2015; Young, Stephens, Logan, & Lenné, 2017), Canada (Chan, Madan, & Singhal, 2016; Walker & Trick, 2019), Italy (Costa et al., 2019) and Slovenia (Topolšek, Areh, & Cvahte, 2016). The study by Marciano and Setter (2017) in Israel utilised a 'text versus graphics' dichotomy hypothesis as a framework for their study (meaning the study focused on what was contained in the roadside advertisement). Several other studies mentioned theories, models or frameworks within the introduction of their paper but did not further apply them (Costa et al., 2019; Walker & Trick, 2019; Zahabi et al., 2017). With the exception of Gitelman et al. (2019) who used a quasi-experimental design and Marciano and Setter (2017) who used a computer–based experimental task, all studies used either a driving simulator (e.g. Marciano, 2020; Stavrinos, Mosley, et al., 2016; Walker & Trick, 2019), naturalistic driving (e.g. Samsa, 2015; Topolšek et al., 2016) or closed course circuit approaches (Chrysler et al., 2017).

The research into the nature and effect of billboard signage on driver distraction is inconclusive. For instance, Belyusar et al. (2016) found that the presence of billboards does result in individuals taking longer glances (measured in seconds) (Belyusar et al., 2016). These findings are supported by Gitelman et al. (2019) who found that the removal of billboards resulted in fewer crashes involving damage to property or injuries to people. When billboards were restored, there was an increase in damage only crashes. However, the presence of billboards also results in less lateral deviation control when compared with on-premise signage (signs used by businesses to advertise their product or service and placed on the site of their business) (Samsa, 2015).

In contrast, Chrysler et al. (2017) found that the display of sponsorship logos on changeable message signs did not result in cognitive distraction, although, they indicated that a further evaluation on open roads (as opposed to a closed driving circuit) was required. Kaber et al. (2015) found that there were minor differences in the amount of time taken to process various types of signage. However, these differences do not translate to decreases in vehicle control. These findings are supported by research undertaken in Australia which identified that there were no differences in average vehicle headway when comparing distraction from static billboards, digital billboards and on-premise signage (Samsa, 2015).

It is possible that there are factors within billboard signage that affect driver distraction. Costa et al. (2019) considered the impact of different types of advertising signs on drivers' visual attention. They found that one of the best predictors of fixation rate and duration (i.e. what the eyes were focusing on and for how long) was the amount of large-size text included in a roadside advertisement. Billboards and vendors' signs tended to have higher textual content that included large-size characters than did the other types of signage such as directional or petrol price signs. They concluded that advertising signs, apart from billboards, could potentially be distracting. A study by Marciano (2020) offers further support for these findings, i.e. billboards that include mostly graphic elements (with limited text) are less distracting that text based billboards. Zahabi et al. (2017) also concluded that signage with pictorial logos were more salient than signs with text-based logos. However, further research is needed in order to identify if sign salience is a factor in distraction.

In a driving simulator study, Chan et al. (2016) considered the effect of billboards that included 'shock value' taboo words (although there were no examples provided in the study) on driver distraction. They identified that billboards that include positive words resulted in drivers travelling at faster speeds. This is consistent with the findings of Walker and Trick (2019) who found that driver speeds were faster when travelling past billboards when compared to the areas without them and Young et al. (2017) who found that drivers focused their attention on billboards when there were fewer driving demands. Additionally, Chan et al. (2016) found that billboards with taboo words appeared to result in better lane control and be more easily recalled. Combined, these studies suggest that drivers may self-regulate their behaviour to limit the effect of distraction from billboards.

There appears to be limited information regarding the effect of signage placement. While Belyusar et al. (2016) were unable, due to the design of their study, to identify whether billboards on the left or right hand side of the road (left hand drive) were more distracting, Brennan, Jesson, and Furlanetto (2019) found that advertisements on the driver's side of the vehicle were looked at significantly more than those on the other side of the road.

Age does not appear to affect how long drivers glance at billboards (Belyusar et al., 2016; Topolšek et al., 2016) or traffic signs (Topolšek et al., 2016). This contrasts with the findings of Stavrinos, Mosley, et al. (2016) who found that adolescents looked at billboards more frequently and for longer when compared with other age groups demonstrating the type of inconsistent findings characteristic in this field of research.

Summary:

There is research evidence suggesting that billboards do distract drivers while other research suggest that billboards do not result in distraction or have limited effect on driving safety. There is a suggestion that billboards that mainly include graphics, as opposed to text, are less distracting. The effect of billboard location and age on distraction is not clear.

3.4.7 Intrapersonal factors and self-regulation

Table B.7 (in Appendix B) lists the 22 studies that examine intrapersonal factors and self-regulation that interact with distracted driving. As with much of the distracted driving research, these are predominantly focused on mobile phone use while driving. As shown in Table 3.2, the studies considered a wide range of factors. They also occurred in a wide variety of places and used a range of methodologies (see Table 3.3).

Table 3.2: Studies examining intrapersonal factors and self-regulation

Factor	Study
Emotional distractions (such as roadside signs that elicit an emotional reaction)	Chan and Singhal (2015)
ADHD	Kingery et al. (2015); Randell, Charlton, and Starkey (2015); Shaw et al. (2019); Stavrinos et al. (2015)
Traumatic brain injuries	Narad et al. (2020); Neyens, Boyle, and Schultheis (2015)
Anxiety	Wong, Mahar, and Titchener (2015)
Personality traits (such as the Big 5 traits including agreeableness, conscientiousness, neuroticism, extraversion and openness to experience)	Braitman and Braitman (2017); Parr et al. (2016)
Mindfulness	Terry and Terry (2015)
Risk perceptions (individual's assessment of risk based on both rational and emotional information)	Rupp, Gentzler, and Smither (2016)
Cognitive dissonance (a situation where an individual experiences conflicting attitudes, beliefs or behaviours resulting in mental discomfort and thus alteration in one of these to reduce discomfort)	Sanbonmatsu, Strayer, Behrends, Ward, and Watson (2016)
Self-regulation (the ability to understand and manage your behaviour and reactions to feelings and things happening around you)	Moore and Brown (2019); Oviedo-Trespalacios, Haque, et al. (2019); Wandtner, Schumacher, and Schmidt (2016)
Self-control (the ability to control behaviours in order to achieve goals)	Meldrum, Boman, and Back (2019)
Cognitive load (the amount of information that be contained in working memory at one time) and working memory	Louie and Mouloua (2019); Nilsson, Aust, Engström, Svanberg, and Lindén (2018)
Aggressive driving	Fountas, Pantangi, Hulme, and Anastasopoulos (2019)
Self-esteem	Lannoy et al. (2020)

Table 3.3: Geographic location and methodology - intrapersonal factors and self-regulation

Country	Studies	Methodology	Studies
USA	Kingery et al. (2015) Neyens et al. (2015); Randell et al. (2015) Stavrinos et al. (2015) Terry and Terry (2015)	Driving simulators	Chan and Singhal (2015); Kingery et al. (2015) Neyens et al. (2015) Stavrinos et al. (2015) Wandtner et al. (2016)

Country	Studies	Methodology	Studies
	Parr et al. (2016); Rupp et al. (2016); Sanbonmatsu, Strayer, Behrends, et al. (2016) Braitman and Braitman (2017) Hayley et al. (2017) Fountas et al. (2019) Louie and Mouloua (2019) Meldrum et al. (2019) Shaw et al. (2019) Narad et al. (2020)		Nilsson et al. (2018) Fountas et al. (2019) Louie and Mouloua (2019) Oviedo-Trespalacios, Haque, et al. (2019) Shaw et al. (2019) Narad et al. (2020)
Australia	Randell et al. (2015) Parr et al. (2016); Wong et al. (2015) Moore and Brown (2019) Oviedo-Trespalacios, Haque, et al. (2019)	Naturalistic driving studies	Randell et al. (2015) Parr et al. (2016);
Switzerland	Lannoy et al. (2020)	Surveys	Terry and Terry (2015) Rupp et al. (2016) Braitman and Braitman (2017) Moore and Brown (2019) Lannoy et al. (2020)
Sweden	Nilsson et al. (2018)	Laboratory studies	Wong et al. (2015) Sanbonmatsu, Strayer, Behrends, et al. (2016) Hayley, et al. (2017)
Germany	Wandtner et al. (2016)	Interviews	Meldrum et al. (2019)
Canada	Chan and Singhal (2015)	Experiment	

Intrapersonal factors impact on distracted driving in several ways. For instance, words that have a negative emotional connotation can reduce a person's ability to drive safely (Chan & Singhal, 2015). Those with a traumatic brain injury have longer and more glances towards tasks while driving when compared with a control group (Neyens et al., 2015). In contrast, Narad et al. (2020) found that a history of paediatric traumatic brain injury did not impact driving performance independent of higher level cognitive skills that are used to control and coordinate other cognitive skills and behaviours.

Individuals with ADHD are more likely to be distracted while driving. For instance, they pay less visual attention to the roadway (Kingery et al., 2015). Randell et al. (2015) in their naturalistic driving study identified that those individuals who do not medicate their ADHD tend to demonstrate poorer observation and gap selection skills and are more likely to travel at speeds higher than the speed limit. However, while control group drivers were able to identify hazards effectively, the response to those hazards were often less effective when compared with drivers who had ADHD. Research suggests that distracted driving impairs the performance of adolescent drivers regardless of whether they have ADHD (Stavrinos et al., 2015). Shaw et al. (2019) identified that drivers with ADHD display more lane position variability than control group drivers when there are roadside distractions. These studies indicated that drivers with ADHD, particularly when they are not taking medication, are more prone to distraction.

Mindfulness may be one way that individuals can manage their distracted driving behaviour. Two aspects of mindfulness, acting with awareness and non-judging of inner experience are negatively associated with near crashes (Terry & Terry, 2015). Moore and Brown (2019) conducted an online survey with 170 participants and identified that individuals with low to moderate levels of mindfulness were more likely to text and drive.

Perceptions of risk are also associated with engaging in distracting tasks while driving. For instance, risk-seeking traits, perceptions of the voluntary nature of the task and previous exposure to distraction influence drivers' engagements in distracting tasks while driving (Rupp et al., 2016).

Personality traits may be important predictors of distracted driving behaviours, although, the specific traits associated with distracted driving may vary across groups. For instance, in older adults, greater extraversion is predictive of greater levels of talking on and interacting with a phone while driving (Parr et al., 2016). Braitman and Braitman (2017) using an online survey methodology identified that extraversion is an indicator of distracted driving including in high-risk situations such as wet weather and in free-flowing, high speed traffic. There is also a relationship between distracted driving and aggressive driving. Fountas et al. (2019) conducted a simulator experiment with 41 participants and identified that distracted drivers are less likely to perceive that they drove aggressively. Drivers who are younger and have higher levels of self-esteem are more likely to engage in dangerous mobile phone use (Lannoy et al., 2020).

Sanbonmatsu, Strayer, Behrends, et al. (2016) identified that many drivers believe they can drive safely while using mobile devices yet lack the confidence in others' ability to do so. Those who believe that they have a stronger ability with their higher level cognitive functions, tend to engage more frequently in distracted driving (Hayley et al., 2017). Similarly, an increased level of cognitive load increases Detection Response Task response times (Nilsson et al., 2018). Louie and Mouloua (2019) investigated the role of working memory capacity in predicting distracted driving performance in a study that used a driving simulator. They identified that the impairing effects of distraction were more pronounced for individuals with low working memory when compared to those with high working memory.

The research regarding self-regulation is relatively consistent. For instance, when drivers have to complete tasks under time pressure, there is a large fall in driving performance. In contrast, when the tasks are completed with no time pressures, there are only small impairments in driving performance (Wandtner et al., 2016). Meldrum et al. (2019) conducted 469 in-person survey interviews and identified that low self-control is associated with higher levels of texting while driving. Oviedo-Trespalacios, Haque, et al. (2019) identified that only a small number of drivers engaged in strategic self-regulation where they pull over in order to use their mobile phones.

Summary:

A wide range of intrapersonal factors including, but not limited to, emotions, ADHD, brain injuries and personality interact with distracted driving. In many cases these intrapersonal factors increase distracted driving. However, it appears that drivers who are able to self-regulate while using their mobile phones have lower levels of distraction.

3.4.8 Behavioural/cognitive theories

While several studies in this scoping review have used theory within their research (e.g. Adeola, Omorogbe, & Johnson, 2016; Kujala, Karvonen, & Makela, 2016; Lawrence, 2015; Lindén et al., 2019), this section focusses on the 18 studies that had theory has a major element of their research project design (see Table B.8 in Appendix B). Although a wide range of theories were considered (see Table 3.4), the Theory of Planned Behaviour was used most frequently. Given the benefits of developing interventions with a theoretical base (Glanz & Bishop, 2010), many of the studies that examined interventions also incorporated theory (e.g. Lindén et al., 2019; Oviedo-Trespalacios, Briant, et al., 2020 See Section 3.4.8). Table 3.5 lists the geographic area the studies were conducted in and the methodologies that were used.

Table 3.4: Behavioural and cognitive theories used in distracted driving research

Theory	Study
Aristotle's conceptualisation of three types of friendship (reciprocal interests, practical and beneficial interactions)	Guggenheim & Taubman-Ben-Ari, 2015
Theory of Planned Behaviour	McDonald & Sommers, 2015; Chen et al. 2016; Rowe et al., 2016; Wang, 2016; Tian & Robinson, 2017; Johansson & Fyhri, 2017; Bazargan-Hejazi et al. 2017; Shevelin & Goodwin, 2019; Oviedo-Trespalacios, Nandavar & Haworth, 2019
General Theory of Crime	Quisenberry, 2015
Attitude functional theory	Wang, 2016
Stages of change model	Sinelnikov & Wells, 2017
Driver behavioural adaptation theory	Oviedo-Trespalacios, et al. 2017
Big 5 personality	Johansson & Fyri, 2017
Perceptual load theory	Murphy & Greene, 2017

Theory	Study
Social norms	Trivedi & Beck, 2018
Prototype willingness model	Preece et al. 2018
Deterrence theory	Truelove et al. 2019
Akers' social learning theory	Tontodonato & Drinkard, 2020

Table 3.5: Geographic location and methodology – studies focussing on theory

Country	Studies	Methodology	Studies
USA	McDonald & Sommers, 2015; Quisenberry, 2015; Wang, 2016; Tian & Robinson, 2017; Sinelnikov & Wells, 2017; Murphy & Greene, 2017; Bazargan-Hejazi et al. 2017; Trivedi & Beck, 2018; Shevlin & Goodwin, 2019; Tontodonato & Drinkard, 2020	Semi-structured interviews	Guggenheim & Taubman-Ben-Ari, 2015; Oviedo-Trespalacios, Nandavar & Haworth, 2019
Israel	Guggenheim & Taubman-Ben-Ari, 2015	Focus groups	McDonald & Sommers, 2015; Truelove, Freeman & Davey, 2019
Canada	Chen et al. 2016	Survey	Quisenberry, 2015; Chen et al. 2016; Rowe et al. 2016; Wang, 2016; Tian & Robinson, 2017; Sinelnikov & Wells, 2017; Bazargan-Hejazi et al. 2017; Trivedi & Beck, 2018; Preece et al. 2018; Truelove, Freeman & Davey, 2019; Shevlin & Goodwin, 2019; Tontodonato & Drinkard, 2020
United Kingdom	Rowe et al. 2016	Driving simulator	Oviedo-Trespalacios et al. 2017; Murphy & Greene, 2017
Australia	Oviedo-Trespalacios et al. 2017; Preece et al. 2018; Truelove, Freeman & Davey, 2019; Oviedo-Trespalacios, Nandavar & Haworth, 2019	Experiment	Johansson & Fyhri, 2017
Norway	Johansson & Fyhri, 2017		

Most of the papers applied theory to distracted driving associated with mobile phones (e.g. C. C. McDonald & Sommers, 2015; Quisenberry, 2015). In some cases, the theory was able to predict a large proportion of the behaviour. For instance, Rowe et al. (2016) identified that the Theory of Planned Behaviour predicted 63% of the variance in intentions to drive while talking on a mobile phone. Wang (2016) found the same percentage for intentions to read or send text messages while driving. When considering a range of mobile phone behaviours such as making or answering phone calls, sending or reading text messages or viewing or posting to social media while driving, Tian and Robinson (2017) found that the Theory of Planned Behaviour predicted between 42% and 58% of intention to engage in the behaviour. The results of Shevlin and Goodwin (2019) and Bazargan-Hejazi et al. (2017) are also consistent with the above. C. C. McDonald and Sommers (2015) suggested that it is a norm for adolescents to connect to technology and, for this reason, interventions that take this into account are more likely to be successful. The Akers' Social Learning theory suggests that perceived benefits is a key explanatory factor for looking at a mobile phone when stopped as it accounts for 18% of the variance (Tontodonato & Drinkard, 2020). The Prototype Willingness Model is also useful in explaining mobile phone use while driving. This model has explained over 30% of the variance in the willingness to text while driving and text while stopped (Preece, Watson, Kaye, & Fleiter, 2018).

Driver behavioural adaptation theory suggests that drivers adjust their driving behaviour when using their mobile phone while driving. For instance, they drive more slowly when using their mobile phone while driving (Oviedo-Trespalacios, Haque, King, & Washington, 2017). Truelove, Freeman, and Davey (2019) used to deterrence theory to examine the use of Snapchat while driving by young people. They found that the traditional legal deterrence variables, such as the certainty, swiftness and severity of punishment by police, did not explain any of the driving behaviour related to Snapchat use. However, those who had friends that had used Snapchat while driving and had been caught were less likely to use Snapchat themselves while driving (vicarious punishment). This contrasts with situations where the driver had been caught and punished themselves for Snapchat use (direct punishment). In these cases, the young person was more likely to use Snapchat while driving.

If looking at introducing interventions to reduce mobile phone use while driving, the stages of change model may assist in identifying who will benefit most from the intervention. Sinelnikov and Wells (2017) identified that those in the pre-contemplation stage (where they do not believe they need to change) did not view distracted driving as a safety concern.

Theory suggests that personality factors are important in the consideration of distracted driving behaviours. For instance, using the General Theory of Crime, Quisenberry (2015) identified, that those with higher amounts of self-control have lower amounts of texting while driving. The Big 5 Personality Model is also a useful explanation for distracted driving. For instance, research suggests that neuroticism predicts distraction (Johansson & Fyhri, 2017). Parr et al. (2016) indicate that in adolescents higher levels of openness and conscientiousness were predictive of greater reported texting frequency and interacting with a phone while driving. Lower levels of agreeableness were predictive of fewer reported instances of texting and interacting with a phone while driving. Extraversion is predictive of distracted driving in high-risk situations such as inclement weather and in free-flowing, high speed traffic (Braitman & Braitman, 2017).

Summary:

Many of the papers that have a behavioural or cognitive theoretical basis apply the theory to mobile phone use while driving. The Theory of Planned Behaviour predicts large amounts of variance in intentions to use a mobile phone while driving. The stages of change model may assist in identifying individuals who will adapt an intervention designed to reduce mobile phone use while driving. Various theories suggest that personality factors are an important consideration in distracted driving.

3.4.9 Sociodemographic factors

Several studies examined the impact of age and gender on distracted driving. As shown in Table 3.6, most studies had a focus on age.

Table 3.6: Studies examining age, gender and distracted driving

Theory	Study
Age	Cuenen et al. 2015; Donmez & Liu, 2015; Engelberg et al. 2015; Hague & Washington, 2015; Hill et al. 2015; Lee et al. 2015; Carney, Harland & McGehee, 2016; Simons-Morton, et al. 2016; Clark & Feng, 2017; Gershon, et al. 2017; Gong & Fan, 2017; Guo et al. 2017; Kidd & Buonarosa, 2017; Mirman et al. 2017; Monroe et al. 2017; Trivedi et al, 2017; Zahabi et al. 2017; Atwood et al. 2018; Carney et al. 2018; Cook et al. 2018; Hill et al. 2018; Lee et al. 2018; Young, et al. 2018; Berenbaum et al. 2019; Gershon et al. 2019; Gliklich, Maurer & Bergmark, 2019; Huisingh, et al. 2019; Calvo, Baldwin & Philips, 2020; Karthaus et al. 2020; Stavrios, McManus & Beck, 2020
Gender	Barr, Kane et al. 2015; Struckman-Johnson, et al. 2015; Tucker et al. 2015

Table 3.7: Geographic location and methodology – studies on age, gender

Country	Studies	Methodology	Studies
USA	Barr, Kane et al. 2015; Engelberg et al. 2015; Hill et al. 2015; Lee et al. 2015; Struckman-Johnson, et al. 2015; Carney, Harland & McGehee, 2016; Simons-Morton, et al. 2016; Clark & Feng, 2017; Gershon, et al. 2017; Gong & Fan, 2017; Guo et al. 2017; Kidd & Buonarosa, 2017; Mirman et al. 2017; Monroe et al. 2017; Trivedi et al, 2017; Zahabi et al. 2017; Atwood et al. 2018; Carney et al. 2018; Hill et al. 2018; Lee et al. 2018; Gershon et al. 2019; Gliklich, Maurer & Bergmark, 2019; Huisingh, et al. 2019; Calvo, Baldwin & Philips, 2020; Stavrios, McManus & Beck, 2020	Survey	Barr, Kane et al. 2015; Cuenen et al. 2015; Engelberg et al. 2015; Hague & Washington, 2015; Hill et al. 2015; Struckman-Johnson, et al. 2015; Tucker et al. 2015; Gershon, et al. 2017; Mirman et al. 2017; Monroe et al. 2017; Hill et al. 2018; Berenbaum et al. 2019; Gliklich, Maurer & Bergmark, 2019; Karthaus et al. 2020; Stavrios, McManus & Beck, 2020
Belgium	Cuenen et al. 2015	Simulator	Cuenen et al. 2015; Hague & Washington, 2015; Clark & Feng, 2017; Zahabi et al. 2017; Karthaus et al. 2020
Canada	Donmez & Liu, 2015; Tucker et al. 2015; Cook et al. 2018; Berenbaum et al. 2019	Secondary data analysis	Donmez & Liu, 2015; Lee et al. 2015; Simons-Morton, et al. 2016; Gong & Fan, 2017; Trivedi et al, 2017; Cook et al. 2018
Australia	Hague & Washington, 2015; Young, et al. 2018	Naturalistic driving study	Carney, Harland & McGehee, 2016; Kidd & Buonarosa, 2017Gershon, et al. 2017; Guo et al. 2017; Atwood et al. 2018; Carney et al. 2018; Lee et al. 2018; Young, et al. 2018; Gershon et al. 2019; Huisingh, et al. 2019; Calvo, Baldwin & Philips, 2020
Germany	Karthaus et al. 2020		

In a simulator study of 32 drivers, Haque and Washington (2015), compared the braking profile of drivers distracted by mobile phone conversations and found those drivers brake faster and more abruptly, especially young drivers. This was contradicted by Clark and Feng (2017) in their simulator study findings of 18 older and 17 younger drivers. Clark and Feng (2017) found that older drivers generally drive slower; however, braked and accelerated more than younger drivers. In a secondary data analysis study, Young et al. (2018), found that while engaging in distracted driving (this was defined as any secondary task), older drivers tended to more self-regulate the type and timing of these tasks, such as spending a shorter time on the secondary task and reducing speed. This correlation between distraction (cognitive) and reducing speed, was also found in Cuenen et al. (2015) simulator study of 52 participants who were drivers aged over 70 years.

Four studies examined crash risk (Calvo et al., 2020; Gershon, Zhu, Klauer, Dingus, & Simons-Morton, 2017; Guo et al., 2017; Huisingh et al., 2019) and one study examined crash type associated with distracted driving (Carney, Harland, & McGehee, 2018). Carney et al. (2018) examined the effect of teen drivers, gender and prevalence on driver behaviours on crash rate through secondary data analysis of 412 rear-end crashes. In this study, it was found that in 76% of rear-end crashes drivers engaged in some type of potentially distracting behaviour, of these 95% were due to operating or looking at a mobile phone, 17% were from out of the vehicle distractions and 16% were due to passengers. One third of the crashes had a least one passenger; however, no differences between male or female drivers were found (Carney et al., 2018).

Calvo et al. (2020) and Guo et al. (2017) compared four similar age groups and looked at the effect on driver distraction and crash risk. Guo et al. (2017), using a naturalistic driving study of 3,542 drivers, and Calvo et al. (2020), using secondary data analysis of 2,139 drivers had different findings. Both studies found that secondary task-induced distraction increased risk for drivers younger than 30 years of age and above 65 years of age compared with middle-aged drivers (Calvo et al., 2020; Guo et al., 2017). However, senior drivers engaged in secondary tasks much less frequently than their younger counterparts (Guo et al., 2017). However, Calvo et al. (2020) also found that older drivers are not as at risk of being injured in a distracted driving crash as previously thought. Some explanations could be exposure to risky driving scenarios or a difference in an age group's ability to conduct specific secondary tasks compared to others (Calvo et al., 2020). This coincides with what Guo et al. (2017) found, high visual and cognitively demanding secondary tasks, such as mobile phones, affected drivers of all ages; however, middle-aged drivers were less affected. Huisingh et al. (2019), using the same secondary data as Guo et al. (2017), examined the association between secondary task involvement and risk of crash and near-crash involvement among drivers over 70 years of age. They found that phone use was associated with almost a fourfold increase in the likelihood of having a major crash, and other glances into the interior of the vehicle were associated with an increased risk of having a near-crash event, at almost 2.5 times more (Huisingh et al., 2019). However, older drivers were associated with a decreased risk of crash from out of the vehicle distractions (Huisingh et al., 2019). Among newly licensed drivers, Gershon et al. (2019) similarly found that using a mobile phone and reaching for objects increased crash risk. The risk was increased because of the driver taking their eyes of the road and the physical demands of operating the phone and additional cognitive load it required (Gershon et al., 2019).

In summary, the research indicates that age and distracted driving interact in different ways. For instance, all age groups engage in secondary tasks while driving. However, it appears that older drivers may self-regulate when and how they engage in these tasks. The type of distraction also appears important with older drivers less likely to crash when the distraction came from outside the vehicle. For new drivers, those who use their mobile phones and reached for objects had an increased crash risk.

The outcomes of distracted driving crashes were also considered in relation to driver age. Two studies investigated the predictors that contributed to the severity of driver injuries (Donmez & Liu, 2015; Gong & Fan, 2017). Both studies used secondary crash data, Donmez and Liu (2015), used a USA national data set 2003 to 2009, which was based on police observations, and Gong and Fan (2017) reviewed 55,355 crashes. Gong and Fan (2017) found that young drivers are more likely to be negatively affected by distracted driving behaviours, particularly by passengers in the vehicle, followed by middle-aged drivers; while no statistical relationships were observed for older drivers. Donmez and Liu (2015) reviewed specific distractions and found that talking on a mobile phone was associated with increased odds of severe injuries for both younger and older drivers but was not significant for mid-age drivers. However, for older drivers, the highest odds of severe injuries were observed with dialling or texting on a cell phone, followed by in-vehicle distractions (Donmez & Liu, 2015). Thus, it appears that the type of distraction affects the risk of crashing by age.

Older drivers appear susceptible to distracted driving. For instance older drivers spend a similar time engaged in a secondary task as younger and middle-aged drivers sampled; however, the nature of the tasks that older drivers engaged intended to differ (Young et al., 2018). This is similar to the findings of Clark and Feng (2017). The cognitive abilities of older drivers appears important. Older drivers (61 to 69 years of age), who have higher cognitive abilities, focus on the road more (J. Lee, Mehler, Reimer, Ebe, & Coughlin, 2018). This is consistent with the Calvo et al. (2020) study that identified older drivers might be more vulnerable to crashes due to a functional cognitive decline.

Five studies used surveys to examine the prevalence of texting among drivers. Cook et al. (2018) and Struckman-Johnson, Gaster, Struckman-Johnson, Johnson, and May-Shinagle (2015), examined the frequency of texting, while Atwood, Guo, Fitch, and Dingus (2018) examined the texting rate per hour, Tucker, Pek, Morrish, and Ruf (2015) used two time periods to examine the differences between genders, and Gliklich, Maurer, and Bergmark (2019) compared 225 millennium drivers with 210 older parents. Using a secondary data set, with 557 participants, Atwood et al. (2018) found that the texting rate for young drivers was significantly higher than for those aged 30 to 64 years. Cook et al. (2018) and Struckman-Johnson et al. (2015) found differences in the prevalence of texting while driving among participants. From 1,113 participants Cook et al. (2018) found that at least one-third of the participants, in particular from urban areas, reported writing an email or text message while driving and at least half did so more frequently. However, Struckman-Johnson et al. (2015) found a higher prevalence of texting through a self-reported survey of 515 psychology students. In this study male and females were reported to perceive risk differently. A higher number of women suggested that texting should be illegal and were reported more responsive to peer pressure (Struckman-Johnson et al., 2015). While Struckman-Johnson et al. (2015) did not report differences in gender in texting while driving, except for the length of the text (males texts were significantly longer), Tucker et al. (2015) reported that male drivers have a higher prevalence of texting while driving than female drivers. Gliklich et al. (2019) examined texting among parents and found it common in both millennium and older parents. However, distracted driving in general was higher for millennium parents (Gliklich et al., 2019). Both Cook et al. (2018); Gliklich et al. (2019) found associations between texting and driving with other risky behaviours such as drink and drug driving. In summary, the research indicates that texting is a common behaviour and that it males are more likely to engage in it. However, older people such as parents also text frequently.

Two naturalistic driving studies looked at the type of other secondary tasks (apart from mobile phones) that drivers engaged in (Gershon et al., 2017; Kidd & Buonarosa, 2017). While Gershon et al. (2017) studied the prevalence of types of secondary tasks among 83 newly licensed drivers, Kidd and Buonarosa (2017) examined the differences of secondary tasks of 148 drivers, divided into four age groups, from teenagers to older drivers. Gershon et al. (2017) found that the most prevalent types of secondary tasks were interaction with a passenger, talking/singing (no passenger), external distraction, and texting/dialling. Kidd and Buonarosa (2017), examined the differences across age groups and found that engagement in a secondary task was statistically significantly lower for middle-aged drivers and older drivers relative to teenage drivers. Teenager drivers were more likely to be engaged in singing or whistling or conversing with passengers, while the other age groups were significantly more likely to engage in mobile phone conversations than teenagers. Young adult drivers were more likely to engage in interacting with a portable device (Kidd & Buonarosa, 2017).

Environmental conditions (e.g., complex roads, low lighting) did not change the amount of secondary tasks young drivers engaged in (Gershon et al., 2017), nor did speed (Kidd & Buonarosa, 2017). Secondary task engagement was more common among drivers who had regular access to a vehicle, when driving alone, and when peers considered it acceptable, friends' engaged in risky driving behaviours, or parents had minimal limitations (Gershon et al., 2017). The association between risky behaviour and distracted driving was also found by Simons-Morton, Li, Ehsani, and Vaca (2016), Monroe et al. (2017), and Stavrinos, McManus, and Beck (2020). Simons-Morton et al. (2016) found that this association was stable over time. Karthaus, Wascher, Falkenstein, and Getzmann (2020) compared visual and sound distractions in a simulator exercise of 89 drivers and found that visual distractions had a stronger impact while middle-aged drivers were better at managing the distraction (Karthaus et al., 2020). Therefore, there are a wider range of distractions than mobile phones and these interact with older and younger drivers in different ways.

Peer pressure on texting while driving was further examined by Trivedi, Haynie, Bible, Liu, and Simons-Morton (2017), through a secondary data analysis of a self-reported survey of 212 young drivers and 675 peers. In this study, it was found that texting among peers was significantly associated with texting among young drivers (Trivedi et al., 2017). In their survey of 2,001 youth and young drivers, Berenbaum, Harrington, Keller-Olaman, and Manson (2019) found that participants who perceived themselves as skilled at texting while driving, were more likely to engage in this activity. They also found social norms and perceived behavioural control reduced texting while driving; however, perceptions of others was still a significant factor in whether to engage in texting. Risk perception did not impact on texting while driving (Berenbaum et al., 2019). This (over)confidence in driving abilities was also examined by Barr et al. (2015), in their survey of 756 high school students.

The perception of being a capable driver when using a mobile phone, either hands-free or handheld, or completing another task was found among older drivers over 65 years and those 18 to 29 years of age (Hill et al., 2018; Hill et al., 2015). Hill et al. (2018) reported that 60% of older adults used their mobile phone while driving at least some of the time. In comparison to Hill et al. (2015) findings in their survey of 4,964 college and university students, where 91% of respondents used a mobile phone while driving (talking and texting), and 66% reported that they were better drivers than their peers and better able to drive distracted (Hill et al., 2015). These “better” drivers reported more mobile phone use while driving than less confident drivers, and the perceived safety of multitasking while driving was a strong inverse predictor of distracted driving (Hill et al., 2015).

Work obligations were found to be a significant factor in using a mobile found while driving (Engelberg, Hill, Rybar, & Styer, 2015; Hill et al., 2018). Hill et al. (2015) found 30% of those who work felt obligated to take work-related calls, this together with over-confidence in driving ability were self-reported contributing factors to using a phone while driving (Engelberg et al., 2015). Engelberg et al. (2015) suggested that there is a potential here to intervene at the workplace, similar to what students suggested in Hill et al. (2015), that insurance penalties, the cost of citations, added points to their driving records, and license suspension could be effective interventions as well as attendance of an educational class for distracted driving violators.

Summary:

Regardless of age, distracted driving increases crash risk for drivers. However, there is some indication that middle-aged drivers may be less affected, although, these findings are not consistent throughout the literature. The effects of gender are inconclusive. For instance, some studies find no differences in texting behaviour based on gender while others find that males have higher rates of texting when compared to female drivers.

3.4.10 Legislation and enforcement

In some jurisdictions, laws have been implemented to reduce distracted driving, particularly as it relates to mobile phones. When coupled with enforcement, legislation has been effective in creating behaviour change in areas such as drink driving and speeding (Bates et al., 2012). As shown in Table B.10 (in Appendix B), there has been limited research into driver distraction laws and regulations with just 16 papers published between 2015 and 2020. Most of the research has been conducted in either the USA or Canada (e.g. Flaherty, Kim, Salt, & Lee, 2020; Lyu, Jewell, Cloud, Smith, & Kuo, 2019; Pope, Mirman, & Stavrinos, 2019; Rudisill, Zhu, & Chu, 2019; Zhu, Rudisill, Heeringa, Swedler, & Redelmeier, 2016), with only one study conducted in the UK (Parnell et al., 2017). No studies have been conducted in Australia.

Most of the papers were focused on examining distracted driving laws as they related to mobile phones. Lyu et al. (2019) did identify that there were several distractions beyond mobile phone use including talking to other passengers, adjusting devices used to play music in the vehicle and adjusting other car controls. A number of methodologies were used to examine distracted driving laws including self-report surveys (e.g. Carpenter & Nguyen, 2015; Qiao & Bell, 2016; Rudisill, Smith, Chu, & Zhu, 2018), media analysis (Brubacher et al., 2016), systematic literature review (Ehsani, Ionides, Klauer, Perlus, & Gee, 2016), secondary infringement data (Rudisill & Zhu, 2016), observational studies (Rudisill & Zhu, 2017; Zhu et al., 2016), accimap analysis (Parnell et al., 2017) and secondary crash data analysis (Flaherty et al., 2020).

The studies suggest that bans on the use of handheld mobile phones while driving use for most groups (Carpenter & Nguyen, 2015; Flaherty et al., 2020; Rudisill, Smith, et al., 2018; Rudisill & Zhu, 2017; Rudisill et al., 2019) with the possible exception of sub-groups including rural drivers (Rudisill, Chu, & Zhu, 2018) or those who were 51 years of age or older (Carpenter & Nguyen, 2015). In some cases, there was a suggestion that these types of laws were more beneficial for female drivers (Rudisill & Zhu, 2017), younger drivers (Zhu et al., 2016) and those with higher levels of education (Carpenter & Nguyen, 2015). However, Ehsani et al. (2016) suggest, following their systematic review of the literature, that there is no sustained reduction in mobile phone use following the introduction of a mobile phone restriction for drivers who were younger than 25 years of age.

The research regarding the effectiveness of laws preventing texting while driving is less clear. When examining laws that specifically aim to prohibit texting while driving, Qiao and Bell (2016) found that these laws can significantly reduce this behaviour for high school students on a restricted licence. Flaherty et al. (2020) found that they lowered the numbers of fatal crashes for young drivers. Recent research conducted in Canada also suggests that texting while driving decreases following the introduction of enhanced penalties, public education and increased enforcement efforts (C. M. Wickens et al., 2020). In contrast, Rudisill, Smith, et al. (2018) did not identify any benefits for texting laws for drivers aged 16 to 18 years of age. Research with lower-income clients of three public health centres within Los Angeles, just after the introduction of laws to prevent distracted driving, identified that mobile phone use and texting were predictive of an increased number of crashes in the 12 months prior to the survey (Lyu et al., 2019). Another study confirms that laws that ban texting behaviours while driving do not reduce this behaviour (Rudisill et al., 2019).

Rudisill and Zhu (2017) examined drivers who received tickets for mobile phone use while driving in 14 states and the District of Columbia within the USA. They identified that the most common type of ticket issued to drivers is for handheld mobile phone use. They also found that males received more tickets than females. However, tickets for mobile phone use were 1% of all traffic citations suggesting that the enforcement of these types of laws is limited.

The enforcement of distracted driving legislation was studied far less frequently than the impact of the existence of these laws. Nevin et al. (2017) conducted focus groups with 26 active law enforcement officers from three large Washington counties. While it may be difficult to generalise the results from this study, they suggested that the enforcement of distracted driving laws would benefit from dedicated traffic patrols, improvements in legislation and ensuring that young officers were engaged and motivated to enforce distracted driving laws. The study also identified that there may need to be cultural changes within the organisation as officers self-reported their own distracted driving behaviours within the focus groups. Rudisill, Baus, and Jarrett (2018) also conducted focus groups with 19 police officers over the age of 18 years and employed for more than one year in five West Virginia law enforcement agencies. They had similar findings regarding the barriers to enforcement of distracted driving legislation including cultural norms, lack of perceived support from courts and/or judges, different laws between states, the need for a general distracted driving law, unclear legislation, wanting to maintain a positive relationship with the public, being unable to see the driver, the multiple functions of phones and lack of resources.

Flaherty et al. (2020) used secondary fatal crash data from the USA to explore the impact of enforcement of mobile phone distracted driving legislation. Whether police officers are able to undertake primary (pull the driver over and issue a ticket for the offence directly) or secondary (only able to issue a ticket after the driver has been pulled over for another offence) appears to affect the number of fatal crashes involving 16 to 19 year old drivers. They found a 29% lower rate of fatalities associated with police officers undertaking primary enforcement for text messaging bans. There was a 20% lower rate of fatalities associated with the secondary enforcement of either hand held mobile phone use or a texting ban. Parnell et al. (2017) also concluded that enforcement was required to support the legislation.

When examining public support for new driver distraction laws in British Columbia, Canada, Brubacher et al. (2016) found that most mainstream news media articles that he and his colleagues examined in their analysis were either in favour of the new laws or did not mention the new laws. Pope et al. (2019) conducted a self-report survey with adolescents aged 15 to 19 years from the southeast region of the USA. They found that there was stronger support for a law that prevented reading and sending a text or email while driving compared to laws preventing drinking and driving and speeding. There was also support for a limit on hand held mobile phone use while driving. Females were two times more likely to support a ban on reading and sending a text or email while driving when compared with males.

Most distracted driving legislation research focusses on mobile phones and it appears that the introduction of these types of laws does reduce hand held mobile phone use while driving for most groups of drivers. However, the benefits of legislation regarding texting and driving is less clear. There is also limited research regarding how to most effectively enforce these laws in order to maximise their benefits. Additionally, many of the studies did not examine the impact of these laws, or the enforcement of these laws, on crashes. While Flaherty et al. (2020) did consider the impact on crashes, due to the limitations of the available data, they focused on fatal crashes only and did not include injury or property damage only crashes.

Summary:

Most distracted driving legislation research focusses on mobile phones and it appears that the introduction of these types of laws does reduce hand held mobile phone use while driving for most groups of drivers. However, the benefits of legislation regarding texting and driving is less clear. There is also limited research regarding how to most effectively enforce these laws in order to maximise their benefits. Additionally, many of the studies did not examine the impact of these laws, or the enforcement of these laws, on crashes.

3.4.11 Perceptions and self-reported behaviour of driver distraction

While there are other papers throughout this report that provide information regarding participants' perceptions of distracted driving and the countermeasures associated with this behaviour (e.g. C. C. McDonald & Sommers, 2015; Oviedo-Trespalacios, Briant, et al., 2020; Truelove et al., 2019; Watters & Beck, 2016), this is the primary focus of the eight papers within this section. As shown in Table B.11 (in Appendix B), most of the research in this section was conducted in either the USA (Kim et al., 2019; Mikoski, Zlupko, & Owens, 2019; Zhu, Rudisill, Rauscher, Davidov, & Feng, 2018) or the UK (Parnell, Stanton, & Plant, 2018b; Rolison, Regev, Moutari, & Feeney, 2018; Wells & Savigar, 2019) with one study conducted in each of Spain (Prat, Gras, Planes, Font-Mayolas, & Sullman, 2017) and Australia (Oviedo-Trespalacios, 2018). Just over half of the papers referred to a theory, model or framework within their research (Mikoski et al., 2019; Oviedo-Trespalacios, 2018; Parnell et al., 2018b; Prat et al., 2017; Wells & Savigar, 2019).

Prat et al. (2017) conducted semi-structured interviews with 426 drivers in Spain. Their research identified that the most reported, unprompted, distraction mentioned by drivers was looking at events or objects outside the vehicle and mind-wandering while the least common distraction was smoking. They also identified that drivers understand the risks associated with distracted driving but continued to engage in those behaviours.

Oviedo-Trespalacios (2018) also had a reasonable sample size for his survey of 484 drivers who self-identified as either using their mobile phone to text or browse while driving. Although there may be potential bias due to the self-report method used, the study identified that higher perceived crash risk was associated with higher self-reported incidence of texting and/or browsing. This is despite higher perceived crash likelihood being usually associated lower rates of texting and/or browsing. Oviedo-Trespalacios (2018) suggested this may because some drivers have a high self-assessment of their ability to multitask or some drivers engage in workload management strategies in complex driving situations. The use of self-regulation as a strategy to manage multi-tasking behaviours while driving was also found by Parnell et al. (2018b) in their naturalistic driving and simulator study with 12 participants. They found that self-regulation was highest when driving in complex road infrastructure.

A study conducted by Rolison et al. (2018) compared the views of the general public and police officers within the UK on the causes of crashes using hypothetical crash scenes. The results suggested that both groups had broadly similar views and concluded that drugs, alcohol and, to a lesser extent, distraction were noted as contributing to crashes for young drivers. Wells and Savigar (2019) also had drivers and police officers as participant within their study. The data that they collected through interviews was analysed using an inductive thematic analysis. They identified that the use of a handheld mobile phone while driving is subject to a range of influences, apart from the law. For instance, they may use their mobile phone because they believe they are acting legally, because they do not endorse to the logic of the law, they believe it is unlikely they will be caught or because they do not think they will cause harm to others.

Zhu et al. (2018) used a Delphi technique with road safety experts and young drivers to identify their perceptions of important indicators for mobile phone use with young drivers. The road safety experts found that the top indicators for mobile phone use was sending a text or email, handheld mobile phone use, reading a text or email, handheld dialling and looking down while driving. This is consistent with what was found by the young drivers except they identified playing music on handheld devices as the second most important indicator of handheld mobile phone use. A key limitation of this study is that only seven young drivers were included in the sample compared with 22 road safety experts. The findings of Mikoski et al. (2019) are consistent with the study above as their cross-sectional self-report survey identified that listening to music was rated the lowest in terms of distraction.

A self-report survey study conducted in the USA with 321 drivers aged 19 to 80 years of age found that there was little difference between young (57%) and older drivers (60%) phone use while driving (Kim et al., 2019). The self-reported rates of use were similar for both genders. Mikoski et al. (2019) also found in their survey of 492 people that there was no difference between age groups.

There was a suggestion that there was a need for more qualitative research in order to understand the decision-making processes of drivers (Oviedo-Trespalacios, 2018) and that enforcement for mobile phone bans should increase (Kim et al., 2019).

Summary:

Combined, these studies indicate that the perceptions of drivers regarding distracted driving affect their behaviours. Distracted driving research is only beginning to explore the perceptions and opinions of drivers. Understanding the motivations (and justifications) that lead to driver distraction behaviours will inform effective government and industry-based interventions.

3.4.12 Interventions

Distracted driving interventions can be understood as an action that is taken with the intent of preventing distracted driving.

As shown in Table B.12 (in Appendix B) and Table 3.8, most studies examining distracted driving interventions were conducted in the USA. There were a wide range of methodologies used to examine these interventions (see Table 3.8).

Table 3.8: Geographic location and methodology - studies examining distracted driving interventions

Country	Studies	Methodology	Studies
USA	Creaser et al. 2015; He et al. 2015; Lawrence, 2015; Adeola, Omorogbe & Johnson, 2015; Fournier, Berry & Frisch, 2016; Hurwitz et al. 2016; Joseph et al. 2016; Hassani et al. 2017; Layba et al. 2017; Allee et al. 2018; Dehzangi, Rajendra & Taherisadr, 2018; Delgado et al. 2018; McDonald et al. 2018; Munira, Henk & Tisdale, 2018; Rana et al. 2018; Basch, Mouser & Clark, 2019; Linden et al. 2019; Arslanyilmaz, 2020; Ehrlich, Costello & Randall, 2020; Gaspar & Brown, 2020; Hill et al. 2020; Pettinico & Debevec, 2020; Reagan & Cicchino, 2020	Experiment	Creaser et al. 2015; Lawrence, 2015; Kujala, Karvonen & Makela, 2016; Layba et al. 2017; Dehzangi, Rajendra & Taherisadr, 2018; McDonald et al. 2018;
Canada	Stewart et al. 2015; Merrikpour & Donmez, 2017; Alvarez et al. 2018; Foglia et al. 2020	Simulator	He et al. 2015; Merrikpour & Donmez, 2017; Alvarez et al. 2018; Jung et al. 2019; Arslanyilmaz, 2020; Gaspar & Brown, 2020
Finland	Kujala, Karvonen & Makela, 2016;	Focus groups	Stewart et al. 2015; McDonald et al. 2018; Ehrlich, Costello & Randall, 2020
Australia	Ponte & Baldock, 2016; Thompson et al. 2016; Oviedo-Trespalacios et al. 2019; Oviedo-Trespalacios, Williamson & King, 2019; Young et al. 2019; Imberger et al. 2020; Ovideo-Trespalacios et al. 2020	Surveys	Stewart et al. 2015; Adeola, Omorogbe & Johnson, 2015; Hurwitz et al. 2016; Ponte & Baldock, 2016; Thompson et al. 2016; Hassani et al. 2017; Allee et al. 2018; Delgado et al. 2018; Linden et al. 2019; Oviedo-Trespalacios et al. 2019; Oviedo-Trespalacios, Williamson & King, 2019; Young et al. 2019; Hill et al. 2020; Ovideo-Trespalacios et al. 2020; Pettinico & Debevec, 2020; Reagan & Cicchino,

Country	Studies	Methodology	Studies
			2020
Israel	Albert & Lotan, 2019	Observations	Fournier, Berry & Frisch, 2016; Joseph et al. 2016; Rana et al. 2018
Germany	Jung et al. 2019	Naturalistic study	Albert & Lotan, 2019; Munira, Henk & Tisdale, 2018; Oviedo-Trespalacios et al. 2019; Ehrlich, Costello & Randall, 2020; Foglia et al. 2020
United Kingdom	Digelmann, Ninaus & Terlutter, 2020	Content analysis	Basch, Mouser & Clark, 2019; Digelmann, Ninaus & Terlutter, 2020
		Expert consultation	Imberger et al. 2020

A number of the interventions explored education programs suggesting that they can reduce the number of distracted driving crashes (Layba, Griffin, Jupiter, Mathers, & Mileski, 2017) and increase knowledge of distracted driving (Hill, Rybar, Jahns, Lozano, & Baird, 2020; Lindén et al., 2019). Adeola et al. (2016) used a pre and post survey design with 1,238 young people. They identified that there was an increase in the number of participants who said they were unlikely or not likely to send or reply to a text while driving. Hurwitz et al. (2016) found that after an interactive education program, adolescent drivers were more likely to correctly identify different types of distracted driving with females responding more favourably to the intervention. However, the impact of the program decreases over time. This decrease in effectiveness over time has been found by other researchers examining educational programs (Allee et al., 2018) and is consistent with the work of Hassani et al. (2017) who suggested that there is a need for constant reinforcement of messages regarding the dangers of distracted driving.

There were also interventions that involved community or media campaigns. For instance, one campaign at a university in the USA involved the distribution of thumb bans and a pledge sheet as well as the use of a fear appeal flyer that was distributed around the campus (Fournier, Berry, & Frisch, 2016). The study identified that there was a decrease for drivers talking on their mobile phone but an increase for drivers texting on their phone. Differences were observed for females but not for males. Similar campaigns have occurred in healthcare environments. Joseph et al. (2016) distributed pamphlets and displayed a banner in a hospital cafeteria. Their study identified a 32% reduction in distracted driving. Rana et al. (2018) also found a reduction in the number of distracted drivers following their hospital campaign. However, there were no effects at the one year follow up point.

A qualitative content analysis of British road safety campaigns identified that the enhancement of campaigns could occur by illustrating the success stories of drivers who have found useful ways to change their behaviour and stop using their phone while driving. To enhance response efficacy, the success stories should highlight that the selected strategies have been successful in avoiding the negative consequences of mobile phone use while driving (Diegelmann, Ninaus, & Terlutter, 2020). Interventions should strongly consider using social media. This is because research suggests that social media is more effective than traditional media in attracting attention to intervention websites (Ehrlich, Costello, & Randall, 2020). This is consistent with Basch, Mouser, and Clark (2019) who identified that videos on YouTube regarding distracted driving are popular and therefore may be a successful method of communicating information about this issue. It also appears that distracted driving advertisements that use text held the attention of young drivers for longer (Foglia et al., 2020).

In summary, the research identifies that best practice is to highlight practical strategies that drivers can do to reduce distracted driving. However, the effects of campaigns are likely to decline over time.

Mobile phone blocking technologies (e.g. “Do not Disturb” while driving functions on mobile phones) have been considered by a number of researchers although one study found that only small numbers of people use this “Do not Disturb” technology automatically (Reagan & Cicchino, 2020). The participants in the study by Ponte and Baldock (2016) found that the phone blocking technology used within their study was not reliable but they did consider the technology to be an effective way of preventing mobile phone use while driving. However, a number of participants with one type of technology were de-activating the software. A study conducted in Israel with 167 young drivers found that the drivers self-regulate their behaviour when checking a blocked phone and tend to touch the screen when the vehicle is not moving (G. Albert & Lotan, 2019). However, Delgado et al. (2018) conducted a survey with 153 adolescents who admitted to texting while driving and found that the predominant reason for not wanting to use mobile phone blocking technology was because they did not want their parents to monitor their behaviour. Individuals are also concerned that about being contacted in an emergency (Oviedo-Trespalacios, King, Truelove, & Kelly, 2019). There is some suggestion that females are more likely to install and activate apps designed to reduce distracted driving (Oviedo-Trespalacios, Truelove, et al., 2019) and that psychological theories are useful in assessing the acceptance of these types of technologies by drivers (Oviedo-Trespalacios, Briant, et al., 2020).

Merrikhpour and Donmez (2017) conducted a driving simulator experiment to identify if the provision of normative information (such as what was considered desirable and what was not) reduced distracted driving behaviour. They had 40 parent-adolescent dyads in their study. They found that the provision of social norms feedback decreased brake response time and the percentage of time not looking at the road when compared to the provision of no feedback.

Interventions that use mindfulness, where drivers are attentive to, and focused on, what is currently occurring may have some value in reducing people’s willingness to engage in distracted driving. The use of mindfulness is negatively associated with the frequency of driver engagement in a range of distractions such as talking or texting using a mobile phone, advanced driver assistance systems and non-technological sources of distraction (Young, Koppel, et al., 2019).

Other interventions consider the impact of in-vehicle or wearable technologies. For instance, Kujala et al. (2016) considered the effects of context sensitive distraction warnings. They found that these warnings can help drivers to place more attention on the road but that the gaze tracking technology currently available for use outside research laboratory conditions was highly unreliable and thus may not be effective in “real life” yet. An Australian study found that drivers recognised that various warning systems could improve safety but did not want to use the system because they found it distracting (Thompson et al., 2016). This is consistent with research undertaken in Germany that found that drivers were less likely to accept disabling too many in-vehicle information systems functions while driving (Jung, Kafl, Zapf, & Hecht, 2019).

Technological interventions interact with distracted driving in different ways. It is possible that using Galvanic Skin Responses (a way of measuring intensity of our emotional state) may be a reliable indicator of driver distraction (Dehzangi, Rajendra, & Taherisadr, 2018). Furthermore, reductions in distracted driving occur when incentives (such as points that can be redeemed rewards) are provided for distraction free driving. The distraction free driving was measured through an app (Munira, Henk, & Tisdale, 2018). Additionally, lane departure warnings which indicate when a car is leaving the land that it is driving in, appear most effective when drivers are distracted as it brings their focus back to the road (Gaspar & Brown, 2020). Finally, a hazard warning system that is integrated with a game-based, multi-player, online simulated training application improves the hazard perception skills of novices who are distracted (Arslanyilmaz, 2020). Thus, a game can be used to train new drivers to reduce their level of distracted driving.

Imberger, Poulter, Regan, Cunningham, and Paine (2020) conducted a project to determine the feasibility of developing a test protocol for rating the distraction potential of new vehicles entering the Australian market. They consulted with 27 experts and found that the three assessment methods that are most suitable for a driver distraction safety rating system are a Human Machine Interface design checklist, a

Detection Response Task and a Visual Occlusion Test. This has not been tested in vehicles in Australian conditions.

There are a number of considerations when developing interventions. For instance, steps such as beta and pilot testing allow researchers to see the theoretical and content issues with the intervention (C. C. McDonald, Brawner, Fargo, Swope, & Sommers, 2018). The effectiveness of campaigns can be improved by telling people the benefits and the explanations behind the benefits (Pettinico & Debevec, 2020). The timing of the delivery of interventions is important. Alvarez et al. (2018) used an app intervention to improve driving performance. They found that nearly a third of participants would have preferred to participate on the weekend and just over 40% would have preferred evening sessions.

Summary:

It appears that education programs and community campaigns can reduce distracted driving. However, the impacts of these programs decrease over time. Social media and videos on YouTube may be more appropriate ways to communicate information regarding distracted driving or attract attention to intervention websites. Technology that blocks mobile phone use while driving appears to have potential. Although, only small numbers of people use this technology automatically, it is not always reliable and sometimes drivers de-activate the software and younger drivers do not want parents to use the technology to monitor them. Additionally, while warning systems in cars may improve safety, some drivers do not want to use them because they find them distracting in themselves. Thus, future research should take into account drivers' perceptions.

3.4.13 Methodology

There were nine papers that fitted the criteria of this scoping review that used more innovative methodologies to examine distracted driving (see Table B.13 in Appendix B). These studies were conducted in a range of countries with two conducted in each of the USA (A. D. McDonald, Ferris, & Wiener, 2020; Osman & Rakha, 2020) and Germany (Morgenstern, Wögerbauer, Naujoks, Krems, & Keinath, 2020; Rydström, Aust, Broström, & Victor, 2015). There was one study conducted in Australia (Wijayaratna et al., 2019), Sweden (Ahlström, Wachtmeister, Nyman, Nordenström, & Kircher, 2020), Canada (Hoekstra-Atwood, Chen, & Donmez, 2017), the UK (Merat, Kountouriotis, Tomlinson, Carsten, & Engström, 2015) and Spain (Prat, Gras, Planes, Font-Mayolas, & Sullman, 2018).

As shown with a number of studies in this report (e.g. Catalina et al., 2020; Purucker, Naujoks, Prill, & Neukum, 2017; Wandtner et al., 2016), there has been an extensive use of simulator studies when investigating distracted driving. Hoekstra-Atwood et al. (2017) used a simulator to investigate how involuntary distraction affects individual drivers and whether varying the perceptual load that is present in the driving environment moderates involuntary distraction. As with many simulator studies (e.g. Parnell et al., 2018d; Stavrinos et al., 2015; Vieira & Larocca, 2017), the Hoekstra-Atwood et al. (2017) study had a relatively small sample with 24 participants. They used a within-subjects design where all participants completed four different driving scenarios. The researchers found that perceptual load, which was operationalised as the visual complexity of the road, did not affect involuntary distraction but it did affect driving performance. Likewise, Merat et al. (2015) used a simulator study with a small sample size of 17 participants, concluding that performance on the detection response task (where you need to respond to a stimulus that is presented randomly within 3 to 5 seconds) is sensitive to more difficult driving conditions.

Sometimes a simulator methodology is used in conjunction with other approaches. Within their study Morgenstern et al. (2020) combined their driving simulator method with two laboratory methods. There were 29 participants in this study. The authors concluded that the box task method, in conjunction with the detection response task, could be a cost-effective method of assessing in-vehicle system demand.

Although A. D. McDonald et al. (2020) also used a simulator to collect data, their focus was on identifying the best-performing algorithms for detecting and predicting driver distraction. They considered 21 algorithms within the study and concluded that the Random Forest algorithm, when it was trained using only driving behaviour measures (and therefore excluding driver physiological data) was the highest performing algorithm when identifying driver distraction. Osman and Rakha (2020) used naturalistic data to identify if deep neural network models could be used to identify three distraction tasks: mobile phone calling, mobile phone texting and having a conversation with passengers. They found that these models were highly accurate (100% for calling, 96-97% for texting and 90-91% for conversation) which makes them useful for developing in-vehicle driving assistance technology.

As shown above, many of the methodologies used in this are quantitative. However, Prat et al. (2018) used a qualitative method, semi-structured interview, to collect information regarding self-reported distraction collision and near misses. They had a very large sample size with 426 interviews. Within the sample, 7% of participants reported having a crash while distracted with the most common self-reported distraction being the drivers' own thoughts. This suggests that, while much of the research focuses on distractions such as mobile phones, there is a need to consider distraction in a broader way.

One paper focused on improving the ways in which data was collected. For instance, Ahlström et al. (2020) aimed to develop a custom-made smartphone logging system which would help to identify the prevalence of phone use in different transportation modes, the type of mobile phone apps that are being used and being able to link this different road types. They concluded that mobile phone logging is a cheaper option compared to other research methods and allows the collection of rich and objective data (but only as it relates to mobile phone use while driving). However, the logging system could only be used on Android phones (not iPhones), could not log the use of floating widgets like Facebook Messenger, and research may lag behind the fast-paced development of mobile phone apps.

Another paper attempted to reconcile the differences in findings between simulator and naturalistic driving studies as they related to distracted driving. Wijayaratna et al. (2019) did this by undertaking a comprehensive review of the literature and consultations with human factors experts. They concluded that simulator studies tended to show a degradation in driving performance which suggests that mobile phone use increases crash risk. However, naturalistic driving studies, may at times, suggest that mobile phone conversation reduces crash risk. They suggest that these differences could occur for a number of reasons including: (a) self-regulation where drivers manage their mobile phone use in a real world driving situation to a greater extent (b) arousal where phone conversations in naturalistic driving scenarios is of greater significance which means that drivers engage in greater compensatory behaviours (c) gaze concentration where real-world phone conversations enhance cognitive loading to the point where gaze concentration is improved (d) task displacement where phone conversations in the real world prevent drivers from engaging in other, more risky, activities that are not captured in simulator studies and (e) cognitive loading tasks may impact driving performance in simulators but may not have an impact when driving in an automatic manner which occurs in the real world. The study did not provide detailed information about the experts or their potential differences of opinion.

Summary:

While a range of methodologies are used to investigate driver distraction, there is the possibility to use more innovative approaches. This could help identify both new knowledge and clarify conflicting findings. However, many of the methodologies are quantitative in approach. The use of more qualitative approaches may help explore concepts in greater detail and take human experiences into account.

3.4.14 New direction – “mind wandering” research

Mind wandering (MW) is characterised by becoming distracted from a primary task towards self-generated thoughts and feelings (McVay, Kane, & Kwapil, 2009; Smallwood & Schooler, 2015). Self-generated thoughts may be triggered by external factors (e.g., seeing or hearing something) or may be completely random and unrelated to the current task. When MW is triggered by external factors, it is described as *task related MW*. Conversely, when MR is more random it is described as *task unrelated MW*. MW is a common behaviour with research demonstrating that people MW (cognitive disengagement or daydreaming) for approximately 25% to 50% of their waking hours and switch between MW and external tasks spontaneously (Buckner & Vincent, 2007). In general, MW constitutes a wide-ranging mixture of thoughts about the future and memories from the past with personal relevance (Schooler 2002 in Burdett, Charlton,

& Starkey, 2019). While some research suggests that MW is associated with more negative/depressive psychopathological states (Ottaviani, Shapiro, & Couyoumdjian, 2013), other research finds it can also be associated with more positive mood (Franklin et al., 2013). An interesting aspect of MW is the individual is often not aware they are in a MW state (Smallwood & Andrews-Hanna, 2013). It is this unbidden nature of MW that is of most concern to the driving task. To measure types and levels of MW, researchers use a combination of methods including experience sampling (ES) techniques (usually a combination of self-report questionnaires and the Probe-Caught method), physical response times, eye glances measures, electroencephalography (EEG), and other biological measures (Martens & Brouwer, 2013; Smallwood & Schooler, 2015).

The road safety literature is only beginning to examine the impact of MW on distracted driving behaviours. A very recent study from the USA (Wotring et al., 2020) mined video segments (3 seconds before crash) from the SHRP2 dataset to determine the prevalence of cognitive disengagement (mind wandering/microsleep) in automobile crashes. Wotring and colleagues (2020) found less than 1% of recorded video segments showed evidence of MW. Instead, the authors claimed 72% of high-level crashes were due to drivers' having eyes off the forward roadway while engaged in visual/manual tasks. These findings are technically correct although perhaps deficient due to methodological issues. For example, the limited time window (3 seconds before crash) masks preceding events that may have led the driver to engage with a handheld mobile phone (Shinar, 2019). Thus, study design (methodological limitations) may hide or diminish underlying causes by limiting a study timeframe. Thus, methodological limitations can affect the interpretation of results presented in the study.

Other distracted driving research explores the preconditions for MW while driving. These include boredom (Steinberger, Schroeter, & Watling, 2017), high levels of emotion (Qu et al., 2015), familiarity with a particular stretch of road (Geden, Staicu, & Feng, 2018), and various external stimuli (Burdett et al., 2019). Burdett and colleagues investigated MW in a naturalistic driving study where a researcher accompanied participants on a 25km driving route with 206 predetermined sections. The participants were surveyed at three points during the drive using the Probe Caught method and completed a general questionnaire at the end of the drive. The self-report data were then compared with historical crash data from the same road sections. Results showed that MW occurred on all sections of the drive but more frequently on quieter, less complex road sections. Moreover, the MW triggers were different depending on the complexity of the road environment. On quieter sections of the road, MW sometimes triggered random thoughts (*task unrelated MW*). While on more complex sections, MW was often triggered by an environmental factor (*task related MW*). For example, when a participant drove past food outlets, it triggered thoughts about what they would like to eat. Moreover, the authors suggest that MW may be a precondition for any distracting driving behaviour (Burdett et al., 2019). For example, a driver may think about a family member (task unrelated MW) then look and reach for their phone (visual/manual distraction) to make a phone call. However, when comparing the self-report data to the crash data for the same road sections, results showed that crashes occurred more frequently on complex road sections (intersections, pedestrian crossings, roundabouts) which is commensurate with general road safety crash data (World Health Organisation, 2018).

Several studies have investigated driving outcomes associated with MW episodes (D. A. Albert et al., 2018; Geden et al., 2018; Young, Koppel, et al., 2019). Albert et al (2018) found MW was associated with faster driving, reduced headway distance, slower response times, reduced driver vigilance, and increased crash risk. Conversely, driver speed was lower when drivers were not MW, for example in complex driving scenarios (D. A. Albert et al., 2018; Geden et al., 2018). MW was not moderated by greater working memory capacity (measured through a colour, word inference test) nor greater vigilance (measured by eye glance movements). Interestingly, Albert et al (2018) found that individuals with greater working memory capacity (higher executive control) experienced more daydreaming episodes, perhaps indicating the involuntary nature of MW. Thus, MW is the opposite of mindfulness or "situational awareness" - an individual's mental model of the driving environment at a specific point in time (Young, Koppel, et al., 2019). Steinberger et al (2017) piloted a gamification intervention designed to improve a driver's situational awareness. The app displayed driving speed and fuel efficiency feedback through a dashboard mounted visual display. Although the experimental condition showed improvements in situational awareness (speed was lower, later control was improved, electrodermal activity measures were heightened), participants had lower reaction times than the baseline (no app) condition. The authors contend this unexpected result was due to the nature of the game – e.g., participants were encouraged to aim for fuel efficiency by not braking sharply (Steinberger et al., 2017).

Summary:

The research is only beginning to examine the impact of MW on distracted driving behaviours. Research suggests mind wandering is a common behaviour, occurs spontaneously, and is a precondition for other distracting behaviour. Mind wandering is the opposite of mindfulness or 'situational awareness'. Mind wandering has been associated with faster driving, reduced headway distance, slower response times, reduced driver vigilance, and increased crash risk.

3.4.15 New direction – "Systems" and the Australian "ecosystem approach"

Systems research is an emerging field within the road safety/distracted driving literature (Parnell et al., 2016; Shinar, 2019; Young & Salmon, 2015), although the field has an established history within organisational development (see Section 1: Narrative Review). Broadly, the field is divided into researchers who examine entire sociotechnical systems (STS) and those that focus their enquiry on social contexts. While transport systems have institutional/contextual factors that include road infrastructure, levels of governments (local, state, national, and international), transport organisations and institutions, road laws and regulations, individual professionals/experts, and road users (e.g., vehicle drivers, cyclists, motorcyclists, pedestrians), the transport system also includes more abstract and subjective institutions, for example social norms and values (social context or culture) that underpin driving behaviours. This social context or “traffic safety culture” (Rudisill et al., 2019) is influenced by families, peer groups, employers, and the broader community.

As systems researchers are primarily interested in relationships between individuals, institutions, and infrastructure, research methods are mainly qualitative and include self-report interviews/surveys/questionnaires (Bingham, Zakrajsek, Almani, Shope, & Sayer, 2015; Briskin, Bogg, & Haddad, 2018; Chen & Donmez, 2016; Islam, Thue, & Grekul, 2017; LaVoie, Lee, & Parker, 2016; Massey et al., 2016; Terry & Terry, 2016; Watters & Beck, 2016), literature review and analysis (Parnell et al., 2016, 2018d; Salmon et al., 2016; Shinar, 2019; Young & Salmon, 2015), development of new explanatory models (Parnell et al., 2016; Salmon et al., 2016), and analysis of pre-existing explanatory models (Parnell et al., 2016, 2018a; Salmon et al., 2016; Young & Salmon, 2015). The recent systems literature is divided equally between studies that examine social contexts (Bingham et al., 2015; Briskin et al., 2018; Chen & Donmez, 2016; Islam et al., 2017; Massey et al., 2016; Terry & Terry, 2016; Watters & Beck, 2016) and studies that take the analysis further, examining both formal and informal elements of the transport system (Parnell et al., 2016, 2018a, 2018d; Salmon et al., 2019; Salmon et al., 2016; Shinar, 2019; Young & Salmon, 2015). The division in research approach is split geographically. Social context studies mostly originates in the USA (Bingham et al., 2015; Briskin et al., 2018; LaVoie et al., 2016; Massey et al., 2016; Terry & Terry, 2016; Watters & Beck, 2016), although there is one Canadian study (Islam et al., 2017). Conversely, the recent transport STS research originates in Australia (Salmon et al., 2019; Salmon et al., 2016; Young & Salmon, 2015) and the United Kingdom (Parnell et al., 2016, 2018a, 2018d).

Social context and distracted driving

Social context researchers base their analysis on behavioural and psychosocial theoretical constructs. Bingham et al. (2015) studied 402 parent/teen dyads (couples) to explore gender differences and social influence (social learning theory) on distracted driving. While results did not show substantial differences between genders (for either parents or teens), the study found a strong correlation between parent/teen dyads distracted driving behaviours (phone use, eating, reading directions, phone use). That is, younger drivers often exhibited the same attitudes and driving behaviours as their parents. This contrasted with Chen and Donmez (2016) who explored the influence of social norms, attitudes and perceived behavioural control (theory of planned behaviour) and found young drivers (18-30 years of age) were more influenced by peer groups than their parents. In contrast, peer group influence was less pronounced for older drivers' whose distracted driving habits were connected to impulsive/malleable personality traits (Chen & Donmez, 2016). Similarly, (Briskin et al., 2018) found individuals with calm, controlled, and selfless personality traits predicted less frequent text messaging when compared with higher plasticity personality traits (energetic, assertive). Nonetheless, the study also found that social values and beliefs were underlying influences together with physical proximity of the phone/device (Briskin et al., 2018). Terry and Terry (2016) compared perceptions of crash risk and social norms on (1) driving under the influence of alcohol and (2) mobile phone use. While young drivers perceived both activities as posing a similar crash risk, they believed mobile phone use while driving was more socially acceptable and self-reported high text/phone use. While Watters and Beck (2016) also found peer and social influence were strong influencers, many study participants also claimed 'distraction' was a weak personality trait rather than a behavioural choice, coinciding with findings from Briskin et al. (2018) and Chen and Donmez (2016). Watters and Beck (2016) explain these findings by referring to the 'health belief model', a theoretical framework for investigating cognitive determinants of particular behaviours. The health belief model predicts social norms are underlying, and often unconscious, influences for behavioural choices.

Risk mitigation strategies and self-regulation were also linked to social contexts and sociodemographic factors. LaVoie et al. (2016) compared calling patterns of young and older drivers and found no major difference in phone use, with both groups limiting their calling to close friends and family. While the study was not theoretically based, findings suggest future countermeasures should address underlying perceived obligation to remain available to close social contexts (LaVoie et al., 2016). Conversely, Massey et al. (2016) compared risky phone behaviours in rural and suburban areas. The study found suburban parents used their phones more often, suggesting geographic areas have different perceived risk thresholds that may influence whether or not to use a phone while driving (Massey et al., 2016). In another study that compared sociodemographic factors and traffic safety culture, Islam et al. (2017) found that the perceived threat to personal safety has the largest effect on driving behaviours. Females, older drivers, and parents were more likely to perceive a threat to personal safety than other groups. Nonetheless, most study participants self-reported frequently using a phone while driving as they believed it was (1) a lesser threat to personal safety than other risky driving behaviours and (2) socially desirable/acceptable to be constantly available to close contacts (Islam et al., 2017). These various studies indicate that distracted driving self-regulation and risk mitigation strategies are strongly influenced by social contexts - that is the underlying relationships, social obligations, values and attitudes of specific groups.

Sociotechnical systems

As discussed above and within Section 2: Narrative review of this report, STC researchers explore and build explanatory models that map contextual factors for risky driving behaviours. STC researchers are critical of driver centric approaches to road safety, arguing these are often piecemeal and ineffective (Parnell et al., 2016, 2018a; Shinar, 2019; Young & Salmon, 2015). A recent treatise by David Shinar (2019) argues that the starting point of distracted driving analysis is often anchored on the methodology of specific fields of enquiry rather than addressing the entire transport sociotechnical system. For example, engineers will focus their enquiry on road infrastructure, police enforcement investigate human error, while the field of cognitive psychology examines socioeconomic and/or psychosocial factors to explain distracted driving behaviours. Interestingly, Salmon et al. (2019) found that vehicle drivers also attribute road crashes to individual driver error as they are often unaware of structural factors that may affect road safety.

STS researchers point out that ecological validity (real world settings) in research design should be the standard not the exception. Young and Salmon (2015) argue that knowledge about systemic contributing factors will lead to more effective policy interventions. For example, instead of blaming and penalising the driver for using a particular portable or in-vehicle technology (IVT), a more effective policy may be to regulate the original equipment manufacturers (OEMs), i.e., the mobile phone and IVT makers and distributers. For example, institute laws and regulations that force OEMs to include phone blocking software while driving. Equally, instead of penalising employees who use IVT while driving, the appropriate action may be to change the workplace health and safety (WHS) laws to ensure employers take responsibility for and communicate safe work practices to their employees. The Heavy Vehicle National Law (HVNL) passed in most Australian states is a case in point (National Heavy Vehicle Regulator, 2020). The HVNL law extends responsibility for road safety across the entire heavy vehicle transport system, rather than just to heavy vehicle drivers.

Two sociotechnical models of driver distraction are found in the recent literature, (1) Salmon and colleague’s (2016) *Road transport system operations control structure* for the Queensland transport system and (2) Parnell and colleague’s (2016) *Priority, Adapt, Resource, Regulate, Conflict system model of driver distraction (PARRC)* applied to the United Kingdom (UK) transport system. Parnell’s analysis is grounded in the IVT distracted driving literature while Salmon et al utilised a modified two-round Delphi study with road safety subject experts to explore structural elements of the Queensland transport system. Salmon et al’s analysis suggests the controls/levers in the road transport system are at the level of ‘influence’ when compared with more regulated transport systems like aviation and rail (Salmon et al., 2016). For example, the aviation industry has tighter drug and alcohol controls (and regular testing) and lower allowable BAC levels than the road transport systems. Moreover, Parnell and colleagues found that drivers within the transport system are expected to constantly manage different goals (driving safely, societal pressure to be available to close contacts, employment pressure to finish work tasks) leading to ‘goal conflict’ and continuous decision making or ‘goal prioritisation’. In short, drivers must ‘adapt to demands’ of life/work rather than prioritise safe driving. See Section 2: Narrative review within this report for a more detailed exploration of the STC approach in Australia and the United Kingdom.

Proposed Australian government ‘ecosystem approach’

The Queensland Government (in combination with the Australian Government) has proposed a new ‘ecosystem approach’ to distracted driving that follows general STS principles (Department of Transport and Main Roads, 2019). This framework, “*The National Roadmap on Driver Distraction*”, acknowledges that pressure to stay connected with social networks, employers, and close contacts is constant, particularly for younger age groups. Current technology bans and fines are often ineffective as they penalise drivers rather than addressing these wider societal triggers. Moreover, the evidence shows banning phone use is not working as 76% of Queensland drivers continue to use their phone illegally (Department of Transport and Main Roads, 2017). An alternative ‘semi restricted’ ecosystem approach seeks to amend laws and regulations to align more closely with current societal expectations. An additional aspect of this policy involves partnering with OEMs and employers to develop responsible workplace health and safety (WHS) policies and work practices that minimise distracted driving.

This ecosystem approach rests on five key ideas (Department of Transport and Main Roads, 2019). First, a safety standard for nomadic (portable) devices that ensure safe and consistent interaction with HMI technology when driving. Second, collaboration between Australian governments, vehicle standards organisations, and OEMs to ensure Australia can influence and be informed of future in-vehicle technologies. Third, recognising that in many industries the vehicle is a workplace therefore the regulatory and education approach must be strengthened and formalised with adequate laws and regulations. Importantly, this applies to both light and heavy vehicle fleets. Fourth, strengthening enforcement policies to encourage greater compliance. For example, development of a national camera network designed to detect mobile phone use. Fifth, data sharing across and between jurisdictions (with tight controls and privacy protection) that exploit opportunities presented by big data. An example would be to detect and prevent repeat distracted driving offenders through innovative education campaigns (Department of Transport and Main Roads, 2019).

Summary:

Systems research is an emerging field within the distracted driving literature. The field is divided into researchers who examine sociotechnical systems (STS) and those that focus on social contexts. Research suggests distracted driving self-regulation and risk mitigation strategies are strongly influenced by social norms and contextual relationships. STC researchers explore and build explanatory models that map contextual factors for risky driving behaviours. STC authors suggest one solution to distracted driving behaviour is to change these wider systemic demands/goals. The new Australian Government ‘ecosystem approach’ to distracted driving follows general STS principles.

4. Legislation and policy – consultation with stakeholders

4.1 Introduction

This chapter reports on the results of a policy scan undertaken primarily in the Australian context as it relates to distracted driving. It commences with the identification of relevant legislation within the Australian and selected international jurisdictions before fleshing out the operation of this legislation within Australia. Semi-structured interviews with researchers and practitioners in road safety from Australia and the UK enabled the identification of how the legislation is applied in practice as well as the types of distraction it targets, why mobile phone use is considered the main form of driver distraction, the effectiveness of enforcement, the role that third parties can play in managing driver distraction, and other opportunities to reduce distracted driving and suggestions for research.

4.2 Method

The policy scan involved three components: (a) a desktop search of Australian legislation and policy (b) a review of selected international jurisdictions for their legislation and policy and (c) interviews with both domestic and international stakeholders. Additionally, to gain further understanding of the Australian context, we reviewed Australian motor vehicle census data provided by the Australasian Automobile Association (sourced from the Australian Bureau of Statistics).

4.2.1 Desktop search Australian legislation and policy

A three-step approach was used to identify all Australian legislation and policy related to distracted driving. In the first step, all traffic laws, road rules and regulations in each State and Territory were examined. In the second step, a search was performed on the public information supplied via websites of transport and enforcement agencies in each State and Territory. In the final step, a review of publicly available Work Health and Safety laws and regulations for commercial drivers was conducted.

In the first step, road rules and regulations that applied in each of the States and Territories were examined for the following search terms: 'distracted driving', 'due care and attention', 'mobile phone while driving', 'display units while driving', 'driving with pets' and 'proper control of a vehicle'. The findings are described in section 4.3.1 and Appendix F.

In step two, the websites of each Australian State transport agency and state police agency were examined for enforcement and prevention strategies, initiatives, campaigns and education materials. The search focused on road safety initiatives, particularly those focused on distracted driving and mobile phone use while driving. The results are described in section 4.4 and Appendix H.

Work, Health and Safety laws and regulations in each State and Territory were examined for 'vehicles as a workplace', 'distracted driving' and 'mobile phone use' in the third part. In this final step, each of the State and Territory agencies responsible for Work, Health and Safety policy formulation and enforcement were reviewed for advice, prevention and -enforcement initiatives for distracted driving. The findings are described in section 4.5 and Appendix G.

4.2.2 International legislation and policy

It was outside the scope to review the distracted driving legislative frameworks for all jurisdictions operating within a Western society context. Therefore, we focused on a few jurisdictions with similar road rules, approaches to road safety and prevention as well as those conducting significant research in the distracted driving space. New Zealand, the UK and Canada were chosen because of their Commonwealth connection, while the Netherlands and Sweden were chosen as representative of European jurisdictions with a strong focus on road safety. Canada and the USA were included because of their multiple jurisdictions within one nation, which is similar to Australia.

A search was performed on the public information supplied via websites of transport and enforcement agencies in each nominated country and, if applicable, each jurisdiction. The search was conducted using terms such as ‘road rules in country X’, ‘distracted driving in country X’ and ‘use of mobile phone in country X’. The findings are described in section 4.3.2.

4.2.3 Interviews with stakeholders

The research team was provided with a contact list of stakeholders in seven different categories of road safety. These categories included State and Territory criminal justice agencies, motoring clubs, government agencies regulating safe workplaces, road safety organisations, government transport departments, research entities and private entities with large commercial fleets, as well as research entities and road safety organisations in the UK.

A list was compiled to ensure at least one interview was conducted from each category. Nineteen invitations to participate in a semi-structured interview were sent out across Australia and the UK. Twelve people were interviewed and two agencies provided written responses, with the comment that these represented the view of their team or agency. The results of the interviews are in sections 4.6 to 4.12.

The invitations were sent out with an information sheet and consent form to participate in an interview. Each interview participant was provided with a unique identifier, starting with a ‘P’. Those participants who opted for a joint response were provided with a unique identifier starting with ‘MP’. All interviews were digitally recorded and transcribed in full. The interviews and written responses were subsequently analysed for common themes using NVivo. The interviews were conducted in accordance with the Griffith University Human Research Ethics protocol, reference number 2020/759.

4.2.4 Australian motor vehicle census data

The Australian Automobile Association provided motor vehicle census data at 31 January in 2018, 2019 and 2020 (sourced from the Australian Bureau of Statistics). A summary of this data is provided in Tables 4.1 and 4.2. As can be seen, Australia registered 19,793,497 motor vehicles for road use at 31 January 2020, of these 74.1% were passenger vehicles, and 17.2% were panel vans and utilities.

Table 4.1: Types of vehicles registered for use on Australian roads 2018-2020 (as per 31/1/2020)

	2020		2019		2018	
		(%)		(%)		(%)
Passenger vehicles	14,671,901	74.1%	14,420,444	74.4%	14,132,118	74.8%
Panel Vans and Utilities	3,404,301	17.2%	3,296,345	17.0%	3,134,068	16.6%
Trucks and Prime Movers	639,584	3.2%	620,353	3.2%	590,890	3.1%
Buses > 9 seats	100,328	0.5%	98,280	0.5%	93,663	0.5%
Motorcycles	880,562	4.4%	864,609	4.5%	848,720	4.5%
Other	96,811	0.5%	94,165	0.5%	90,037	0.5%
Total	19,793,487		19,394,196		18,889,496	

Source: Australian Bureau of Statistics (Motor vehicle census data)

As per 31 January 2020, 67.9% off all vehicles were reported as registered in the major cities, and of all passenger vehicles, 72.5 % were reported as registered in the major cities. Utilities and panel vans were reported in the major cities at 52.5% (see Table 4.2). Table 4.2 also shows that almost half of all registered vehicles were over 10 years old (recorded from the year of manufacture) and over three-quarters were over 5 years old. As per 31 January 2020 almost half of all passenger vehicles (48.1%) were over 10 years old and 76.7% were over 5 years old.

Table 4.2: Types of vehicles - location and age (as per 31/1/2020).

	Major Cities		Vehicle age > 10 years		Vehicle age > 5 years	
		(%)		(%)		(%)
Passenger vehicles	10,638,542	72.5%	7,055,186	48.1%	11,244,464	76.6%
Panel Vans and Utilities	1,787,172	52.5%	1,658,381	48.7%	2,559,651	75.2%
Trucks and Prime Movers	342,986	53.6%	387,347	60.6%	509,712	79.7%
Buses > 9 seats	60,107	59.9%	56,587	56.4%	81,499	81.2%
Motorcycles	551,485	62.6%	441,453	50.1%	682,508	77.5%
Other	54,706	56.5%	65,185	67.3%	80,693	83.4%
Total	13,434,998	67.9%	9,664,139	48.8%	15,158,527	76.6%

Source: Australian Bureau of Statistics (Motor vehicle census data)

A substantial number of vehicles are less than one year old, as can be seen from the MarkLines report, published by the Federal Chamber of Automotive Industries. They reported that in 2019 in Australia 779,263 new passenger vehicles, including SUV's were sold, which was similar to the year before (773,713) (Federal Chamber of Automotive Industries, 2019).

4.3 Distracted driving legislation

4.3.1 Australian distracted driving legislation

The review of legislation in Australia identified that there is not a single offence for distracted driving. As can be seen in Table 4.3 (and Appendix F), all States and Territories have legislated for four offences that relate to distracted driving or that can be used for enforcing distracted driving. These offences are applied from the Australian Road Rules (ARR):

- Interfering with the driver's control of a vehicle etc.
- Driver to have proper control of a vehicle etc.
- Television receivers and visual display units in motor vehicles
- Use of mobile phones.

'*Interfering with the driver's contro*l' prohibits a passenger in or on a vehicle from interfering with the driver's control or obstructing their view of the road or traffic. While the offence of *driver to have proper control* states that the driver must have a clear view of the road and traffic ahead, behind and to each side. This includes not driving with an animal on their lap. While neither of these are not specifically designed for distracted driving, they include actions of the driver or the passenger/s that could distract the driver from their driving task.

In addition to these offences, all States and Territories have a further offence that relates to driving without due care and attention. Queensland, South Australia, Victoria, Western Australia and refer to it as *Careless Driving*, while New South Wales refer to it as *Negligent, Furious or Reckless Driving*, the Australian Capital Territory as '*Negligent Driving'* only, and the Northern Territory refers to it as '*Dangerous Driving'*. There are some variations in the interpretation and what the offence code encompasses but they are similar in that it includes a degree of driving without due care and attention; however, it does not necessarily have to include an element of distracted driving. The Northern Territory has extended their legislation to include other road users such as pedestrians and riders (S18 Careless walking or riding).

Table 4.3: Distracted driving offences

State	Legislation	Offences
QLD	Transport Operations (Road Use Management) Act 1995 Transport Operations (Road Use Management–Road Rules) Regulation 2009	S83: Careless driving. S272: Interfering with the driver's control of a vehicle etc. S297: Driver to have proper control of a vehicle etc. S299: Television receivers and visual display units in motor vehicles. S300: Use of mobile phones.
SA	Road Traffic Act 1961 Australian Road Rules (applicable under the Road Traffic Act 1961)	S45: Careless driving S272: Interfering with the driver's control of a vehicle etc. S297: Driver to have proper control of a vehicle etc. S299: Television receivers and visual display units in motor vehicles. S300: Use of mobile phones.
NSW	Road Transport Act 2013 NSW Road Rules 2014	S117: Negligent furious or reckless driving S272: Interfering with the driver's control of a vehicle etc. S297: Driver to have proper control of a vehicle etc. S299: Television receivers and visual display units in motor vehicles. S300: Use of mobile phones.
VIC	Road Safety Act 1986 Road Safety Road Rules 2017	S65: Careless driving S272: Interfering with the driver's control of a vehicle etc. S297: Driver to have proper control of a vehicle etc. S299: Television receivers and visual display units in motor vehicles.

State	Legislation	Offences
		S300: Use of mobile phones.
WA	Road Traffic Act 1974 Road Traffic Code 2000	S59BA: Careless driving causing death, grievous bodily harm or bodily harm. S62: Careless driving. S246: Interfering with driver's control of vehicle S263: Drivers to have uninterrupted and undistracted views etc. S264A: Dogs etc. on motorcycles. S264: Use of visual display units etc. in vehicle. S265: Use of mobile phones
NT	Traffic Act 1987 Traffic Regulations 1999 Australian Road Rules (applicable under S71 of Traffic Regulations 1999, can be found in Traffic Regulations, Schedule 3).	S30: Dangerous driving S15A: Prohibition on mobile phone usage. S18: Careless walking or riding. S272: Interfering with the driver's control of a vehicle etc. S297: Driver to have proper control of a vehicle etc. S299: Television receivers and visual display units in motor vehicles. S300: Use of mobile phones.
TAS	Traffic Act 1925 Road Rules 2019	S32: Reckless driving S42: Use of loudspeakers on or from vehicles S272: Interfering with the driver's control of a vehicle etc. S297: Driver to have proper control of a vehicle etc. S299: Television receivers and visual display units in motor vehicles. S300: Use of mobile phones.
ACT	Road Transport (Safety and Traffic Management) Act 1999 Road Transport (Road Rules) Regulation 2017	S6: Negligent driving S272: Interfering with the driver's control of a vehicle etc. S297: Driver to have proper control of a vehicle etc. S299: Television receivers and visual display units in

State	Legislation	Offences
		motor vehicles. S300: Use of mobile phones

In the legislation, there is a clear distinction between handheld mobile use and hands-free use of a mobile phone (e.g. use of mobile phone through in-vehicle HMI or having the phone in a cradle). The ban of handheld mobile phone use and visual display units are similar across all jurisdictions (further details Appendix F). While the legislation is similar, there are variances in penalties, ban on hands-free use for Learner (L) drivers and Provisional (P) drivers, as well as the definition of a mobile phone (ACT only).

As can been seen in Table 4.4, Queensland has the largest fine, $1,000 and 5 demerit points when caught using a handheld mobile phone, while Tasmania has the lowest with $344 and no loss of demerit points. Most States and Territories have a complete ban on mobile phone use for L and P platers, except for Tasmania and Western Australia. New South Wales, Victoria, Northern Territory and the Australian Capital Territory ban all L and P platers from using all (handheld and hands-free) mobile phone use while driving, while Queensland and South Australia only ban P1 platers.

Western Australia and the Australian Capital Territory have an increased fine for sending, creating, or looking at a text, email social media, photo, video or similar, with Western Australia doubling the fine to $1,000 fine and increasing the demerit points from 3 to 4, while the Australian Capital Territory increases it from $477 to $588, but keeps the demerit points at 4.

The Australian Capital Territory is the only jurisdiction that has extended its definition of mobile phone to include any other wireless handheld or wearable device designed or capable of being used for telecommunication, not including a CB radio or any other two-way radio. This Territory has also added an exception for handheld use for taxis, rideshare or hire cars; as long as the device is used as a drivers aid in relation to the transport of passengers, it is not illegal to use the device.

Table 4.4: Handheld Mobile Phone Use Penalties

State	Fine	Demerit Points	Comments
QLD	$1000	5 Double demerit points for subsequent offence within one year	• Total ban mobile phone use for L and P1 platers under 25 years • Passenger must not use mobile phone in loudspeaker mode when driving by an L, P1 platers under 25 years
SA	$534	3	• Total ban for L and P1 platers

State	Fine	Demerit Points	Comments
NSW	$349 or $464	3 - 5	• Total ban mobile phone use for L and P platers • Increased fine for use in school zone – fine $464 – 5 demerit points/ double demerit points on public holidays
VIC	$469	4	• Total ban on all phone use for L platers, P platers, and motorcyclists who have held a license for less than 3 years. Same penalties apply (maximum 10 penalty units). • The ban includes cyclists, wheeled recreational device, or any other vehicle
WA	$500 or $1000	3 or 4	• Creating, sending or looking at a text, email social media, photo, video or similar: increased fine -$1000 fine – 4 demerit points • Double demerit points on public holidays and special in restricted areas • Exception: use of phone in relation to work by a driver in control of an on-demand vehicle, but not in a restricted area. (On-demand vehicle prescribed under Transport (Road Passenger Services) Act 2018 section 4(1)).
NT	$500	3	• Total ban on all phone use for L platers, P platers • Modification from S86C of Traffic Regulations 1999: mobile phone use is allowed when a car is in stationary in a place other than a marked lane or line of traffic on a road.
TAS	$344	3	
ACT	$477 or $588 (device sending, receiving texts or similar)	4	• A total ban on mobile phone usage for L and P platers • Exceptions: the phone is used to make or receive a call or is a driver's aid, or to play/stream/listen to music/audio files, and is secured in a mounting affixed to the vehicle or does not require the driver to touch the phone at any time, • Exceptions: the vehicle is taxi, rideshare or hire car and the device is used as a driver's aid in relation to the transport of passengers • Increased fine for devising, sending or receiving texts or similar • Has extended its definition of mobile phone to include and any other wireless handheld or wearable device designed or capable of being used for telecommunication; but does not include a CB radio or any other two-way radio

***** Exemptions of mobile phone use for police and emergency vehicles driving. A driver must not use a phone while the vehicle is moving or in stationary mode but not parked.**

In all States and Territories, the ban on handheld mobile phone use extends to include any vehicle. A vehicle is defined as including, a motor vehicle, trailer, tram, bicycle, animal-drawn vehicle, and an animal that is being ridden or drawing a vehicle, a motorised wheelchair that can travel at over 10km/h (on level ground). Queensland, Australian Capital Territory and Victoria, specifically mention a personal mobility device (mobility scooter) as not included in the definition of a vehicle, while the other States and the Northern Territory do not. However, it should be noted that Victoria appears to have some conflicting legislation; s244V to the Road Safety Road Rules 2017 does not allow handheld mobile phone use while riding a personal electronic transporter (mobility scooter), while s15 and s300 of that same Act do not define vehicle as including a mobility scooter. This means that Victoria is the only state that clarifies that you can not use a handheld mobile phone while on a scooter.

4.3.2 International legislation

Nearly all Western jurisdictions ban the use of handheld mobile phones while driving. We reviewed six countries, two with multiple jurisdictions, the USA and Canada (see Table 4.5). New Zealand's legislation is similar to Australia's except that the fine is comparatively low at $80NZD. The Netherlands and the UK have a similar fine to Australia. In the Netherlands, if you are a cyclist the fine is reduced from €240 to €95. However, in the UK and Sweden, enforcement of the legislation is difficult. In the UK, police officers are reluctant to issue a fine, because it has to be proven that the phone was used for a communicative purpose, while allowing all other functions of the phone. Similarly, in Sweden, while there is a ban, police officers are reluctant to fine drivers, because they have to prove that using a handheld mobile phone while driving affected the driver adversely.

Table 4.5: International legislation

Jurisdiction	Comments
New Zealand	Drivers can't use, while driving, a handheld mobile phone to make, receive or terminate a telephone call; create, send or read a text message or email; create, send or view a video message; or communicate in a similar or any other way. Penalties are an $80 fine and 20 demerit points (100 point system). Drivers can use a mobile phone to make a call while driving only if it is an emergency situation and unsafe or impracticable to stop the vehicle to make the call. For full review: https://www.nzta.govt.nz/safety/driving-safely/driver-distraction/driver-distraction-resources/legal-mobile-phone-use-while-driving/

Jurisdiction	Comments
UK	Drivers are not allowed to use a mobile phone while driving Penalties are a £200 fine and 6 demerit points on their licence (12-point system) Drivers caught using their mobile twice or accruing 12 points on their licence face magistrates' court, being disqualified and fines of up to £1,000. New drivers risk having their licence revoked, and truck or bus drivers can have their licence suspended on the first offence if caught. Police are reluctant to issue fine due to a loophole (has to prove that phone was used for a communicative purpose) (information obtained from interviews).
Netherlands	Drivers are allowed to use a phone, tablet or music player only with a hands-free set-up and when handheld when the vehicle is parked or stationary (for example if you are stopped in a traffic jam or at a red light): 'It is prohibited for a person driving a motor vehicle, moped, scooter or motorised mobility vehicle to hold a mobile telephone while driving.' Fine is €240, for a cyclist it is €95 (if under 16 years – half the fine).
Sweden	There is a ban on using handheld mobile phones while driving in Sweden, but it only applies if it affects the driving negatively. Two years have passed since the ban was introduced, but the number of people who are prosecuted is decreasing, and police officers complain that the law is difficult to apply. To view all European jurisdictions: https://autotraveler.ru/en/spravka/penalties-for-using-mobile-phone-while-driving-in-europe.html#.X9apyS0Rp0I https://www.fiaregion1.com/club-news-29-european-countries-prohibit-the-use-of-mobile-phones-while-driving-reports-adac/
Canada	All Canadian provinces have legislation prohibiting handheld mobile phone use. However, there are concessions that allow for mobile phone use while driving to report an emergency situation. Some provinces have changed wording to broaden the definition of the type of device used. The fines in each state vary and some use an increasing scale for additional offences or even impounding of vehicles and/or driving license suspension. In most states stricter rules for novice drivers apply, for example in British Columbia, for novice drivers the law extends to using a mobile device in hands-free mode. In other states, third parties are becoming involved, for example in Alberta, when convicted of a distracted driving offence, insurance companies are increasing the premiums by up to 25%. To view per jurisdiction: https://www.caa.ca/distracted-driving/distracted-driving-laws-in-canada/

Jurisdiction	Comments
USA	In 26 states, the use of handheld mobile phones is prohibited by all drivers. In 20 states there is no ban and in 6 states there is a partial ban. The partial ban relates to areas where the mobile phone is not allowed to be used, such as school zones, work zones, construction areas. However, these areas are not consistent across the states. For novice drivers there are more states, 39 in total, prohibiting novice drivers from using a handheld mobile phone. All states, except Montana prohibit text messaging for all drivers, and Missouri only prohibits it for drivers 21 years and younger. To view per jurisdiction: https://www.iihs.org/topics/distracted-driving#cellphone-laws.

Canada and the USA are two countries with multiple jurisdictions, each with varying in their legislative frameworks. While in Canada the use of handheld mobile phones is generally banned, in the USA, 20 States have no ban and 6 States have only a partial ban. The partial ban relates to geographical areas (e.g. schools) where the mobile phone is not allowed to be used and some states are stricter on novice drivers than others. In one province in Canada (Alberta), insurance companies are becoming involved by raising the insurance premium by up to 25% when convicted of using a mobile phone while driving.

4.4 Awareness campaigns and education

This section provides information regarding road safety awareness campaigns and education campaigns relating to distracted driving within Australia. Each State and Territory has a road safety plan and run various awareness and education campaigns. The road safety plans and campaigns are designed to complement the *Australian National Road Safety Strategy 2011 -2020*. Most of the States and territories operate on the 'safe system' approach, which includes a focus on safer roads, safer speeds, safer vehicles and safer people. In the last few years, distracted driving and mobile phone use have become more prominent in the awareness campaigns (see Appendix H).

In all States and Territories road authorities are partnering with police organisations, and often with other government agencies and non-government agencies, including research entities and automobile clubs, to promote and educate drivers on road safety. In some States other entities, such as sporting clubs or entertainers are becoming involved to promote safe driving. For example, in New South Wales, the Sydney Swans AFL team has partnered with Transport for NSW to promote the risks of mobile phone usage and distracted driving; and in the Northern Territory the Recording Artists, Actors and Athletes Against Drink Driving have become involved to promote other safe driving practices. In South Australia, New South Wales, Western Australia and Tasmania, WorkSafe or SafeWork, are becoming more involved in promoting vehicles as a workplace and road safety awareness. A summary of the strategies and campaigns identified can be seen in Appendix H.

4.5 Vehicle as a workplace

In all Australian States and Territories, legislation regarding the Work, Health and Safety of employees exist. The purpose of these laws is to protect the health, safety and welfare of employees, volunteers and other persons who are at, or come in to contact with a workplace. All States and Territories list a vehicle as a workplace under their Work, Health and Safety Act, applying all safety laws and regulations that apply to any workplace, whether it is office building, factory floor or vehicles.

Each State and Territory has their own department or agency (WorkSafe or SafeWork) that administers and enforces the Work, Health and Safety Act and Regulation. Table 4.7 (and Appendix G) provide an overview of the activities of WorkSafe or SafeWork in each State and Territory regarding 'vehicles as a workplace'. In addition to Work, Health and Safety legislation, most WorkSafe or SafeWork agencies across Australia provide guides, manuals and further information and links on their websites about safe driving practices. As can been seen in Table 4.6 below, there are significant variations between the States and Territories.

Table 4.6: Vehicle as a workplace

State	WorkSafe guides and manuals
QLD	**Vehicles as a Workplace: Work Health and Safety Guide 2019:** Section 5.6 'unsafe drivers', risks and potential control strategies of distraction and inattention, focussing primarily on mobile phone usage, are mentioned. **Road Safety Manual 2016:** Specifies 6 risks, nominates mobile phone use and other driving distractions as high risks. Covers legislation, statistics, and provides suggestions for reducing risks.
SA	Refers to Queensland Safety Manual 2016 On their website specify distracted driving as a hazard for vehicle use and detail that employers must inform and train workers on their policies and procedures, including those on distracted driving, and that workers must remove distractions such as mobile phones.
NSW	**Road Safety and Your Work: A Guide for Employers 2018** The guide focuses on risk management and suggests specific strategies for a large variety of factors, including distracted driving. Additionally mentions specific legislation around mobile phones, and encourages to minimise legal usage of phones (hands-free use); pp. 18 & 25 **Work Health and Safety Procedure: Safe driving 2017** Published in 2017 to educate workers on road safety when driving for work. The handbook provides risk management strategies in work-related driving, states that managers

State	WorkSafe guides and manuals
	and employers must train their employees and outlines the largest factors in road fatalities. The guide does not specifically mention distracted driving.
VIC	**Guide to safe work-related driving 2008** Outlines the duty of care of employers (risk management, and information and training for employees) and employees (abiding by road rules and driving safely). Specifies both mobile phone use and in-vehicle distractions as risk factors, suggesting ways to reduce these risks, pp.19. **Employee Safety Handbook 2016** Outlines workplace health and safety in relation to driving. Specifies legislation, the implementation of risk management, and that all employees should have a safety induction. Further specifies legislation around mobile phones and that reckless driving is unlawful, but does not mention distracted driving as a whole. Additionally publishes information on website regarding work-related driving, but does not specify distracted driving.
WA	Provide information about work-related driving on website, however main focus is on driver fatigue, nothing specific regarding distracted driving.
NT	**Safe Driving Guidelines for Workplaces 2020** Outlines compulsory risk management processes, associated legislation and risk factors. Distracted driving is specifically mentioned on pp.7 and what employers and employees can do to minimise the risk**.** **Vehicles as a Workplace: Work Health and Safety Guide 2019** Section 5.6 specifies unsafe drivers, lists the risks and potential control strategies of distraction and inattention, focussing primarily on mobile phone usage.
TAS	WorkSafe Tasmania has additional information on their website and links some resources, however other than the national Vehicles as A Workplace handbook, there is nothing specific about distracted driving.
ACT	As per 14/12/2020 has video on mobile phone use as a distraction in the workplace generally, not only when driving. Nothing specific regarding dsiracted driving on website.

Thus, Western Australia primarily focuses on fatigue and the ACT refers to mobile phone use as a distraction, however in the broader workplace setting, not only when driving. The other States and the Northern Territory refer to distracted driving as a risk and provide suggestions for reducing those risks. However, there is no mention of enforcement or penalties under the Act or Regulation and thus there is a reliance on the road use or road safety legislation to penalise drivers for distracted driving, particularly mobile phone use.

4.6 Distractions

While the previous sections have provided an overview of the legislative frameworks that operate in Australian and international jurisdictions regarding distracted driving, the following focuses on policy and distracted driving.

4.6.1 In-vehicle distractions

Interview participants were asked what they perceived as the main distractions in the vehicle. The answers ranged from the driver themself, passengers, technology that is brought into the vehicle and technology that is built-in the vehicle.

Participants considered that two of the greatest causes of distraction are the driver themself and passengers (P2, P3, P8, P10, P11, MP12), especially when the passengers are young children (P8, MP4). Two participants commented that what is going on in the driver's head is a significant cause for concern (MP4, P8). Drivers can be distracted by their moods, stress because they are running late or had an argument, which causes a reduction in cognitive processing abilities:

> *"the greatest cause of distraction is what's going on in the driver's head….they are running late, have they had a fight, are they tired, have they got screaming kids, whatever is there, and something big going on at work, have they just gone through a really traumatic event, or whatever's going on in their life, and therefore whatever's going on in their head I think is the biggest distraction" (MP4).*

Another cause of in-vehicle distraction is the technology that is brought into the vehicle. Of these, mobile phones are one of the main concerns (mobile phones will be discussed in greater detail in section 4.7). Other devices such as a tablet, wearables such as smartwatches were also raised as a causing in-vehicle distractions (P2, P8, P10).

Built-in technology, such as infotainment systems and even some safety features of the vehicle are considered distracting. Some infotainment systems are very complex. They require touching and significant focus, and therefore cognitive capacity (P5, P9, P10). Those that allow voice activation are still considered distracting (P10):

> *"do allow voice activation, which we're not really happy about because research shows you can be distracted for at least 18 seconds after you know spitting out a voice command" (P10).*

However, it is not only infotainment systems that cause distraction. Some of the in-vehicle technology designed to minimise the negative outcomes of distraction or keep the driver safe may also cause distraction (P1, P2, P7):

> *"you're distracted by wondering what… because the alarm sound is the same for all of them. So whether it's lane departure or obstacle detection or the vehicle in front has moved, the audible sound is the same. So you end up having to look down at the dashboard, and you know I might well have seen that the vehicle in front has moved and I'm preparing to move off, but because I'm half a second slower than the electronics it's alarmed" (P7); and*

> *"a lot of this sort of in-vehicle warnings etc. fall into, where if they come up at the wrong moment, they could have the unfortunate element of distracting you from something really important that you should be aware of" (P2).*

This same technology can further lead to negative consequences. For example, the driver may become over-reliant and complacent because they consider that the vehicle will keep them from harm. This might lead to driver inattention (P2, P5, P8, MP4) and reduction in situational awareness (P5):

> *"as we move forward is with technology, where there's a risk of greater inattention as vehicles do more and more of the driving task, that also means that technology can help too and I guess rectify any issues from inattention, so if you start leaving the lane, the lane assist keeps you in the lane, so that's good for preventing a crash, but it also I guess perversely can encourage you to pay less attention in the first place, because it's like oh if I don't pay attention the vehicle will sort it out" (P2): and*

> *"It reduces the demands on the driver … the unfortunate implication of that is it also acts to reduce that driver's situational awareness" (P5).*

At the same time, one participant raised concerns that over time people might become desensitised to the alarms, and the brain will no longer register them (P6). Participants further suggested that if the driver is unaware of the technology and the vehicle auto-corrects, for example with lane departure features, it will distract the driver by focussing on what the car is doing and not what is going on around them (P6). These smart features can also increase risk when not present, for example when the driver swaps vehicles. If the driver is used to driving a vehicle with the technology and then drives a vehicle that does not have that technology, there may be an increase in risk (P2, P6):

"the highest risk is if you take them out and put them into a number one [the main family vehicle], and suddenly they're looking around for the camera or this or the blind spots, and they've got to go back to holy crap I've got to use mirrors, and you get caught out" (P6); and

"and then I suddenly get into another vehicle which doesn't have those features, then there might be some risks there because I expect the vehicle to do stuff that it doesn't do" (P2).

Summary:

In-vehicle distractions were categorised as: passengers and drivers themselves (moods, stress), technology brought into the vehicle (mobile phone) and technology built-in the vehicle (infotainment and technology designed to keep driver safe). Technology designed to keep the driver safe might cause distraction on one hand, and over-reliance on the vehicle to keep the driver safe on the other.

4.6.2 Out-of-vehicle distractions

Participants were asked what they consider to be the main causes of distractions outside the vehicle. While some commented that it could be anything, other participants suggested other road users, traffics signs and detection cameras, and billboards lead to distraction (P2, P6, P8, P10, MP4).

One participant commented that other road users are a cause of distraction. People are focused on other road users, particularly cyclists, and the ways in which others drive, and become distracted:

"they've been cut off or someone's done the wrong thing by them, you know I think that causes a lot of distraction as well. A lot of people aren't focused on the task; they're more focused about you know what's been done to them, they feel aggrieved" (P8).

Road signage and detection and speed cameras were also mentioned as a cause of out of vehicle distraction (P8, MP4). Road signs are a concern, especially those that keep changing, while the flash of detection and cameras were also mentioned as distracting:

"where we have variable speed limits on motorways so they can change as your driving under them – that's bad as well, that distracts people" (P8); and

"is a camera over here that detects the use of mobile phones by detecting the signals going in and out of the car, so it flashes if it detects a car going past where a mobile phone is in use, so it flashes up an image of a mobile phone in a red circle – it's not linked to enforcement - it's meant to be a warning, but people have complained that that's distracting" (P8).

Billboards were further raised as another concern, especially the electronic advertising notice boards (P2, P6, P8, P10, MP14). Ironically, some of these contain road safety advertisements (P2, MP4):

> *"billboards have always been an issue, and there are mixed results, but there's enough to show that billboards could be distracting and may be a factor in crashes, depending on the nature of the billboard, what's on it, how often it might change over an ad, where it's placed, stuff like that" (P10); and*

> *"they're sort of designed to be distracting, that's the whole point of them: to distract you from the driving task … and obviously ironically some of them are road safety ads you know" (P2).*

Summary:
Out-of-vehicle distractions can be anything. They include other road users, traffic signs (especially the continuously changing ones) detection cameras and billboards.

4.6.3 Environmental context

In some environments, some level of distraction might be safe, while in others it is not (P5, P6, P7, MP4). For example, in low populated areas where there are long stretches of open road or when there is very little traffic around, some level of distraction might be necessary to keep the driver-focused on the driving task (P5, P6, MP4):

> *"some of the evidence might actually indicate that some of the distractions, particularly you know some of the outdoor signage that's put, that is put on long stretches of high-speed rural roads, with little else going on, can be a good thing" (MP4); and*

> *"If someone is driving out in the remote sort of areas and regional and they are feeling tired or checking in, choose the other way, the phone might be away, and I've heard where some shift workers have a number they call and they can just talk through with someone to get home" (P6).*

However, it is difficult to recognise what level of distraction is safe. Distraction in diverse environments can have different consequences, and distractions are rarely caused by one factor. Distraction is often a combination of factors, and the risk of harm because of that distraction should be assessed in context:

> *"The likelihood of a smash each time is going up, so bad weather, congestion, end of the day, I've had a crap day, and then I add the mobile phone into it, and it's wet, well what do*

you think is going to happen. You're super distracted in a high-risk environment; it doesn't matter if it's 50k's an hour or stop-start, your likelihood for a crash has gone through the roof" (P6).

Summary:

The outcome of distraction should be seen in the environmental context. In some contexts some level of distraction is necessary to keep the driver safe. However, what level of distraction is safe is difficult to quantify.

4.7 Legislating distracted driving

4.7.1 Defining distraction

Distracted driving can include all sorts of things from interacting with a phone, the in-vehicle systems, talking to a passenger, daydreaming, being distracted by billboards while driving and so forth. In essence, it is anything that distracts a driver from the primary driving task and impacts on their driving ability (P2, P5, P6, P7, P9, P10, MP4, MP12) and their *"inability to react to evolving situations"* (MP12). They are "*applying their focus to something other than the primary driving task"* (MP4).

There is a distinction between driver -nitiated distraction and other distractions the driver does not have control over (P5, P9, MP12). From a legislative perspective, it is difficult to define distracted driving (P1):

"When we talk about driver distraction to the public, we talk about driver-initiated distractions, so the things that the driver is in control of, so they can decide whether or not they're going to start eating while they're driving, doing their make-up, going on their mobile phone, we tend to focus on those things that are more in the driver's control" (P9).

Choosing to do something other than focussing on the driving task is enforceable, under the 'proper control' road rule:

"there's nothing that says you're not allowed to eat in the vehicle, but if you are eating, say you didn't have your hands on the wheel, because you're meant to have your hands on the wheel and your eyes on the road basically, and if it looked like you didn't have proper control because you were holding a cereal bowl, that's the rule they get you on, the proper control" (P10).

However, this road rule is non-prescriptive and vague:

"The NTC [National Transport Commission] is developing a new distraction road rule at the moment, so that will include the proper control rule, and it seems for some reason that they don't want to get too prescriptive about what proper control means" (P10)

When referring to distracted driving in the enforcement legislation, it tends to be about things that are within the driver's control and is often synonymous with mobile phone use (P3, P5, P9), and the interaction with that device (MP4):

"A police officer would say it was just handheld mobile phone use that they are actually in any position to do anything about in terms of distraction…. kids in the back are distracting, but no one's trying to ban that are they that kind of thing – ignoring the fact that's a very different kind of distraction and actually when you pick your phone up or use your phone you're volunteering to be distracted" (P3); and

"in this country distracted driving tends to only really be about mobile phone use, we don't really have much that's about any kind of distracted driving" (P3).

Summary:

Distraction includes anything that distracts a driver from the primary driving task. However it is difficult to define in the distracted driving legislation and is therefore often synonymous with mobile use and the interaction with that device.

4.7.2 Defining 'without due care and attention'

Driving without due care and attention incorporates a wider range of activities and non-activities by the driver. It is a manner of driving that puts the driver, passengers and other road users at risk (P2, P5, P7, P9, P10, MP12). It ranges from inattentive driving to distracted driving, to driving in a manner that is inconsiderate towards other road users. Below are some examples of what driving without due care and attention include:

- *"it could mean a lot of things, it could in effect mean fatigue, it could mean you know obviously outwardly distracted behaviour, but it also could in the event of a serious crash, for example, it could be retrospectively identified that someone wasn't paying attention, which directly contributed to the crash"* (P1);
- *"not signalling appropriately – not interpreting evolving situations – not taking appropriate action to mitigate situations"* (MP12);

- *"being distracted by something such as adjusting a stereo, attempting to make inputs into a GPS, etc."* (MP12);
- *"is driving that falls below that standard or driving that's kind of inconsiderate towards other road users"* (P9); and
- *"things like turning into the path of another vehicle, eating or smoking while driving and not concentrating on the road, or maybe driving too close to another vehicle"* (P9).

As can been seen from the above quotes, driving without due care and attention includes inattentive driving, distracted driving as well as having elements of reckless driving (P6, P10), however not to the extent that it is negligent or dangerous driving (P1, P8, P10). The offence of *'driving without due care and attention'* or *'careless driving'* provides an opportunity for the enforcement of activities that could potentially endanger the life of the driver and other road users, but are not so easily defined as for example mobile phone use or dangerous driving (P9, MP4):

> *" I guess an offence where the offence doesn't neatly sit in something else" (MP4).*

Summary:

Driving without due care and attention goes beyond distracted driving. It incorporates a wide range of activities and non-activities by the driver. It is a manner of driving that puts the driver, passenger and other road users at risk.

4.7.3 Defining inattention

From the participants comments regarding defining distracted driving and driving without due care and attention, a third category of ………………was identified: inattentive driving. Inattentive driving can be many things (P7). However, participants were in consensus that the inattention is caused by a '*busy*' or *'drifting mind'* (P6, P7, P8, P9, MP4, MP12), *"the headspace is not on the driving task"* (P6):

> *"inattention, those are the sort of moments where basically I reflect back where the mind is being really busy and sort of escaping from it, you've sort of drifted off, and you could be thinking about anything else but the road task" (P6).*

One participant commented that the environmental context impacts on inattention, causing the mind to drift, for example, the monotony of a journey (P7) or long open straight roads (P5):

"inattention can be so many things, that could be you know the falling asleep or the monotony of the journey or the complacency because you make the same journey day in day out, so you don't – you know we've all done it, we've all driven home or driven somewhere, and we know the journey well, and I would defy almost any experienced driver to have done that, to have driven a journey and then got to their destination and thought "gee I don't remember half of that journey" (P7).

While inattentive driving does not include the deliberate act of completing a secondary action away from the driving task, it does pose a risk to the driver and other road users (P2, P6):

"the greater risk is almost that mindfulness what's going on inside people's heads, because I think that's when people get in their cars, they can dwell on that, so a lot of people are travelling, commuting by themselves and that is where people can – that's why, how many times do you sit there and people are driving, and they're like "oh, shit where did that car come from" (P6).

Summary:

Inattention is caused by a 'busy' or 'drifting mind' and does not include the undertaking of a secondary task.

4.7.4 Distraction, in-attention and due care and attention

When participants were asked: "what is the difference between distracted driving and driving without due care and attention", one participant provided a clear distinction between the two:

"Distraction can be controlled or even avoided with proper planning – driving without due care may be an inherent issue which requires re-education" (MP12).

However, most of the other participants commented that there is some overlap between the meaning the terms, distraction, in-attention and without due care and attention. Enforcement legislation relating to some specific forms of distracted driving is clear, such as mobile phone use or use of visual display units; however, legislation about other forms of distracted driving is not as clear. Other activities drivers complete that take them away from the primary driving task are potentially enforceable under '*driving without due care and attention*' or '*careless driving'* (P9, MP4).

"driving without due care and attention can basically be used to capture any kind of distracted driving that doesn't have its own law" (P9).

Driving without due care and attention, however, is more comprehensive. It does not only include distraction, but also incidences of inattentive, careless or negligent driving, for example constantly changing lanes and tail-gating (P2, P9, MP12):

> *"Distracted driving is caused by something else such as using a GPS, talking to passengers and adjusting the stereo while driving without due care and attention can result from being inattentive" (MP12); and*

> *"it is certainly possible to drive without due care and attention and not be particularly distracted, you may just, you may be just failing to I guess give sufficient attention to the driving task without particularly being focused on anything else" (P2):*

While some see a clear distinction between distraction and in-attention, others do not. Some see it more as a grey area (P7, P9) or see distraction as part of inattention (P10). However, there is some consensus that inattention is related to cognitive processing (P8, P9, P10, MP4, MP12), while distracted driving involves the undertaking of another activity:

> *"you can be inattentive to the driving task, but you haven't become fully distracted yet because you're not doing something else" (P10);*

> *"distraction is the use of a device or an activity that draws the driver's attention away from the task of driving. Inattention is the state of mind of the driver where they have not devoted adequate thought process to the task of driving" (MP12); and*

> *"distracted driving … the driver chooses to focus on something else, whereas perhaps inattention is not devoting maybe the kind of cognitive resources" (P9).*

The above shows that there is not always a '*massive difference between them'* (P5), and that '*it is all sort of fairly vague*' (P2). These difficulties of clearly defining distraction, inattention and due care and attention leave it to the individual to interpret:

> *"we've got specific legislation that tells you when you can and can't use a phone and how to use it legally or illegally more to the point. But there's no legislation that really talks about what is distraction. So it just really talks about care and attention or undue care if you don't have care and attention. And that's really; I guess up to the police and the individual circumstances to determine whether a driver was paying enough care or attention to the road. And that usually occurs as a result of that crash rather than just general driving" (MP4).*

Summary:

There is some specific law enforcement regulation of particular forms of distracted driving (mobile phone use and use of visual display units). For other forms of distracted driving, other sections of the legislation are available, such as driving without due care and attention. However, these have some overlapping features and are difficult to define, leaving it to the individual to interpret.

4.8 Focus on mobile phone use

4.8.1 Handheld mobile phone use

For researchers and practitioners alike, distracted driving is often (erroneously) synonymous with mobile phone use (P3, P5, P9). Handheld mobile phone use together with the use of visual display units (VDU's) is specifically nominated in the Australian enforcement legislation. These two forms can be clearly defined and separated from other distracted driving, it is enforceable, and it is considered to be one the most dangerous in-vehicle distractions (P3, MP4):

> *"we're focused on mobile phones because …, it's one of the few causes of distraction that triggers all 4 types of distraction, from cognitive, visual, manual and auditory" (MP4).*

Prior to using the phone as a communicative device, the mind, eyes and hands are drawn away from the driving task and focused on the mobile phone. After using the mobile phone, these distractions continue to linger:

> *"there's a switching cost from changing between tasks" (P10).*

However, the actual conversation itself distracts the most (P5, P9):

> *"if you're talking about a conversation, a phone conversation, we were able to demonstrate that when you have a conversation with someone who isn't physically present in the room or in the vehicle with you, you tend to create mental images based on what they're discussing, where they are, what they're describing. And mental imagery uses the same brain areas and the same cognitive resources that are needed for visual perception. So, in effect you've got competition between your phone task and your driving task, for these precious cognitive resources, and if the phone conversation wins those resources, that can explain why a driver can look directly at a hazard yet fail to see it" (P5).*

Summary:

Handheld mobile phone use is considered as one of the most dangerous distractions while driving.

4.8.2 Hands-free mobile phones use

Handheld mobile phone use while driving is banned. Some participants argued that hands-free mobile phone use does not reduce the amount of distracted driving, it "*just changes the form of it"* (P3), and unfortunately hands-free mobile phone use is becoming the *"default safe option"* (P3) for drivers, while experts do not consider it to be safer at all as it still takes the same cognitive attention away from the driving task (P2, P3, P5, P9):

> *"it also doesn't really help the problem that actually holding the phone wasn't the problem in the first place – it's the cognitive distraction not the physical distraction" (P3); and*

> *" talking to someone on a hands-free phone you might be visualising what you're speaking about and therefore not focusing on the road" (P9).*

However, even hands-free use usually requires touching the phone at some stage, and depending on the complexity of making or answering that call, some still take the visual focus away from the road for a period of time (P2, P9):

> *"it all depends on kind of the interface of the car really, like how complex it is to answer that call, because some cars you might be forced to look away from the road and touch something on the screen or that kind of thing" (P9); and*

> *"at some point you may need to press a button on the phone to make the call or to hang up, and I guess that's often the most problematic part of the time when you actually, again your eyes are totally focused away from the road" (P2).*

The problem, of course, is the ability to detect hands-free mobile phone, and some participants suggested that because it is very difficult to detect, it is not illegal (P3*):*

> *"hands-free is dangerous and they don't directly dispute the years and years and decades of research that proves that they say it's unenforceable and that's why it's not illegal" (P3).*

Summary:

With increased enforcement practices for handheld mobile use, drivers are diverted to use a mobile phone hands-free, which is legal. However participants commented that hands-free mobile phone use is not less distracting or less dangerous.

4.9 Effectiveness of enforcement

4.9.1 Difficulties with distracted driving legislation

Drivers can be distracted by many things. Many distractions are difficult to regulate (P1, P6, P8, P10, MP4, MP12). Not all distractions draw the attention away from the driving task under every circumstance:

> *"it's a really difficult one for us as government to, I guess, define from a legislative perspective what's distracted driving. I mean as you're probably aware there's a lot of things that are potentially distracting, so there's some things that you could be specific about in terms of legislating against, but then there are other things that could be potentially distracting in a given situation or circumstance for the driver – and that's where an element of flexibility in the interpretation of the law is needed" (P1).*

One participant commented about the difficulty of legislating some distractions, because they might infringe on health and civil liberties (MP4):

> *"an example like are we going to say you can't drink water or you can't eat your lunch, or you can't talk to your passengers or your children, like to try and start to say 'no' to some of these things I think from a government perspective you're going to start impinging on some health and civil liberty issues" (MP4).*

Some forms of distractions are legislated to some extent, when considered to be at heightened risk to the driver or other road users. For example, P1 platers have restrictions on the number of passengers between certain times (MP12); and for some of the other distractions such as drinking and eating, the driver can be fined under one of the other distracted driving regulations such as driving without due care and attention. However, this is left to the discretion of the police. One participant commented that the police look at whether the distracting activity poses a risk that could endanger the driver of other road users, and regulate that risk through enforcement (P1):

> *"the way in which that's written is really to give, to provide some level of interpretation for police to I guess enforce something they perceive to be risky" (P1).*

Some participants commented that the legislation must be flexible enough to account for future technological changes (P1, P10, MP12), population growth and changes to road infrastructure (MP12):

> *“it's got to be flexible, we can’t just be prohibiting specific distracting things, because we may not account for some future technology, some future things that come in after you know legislative changes. So we don’t want to be continually chasing our tail” (P1); and*

> *“Road laws will need to evolve with; population growth, vehicle technology, infrastructure, licencing to remain effective” (MP12).*

While flexibility in the legislation is important, it is imperative that changes to the legislation do not negatively impact on the ability to enforce other forms of distracted driving by becoming too restricted or vague (MP12):

> *"We used to have an offence for driving without due care and attention …. We no longer have this offence and have to deal with offences which results from things such as not driving within a traffic lane or driving without proper control” (MP12).*

Some participants proposed the legislation should be extended or widened to include all road users (MP12); headphones (MP12); and other technology (P2):

> *"Things that aren't mobile phones that might be used as tablets or smartwatches or other tech, just I guess ensuring that they are adequately covered by the rules… you don’t want to define a mobile phone too narrowly, I guess because some of the other similar sort of connected portable technology has basically the same sort of pros and cons and risks as mobile phones do. So I think that needs consideration” (P2).*

However, the focus of distracted driving enforcement remains primarily aligned with handheld mobile phone use (P2, MP4, MP12). Not only by the community, who believe that distracted driving and the use of handheld mobile phones are the same, but also when exploring large emerging projects, such as the National Roadmap: (MP4, MP12).

> *“people generally in the community think mobile phones. They don’t think eating a hamburger, yelling at the kids, doing – oh some of them do make up, I shouldn’t rule that out – but I think as a generalisation they generally think the interaction with the device is distracted driving” (MP4);*

“The focus remains on mobile phone use, apart from mobile phone use, not much other than offences that take place as a result of distracted driving” (MP12).

Summary:

Distracted driving legislation focuses primarily on handheld mobile phone use (and visual display units). Other forms of distraction are not so easy to define. Some suggest that flexibility in the legislation is necessary while others are concerned about the legislation become vague or restricted.

4.9.2 Difficulties with enforcement

In the previous sections, we saw that legislation that covers aspects of distracted driving is centred around handheld mobile phone use. The legislation for handheld mobile phone use is relatively unambiguous, however the ability to enforce it is another matter (P8). Currently, enforcement is ineffective and requires significant policing resourcing (P2, P5, P10), which police agencies do not have (P2, P5). This might change with the rollout of mobile phone detection cameras in some Australian jurisdictions. However when not (yet) in effect, or in places where they will not be positioned enforcement is difficult because of the lack of resources (P2, P10):

“enforcement is very ineffective and resource-intensive due to needing to police officers, one stationed at one point in the road checking for illegal phone use and another further down the road to apprehend the offender" (P10); and

that illegal use is very high… with limited police resources to enforce it, certainly when they do their blitzes with patrols etc and they seem to find quite a lot of people and fine a lot of people, but that sort of suggests there's a lot of it going on unfortunately" (P2).

While the enforcement of handheld mobile phone use is unambiguous in Australia, other aspects of distracted driving is not. It is very difficult for police to identify other forms of distracted driving (MP4, P10), and this can often only be detected after an incident, such as a crash has occurred (P6, MP4):

"It is too difficult to determine if a driver is distracted other than something very obvious such as not having one’s hands on the wheel and eyes on the road” (P10); and

“it's such a difficult thing for the police to pick up, you may be cognitively distracted but you haven’t actually done anything on the road to show you're cognitively distracted yet, or visually or audibly distracted. So, police can pick it up if once the crash has happened, but they can’t often pick it up before a crash has happened” (MP4).

However, as one participant commented, police officers not only find it difficult to identify distracted driving, not all of them understand the distracted driving legislation well enough to enforce it (P3):

> *"There are 3 or 4 laws the police could use in relation to hands-free driving – but they don't mention the phone or – they would be driving without due care and attention or driving in not proper control. I think your average police officer wouldn't really know the finer points of that" (P3).*

The legislation also leaves the interpretation open to what distracted driving is, allowing for use of discretion by the police officers. Police officers could enforce other forms of distracted driving (in addition to handheld mobile phone use), but much is left to discretion (P1, P11);

> *"police could enforce careless driving or negligent driving etc, it opens up the ability to actually enforce a range of distracting behaviours, it just depends on the circumstances and the mechanisms of the incident, but that's at the discretion of police really" (P1);*

> *"in the real world I think police give them leeway because they're [name withheld] drivers and will let them go" (P11).*

Even if the legislation is clear, enforcement as a tool of deterrence is not always effective. Drivers know it is unlikely they will be caught (P5, P8, P10), and if caught there is often a time delay between enforcement and receiving the fine. This time delay allows for the driver to disassociate the handheld mobile phone use while driving from the illegality of the act (P6):

> *"People know that, they're not deterred because they know they won't get caught, very rarely will get caught, there's little consequence for their behaviour, and if they don't have a crash or a near miss, the behaviour is reinforced" (P10).*

Summary:

Enforcement of distracted driving is centred around handheld mobile phone use because it is relatively unambiguous, however the ability to enforce it is another. It requires significant police resources and people do not think they will be caught. Other forms of distraction are difficult to identify, and often not possible until after an incident.

4.9.3 Mobile phone detection cameras

Using artificial intelligence, mobile phone detection cameras are a tool to assist road authorities with enforcing the ban on using handheld **mobile phones** while driving**.** In Australia, New South Wales currently uses mobile phone detection cameras and they are being trialled in Queensland and Victoria.

The use of the mobile phone detection cameras will address some of the resource issues for enforcement (P2, P5). In addition they will also allow for a measure of the extent of handheld mobile phone use amongst drivers:

> *"These mobile phone detection cameras which they're quite neat in the way that they're both an enforcement measure but they're also an actual way of measuring the extent of the problem" (P2).*

One participant commented that the cameras showed some great promise (P2), while others were less optimistic (P5, P6, P8, MP4). Participants raised concerns about the use of the camera as a deterrence (P8), especially in the long term (MP4, P5). While other raised concerns about their accuracy in terms of detection (P6).

> *"The experience in NSW has shown, they're still detecting quite a lot of people, even after you know they've had the pilot and they've promoted it and the cameras have been in there for maybe 12 months now, maybe longer, but they're still getting quite a lot of people so" (P8); and*

> *"when they're new they will have a greater impact, then people will get used to them, and they will lose some of the impact and then over time they will come back up slightly, and then plateau out. Probably follow quite a similar trajectory of what happened when speed cameras were introduced" (MP4).*

Summary:

Mobile phone detection cameras overcome some of the resource issues experienced by police agencies. They show promise as an enforcement tool, but not necessarily as a deterrent.

4.9.4 Human behaviour

To address handheld mobile phone while driving, a change of behaviour and attitude towards the driving task is necessary (P5). However this is difficult as people are desperate to keep using their phone (P3, P10), they do not understand the risk of multi-tasking while driving (P3, P6, P8, P10), and do not think they will get caught (P3, P10), or caught only once (MP4);

> *"drivers are not deterred by their illegal behaviour as they know they will not be caught, very little consequence for the illegal behaviour, many drivers keep engaging in it and are not caught therefore their illegal behaviour is reinforced - further information can be provided around what is needed for penalties to be effective e.g. are enforced so that drivers believe that there is a good chance they will be detected and caught when they undertake specific behaviours" (P10); and*

> *"many people who get caught through traditional roadside policing methods now actually feel like they're less at risk of getting caught again than people who have not been caught in the first place, and we hypothesise that's a bit of a resetting effect almost like they're thinking well lightning never strikes twice in the one place if you like, I've been caught once, there's no way I'm going to get caught again" (MP4).*

Drivers continue to use their phones while driving, because they feel under pressure to stay connected (P10) and feel that driving itself is not enough (P3):

> *"People are addicted to their phones, often are under pressure to stay connected to their networks via the phone, there is one study … who found young drivers feel under pressure from their friends to respond immediately to text messages" (P10); and*

> *"Time is short, time is precious, that sense that actually we need to be doing other stuff it's not just enough to be driving" (P3).*

People do not understand the significant risk of handheld mobile phone use while driving poses and they also do not understand the risk of engaging in other distracting activities while driving. Drivers, especially young people, underestimate the difficulties and cognition it requires to drive. People think that driving is intuitive (P3), or that they are better than average drivers (P3, P10);

> *"all drivers have optimism bias, especially young people, so they think that they can safely use their phone and drive" (P10); and*

> *"We have these really emotive tragic stories of families left behind, people who were wiped out by people using their phones etc – and we still expect that to change behaviour and it will for a few people, but the problem I think is that people don't believe it will be them, so*

> *every time – most drivers think they're better than average, they think they can handle it – most drivers support banning mobile phone use because they think other people will be distracted by it" (P3).*

However, it is not only handheld mobile phone use while driving that is considered risky, other activities are as well. The risk is underestimated and because it is not unlawful or not enforced, and because everyone is doing it (P10), people think it is not unsafe (P3, P6, P10);

> *"some people genuinely think if it was dangerous it would be illegal, and they know full well that it isn't so, they assume the law is a good guide to what's safe and what's dangerous when it isn't in this case" (P3); and*

> *"All these other little intentional things like eating, smoking, putting nail polish on … all those little things where people they just don't understand the risk" (P6).*

Summary:

To reduce mobile phone use while driving requires an attitude change. People do not understand the risk. However, it is not only handheld mobile phone use, other activities, such as hands-free mobile phone use, is also dangerous. But people do not regard it as unsafe because it is not illegal.

4.10 The role of third parties

4.10.1 Vehicle manufacturers

The relevant technology in cars can be broadly divided into two categories: infotainment systems or human-machine interface (HMI), and in-vehicle safety technology that keeps the driver safe, such as lane control, automatic braking systems and forward-collision warnings.

Infotainment systems

Participants agreed that infotainment systems distract the driver (P1, P2, P3, P5, P9, P10, MP4). The concerns are that "*infotainment is increasingly marketed as a safety feature*" (P3), and because they are legal and manufacturers are building them in cars, people do not regard them as unsafe. However, "*emerging technology in vehicles is a major problem"* (P5). Some infotainment systems are very complex and still require touching and significant focus, and require significant cognitive space (P5, P9, P10). Despite these concerns, car manufacturers are increasingly putting infotainment systems in vehicles, because it is a feature that helps to sell cars:

"An issue here is drivers think that as the manufacturer has provided, it is safe to use, when this is most often not the case" (P10).

"they are legal, but they're also being marketed in a way that suggests make driving more rewarding, so it's not rewarding enough to get somewhere safely without killing anybody, you now have to make that driving experience more interesting because it's quite boring driving a car – the manufacturers who have made it boring by making it so assisted and so smooth are now giving us extra things to fill our brains because they think we're not – there is not enough of our brain being used to drive" (P3).

However, it is not only the cognitive space that the interaction with the infotainment system requires (P2, P3, P5, P9) that is a concern, it is also the placement of the infotainment system drawing eyes away from the road towards the HMI (P1):

"what degree does it impact on your visual field, so even if you're not using it, it can still be distracting" (P1).

In-vehicle safety technology

Some participants raised concerns about in-vehicle safety technology. It can reduce the demand on the driver which then cause distraction from the driving task and lead to complacency and over-reliance on the vehicle's ability to keep the driver safe (P2, P5, P8, P9, P10, MP4):

"The more tasks it does, the less you have to pay attention, but then the less you do pay attention the greater the risks at the same time" (P2).

However, the technology is still in its infancy and is only a system to guide and support the driver rather than being a substitute (P2, P5, P9, MP4). The more the vehicle becomes automated, so does the risk of distraction, and then when the vehicle does not cope with the driving context, the driver might be distracted or be doing something else (P2):

"it can lead to complacency and people think that they can never have a crash and that their cars can save them and things like that" (P8).

The other issue raised regarding these technologies is that they are only available in a small proportion of vehicles. As already discussed in section 4.6.1 of this report, when drivers switch between cars, the risk of crashing goes up when they are not aware that the in-vehicle safety technology is not present or when it has been switched off. One participant commented that some of these technologies should not be allowed to be switched off (P1), but some people were switching them off because they found them annoying (P1). It takes time for people to get used to them and with almost half of all passenger vehicles on the road over 10 years old (see Table 4.2), a significant number of drivers have received little exposure to these new technologies.

Governance of car manufacturers

There is a gap between the level of technology manufacturers are building in their vehicles and the consensus among road safety experts of what minimises distraction. There are concerns that infotainment systems in cars are increasingly marketed as safety features and cars are increasingly marketed as fun to drive. However, concerns are that not all manufacturers adopt the same features and that there is no third-party governance regarding the development of these features:

> *"car manufacturers putting technology into vehicle which sell, which sells a version of safety that people want, because everyone wants the tech in the cars because it looks good and it's handy and it's useful. But actually it's not stringently tested for safety and it ignores all of the cognitive psychological research in the area which tells you that you really shouldn't be doing this" (P5).*

Not all the technology is considered safe, and the amount of technology that is making its way into vehicles is a problem (P1). In addition, the design of the vehicle is important, but none of this is fully regulated and more technology is generally considered better, which is not always the case (P6):

> *"We give out these awards to these beautiful design of these high end cars, like the BMW, the Mercedes and you have this toggle and you've got to move through all these bloody screens while you're going, got to rotate through to find the one thing you want to change, because apparently having buttons on a thing looks horrible, so you've got to focus on that to find where you are where you're driving, whereas then I think it was the Ford Focus where everything is a one-press button for everything was viewed as disgusting and got badly scored because it was an eyesore, but from a safety point of view it's one-touch bang you're away" (P6).*

Some participants commented that there is need for more regulation for car manufacturers to ensure that technology is safe and not adding to the distraction (P2, P5, MP4). Some regulatory responses need to be developed (P2, P5), or at least a third-party oversight, which can assess whether new technologies are safe (MP4):

“The amount of technology that's making its way into vehicles is a big problem, particularly because it doesn't seem to be regulated” (P5); and

“that those principles are industry generated, they're voluntary and they haven’t really, at least up until now, been subject to any kind of rigorous third party review or audit if you like” (MP4).

Summary:

The technology in the cars can be broadly divided into two categories: infotainment or human-machine interface (HMI), and in-vehicle safety technology. Infotainment is increasingly marketed as a safety feature and as they are built-in people do not consider them unsafe. In-vehicle safety technology is also raising concerns as it might lead to overconfidence and complacency by drivers thinking the vehicle will keep them safe. Car manufacturers should be subjected to more regulation and/or oversight by third parties.

4.10.2 Vehicle retailers

In addition to more regulation for vehicle manufacturers, some participants commented that vehicle retailers also have a role to play in educating drivers about the safety features of their car (P2). When people buy a new car, they want these safety features, but do not really know how to use them (P3). Many people do not read the user manual as they are massive documents because vehicles are complex machines (MP4):

“they’re like desirable but then you don’t really want them because you’ve got to do homework to find out what you actually do with them” (P3).

The technologies have the potential to reduce the risk of collisions, however people need to learn to understand or interpret them, otherwise it will negate all the positive effects (P9):

“These technologies do have the potential to reduce the risk of being involved in collisions, but what is really really important is that the driver when they collect that vehicle is taught how to understand all of those different cues and feedback” (P9).

A big risk is when people do not understand the features (P1, P2, P6, P8), they will ignore them or switch them off, with the potential to deskill or desensitise them to the safety features of their vehicle:

"When someone buys a new vehicle you know they don't really get any training as to how, they can get their manual and stuff and look it up themselves, but I think we're not really tapping into the benefits that we could if they knew how to use things and – because what

people do if they're not sure about something they'll just turn it off and then lose all the potential benefits that that may bring" (P8); and

"This comes down to are people taught to understand what the different sounds are, or they just get in the car and there you go best of luck with it all. Because otherwise I think it deskills and just desensitises people and they just switch off to it. And that's why I think when you get reversing cameras and all those other bits and pieces, it dumbs you down, which I think from what I understand is you're seeing an increase in the number of small incidents and bingles as a result, because people get more reliant on it" (P6).

> Summary:
>
> Not everyone understands the safety features of their new cars which might result in them being switched off. Vehicle retailers have a role to play in educating buyers regarding the safety features of vehicles.

4.10.3 Commercial vehicles

Workplace health and safety legislation and regulations recognise vehicles that are used for a commercial purpose, are a workplace. While 'vehicle as a workplace' is increasingly recognised by road safety organisations, within the workplace vehicles are not always recognised as such (MP4):

"in the workplace health and safety area is the people who still really don't see the vehicles as a workplace, they still think don't see them as worksites, and then we don't have resourcing in the compliance side of the investigation side of the workplace health and safety regulator areas, the government agencies, to actually investigate a crash and whether there was some fault or some expectation of an employer on an employee that led to an employee having a crash" (MP4); and

The other difficulty is the enforcement of the workplace health and safety legislation and regulation. It is **'***still a very immature area in terms of legislation [for distracted driving]'* (P7)**.** The primary focus is on fatigue (P2, P6, P7) and even that is not always easily enforceable. It becomes more easily enforceable when distraction software is installed in the vehicle, however that is not always the case:

"The legislation really only comes back to fatigue. If the distraction software that [Company X] had you know tells me that the guy or the girl had 26 micro naps before they crashed the truck, despite the fact that they'd only been driving for 3 hours, then I wouldn't have an issue prosecuting them if I wanted to for fatigue. But if they didn't have the driver distraction

> *software and they had a crash after 3 hours, we wouldn't be prosecuting them for fatigue because we would have no ability to be able to demonstrate that they were actually tired" (P7).*

Anti-driving distraction software is restricted that it is only "*geared for long journeys on the open road where fatigue and falling asleep are the biggest concerns"* (P7). In addition to keep the driver safe, it has found to produce another positive effect:

> *"in the early days of fitting it a lot of the drivers thought it was just big brother watching me, but now they're beginning to realise that this actually will stop me being distracted, it will stop fatigue, it means I get home safely at the end of the day, and actually it's not such a bad thing" (P7).*

While some employers are taking considerable duty of care for keeping their drivers safe, others are taking less responsibility. The large trucking companies, especially those that transport dangerous goods are increasingly fitting their vehicles with anti-distraction devices, are not allowing mobile phones in cabin and have a control centre to monitor the drivers (P7). Unfortunately smaller companies do not have the advantage of that economy of scale:

> *"in the dangerous goods world we would have probably about 30 truck rollovers reported to us a year, but we don't get any from XYZ [the large trucking companies], we generally get the notifications from the mid to smaller players who either can't afford the software, and it's not only so much affording the software, because the software the facilities to go in the vehicles is not that expensive, what becomes expensive is manning an operations room, having 24 hour people there to advise and assist" (P7).*

However, there are also examples of companies with smaller commercial vehicles taking responsibility for keeping their drivers safe:

> *"take XXX [entity with large passenger vehicle commercial fleet] as an example, they've got absolutely great fleet management risk management systems in place, but they've done it off their own back, because they realise that their staff are on the road every day, they're going door to door to door to all of their clients to deliver their service, and so they recognise that they had a significant risk because they were on the road all the time. A lot of smaller, not smaller, a lot of light vehicle fleets aren't as mature" (MP4)*

Mobile phone use in vehicles is a continuing issue. Some companies are still expecting their workers to answer the call on their handheld device (P3):

> *"most of them will say "you will get sacked for using your phone handheld – never pick up the phone when you're driving" but most of them will still have an implicit or explicit expectation that you do answer calls hands-free because it's legal" (P3).*

However, even hands-free mobile use while driving, while it is legal, is still considered a significant distraction (see 4.7.2) and should not be allowed in commercial vehicles (P3, P9). However, it is difficult to change the mindset of employers, that using a mobile phone while driving, even in hands-free mode, is distracting. Not allowing mobile phone use while driving takes time away from another task that could be completed in the workday. Making the driver to stop and park to take a phone call is seen as reducing productivity of the worker:

> *"Employers are 'split between productivity and what they want their drivers to do" (P3): and*
>
> *"There is still some pressure in some organisations where drivers feel like they have to answer their phone, or they might be under pressure to get to their destination quickly" (P9).*

The focus should be on what is safe (P3), and it should be a two-way conversation (P6). There are great opportunities for employers to improve road safety (P1, P3, P8, MP4):

> *"there's also a role there particularly around distraction and mobile phones of making sure that employers aren't expecting employees to be answering their phones and taking calls and responding to text messages and having meetings, using their phone or using their phone illegally while they're driving, particularly if they spend a lot of time on the road" (MP4).*

While increasingly employers are taking responsibility and not allowing employees to use their mobile phone, some are not (P6, P7, P8, P11). For those employers who are not taking these regulations seriously, there should be stricter enforcement of their duty of care (P6, P9):

> *"they're more worried about their potential liability, so they might say to employee once 'oh you've agreed not to use your phone' or, and things like that, so they can almost if something does happen their accountability is decreased in their eyes (P8); and*
>
> *"there's kind of cause and permit offences that businesses can be charged with. So if the boss is expecting a driver to answer their handheld phone while they're on the road, the*

business can be charged with causing or permitting the driver to do that, so that acts as a deterrent to them encouraging drivers to do that while they're on the road" (P9).

As one participant commented, specific national laws for distracted driving in the workplace are needed as well as increasing the awareness of the dangers mobile phone use, both handheld and hands-free, poses to employees:

"don't think there are specific laws, regulations around distracted driving at that high level, it's just kind of at the company level. And at the company level in a lot of places, it's a big mess"(P5); and

"The distinction between what employees and management think is acceptable, and the employees understanding of the mobile phone policy compared to the management understanding, is quite shocking" (P5).

Summary:

Vehicles are considered a workplace under the workplace health and safety legislation; however some workplaces are lagging behind in recognising that. Not allowing mobile phone use while driving reduces worker's productivity. It appears that some employers are slow to recognise that all mobile phone while driving should be prohibited and that change of their practices is necessary.

4.10.4 Sole commercial operators

Outside the organisational vehicle fleets, there are many sole operators, such as single contractors, taxi drivers and rideshare operators. For these drivers, the application of the relevant workplace health and safety legislation falls in a grey area. They often drive long distances and long hours and their level of interaction with a mobile phone, or other device is high. Drivers have to rely on their device to get the next job (P5, P6, P7, P8, P9, P11), and they are relying on the next job to make a living.

"they're relying on the next job to make a living and you know you can understand them being, they'd be looking at that screen all the time, even when you're – I've been in a taxi and you can see that the halfway to where you're going and then they're sort of looking and planning where they might pick up their next job from, where they're dropping you off" (P8); and

"there's people like Uber, and fast food delivery companies where the driver actually has to interact with their phone as part of their job" (P9).

While taxis and rideshare agencies deliver the same service, there are significant differences between them. As a taxi driver there is more regulation or Code of Conduct by which the drivers have to abide when it comes to interaction with a mobile phone or other device (P2, P11) as well as some level of training, neither of which are necessarily the case for rideshare drivers, exposing them to greater risk of distracted driving:

> *"The advantage with groups like taxi drivers is because they're professional employed drivers, and there's regulations around their use, I guess they have certain levels of training etc that they have to go through, and so it's actually much easier to enforce higher standards and to ensure that you put in place practices and regulations that control what they do" (P2).*

Summary:

Some operators, such as rideshare, taxis and single contractors often rely on interaction with their device to make a living and the application of workplace health and safety legislation is

4.10.5 Other third-parties to assist in addressing distracted driving

Within, the distracted driving space there is room for to engage other agencies in assisting with addressing distracted driving. For example, there is an opportunity for enforcement through stricter distracted driving guidelines in t workplace health and safety policies (P2), as well as making employers accountable for employee's mobile phone use while driving (P6).

Other options that were mentioned in the interviews were the involvement of insurance companies. For example to build into their policies the requirement for anti-distraction software (P8). Or when procuring services from a transport agencies, only choosing those who have anti-distracted driving software and policies in place (P2, P7):

> *"let's say X owns a trucking company and you want to bid for some work, and the company that is requesting your work wants you to have driver distraction software in your vehicle, so some companies are building that into their contract, but you don't have any of those vehicles, it's not unusual here for you to subcontract to somebody else and part of that subcontract says you have to have to have it" (P7).*

Summary:

There are some options to engage other third parties in addressing distracted driving. These third-parties range from insurance companies (e.g. increasing premiums when convicted of distracted driving and/or not having anti-distraction devices), procurement services (e.g. only procuring contracts when anti-driver distraction devices are in vehicle), WorkSafe or SafeWork (e.g. enforcing distracted driving in the workplace).

4.11 What else is needed to reduce distracted driving

Deterrence through enforcement alone is not sufficient (see section 4.8 of this report). Some people see issuing fines as revenue-raising rather than enforcing a behaviour to reduce it because it is dangerous (P8). We need to create awareness that using your mobile phone while driving is dangerous (P5), otherwise people will continue to use their phones:

> *'unless they are convinced that there's a very good reason why they shouldn't be doing that' (P5).*

In the long term, cultural and attitude change is necessary (P9, P10). A change in social norms is needed and for people to understand that using your mobile phone while driving is unacceptable. People need to learn to accept that not answering your phone straight away while driving is acceptable (P2, P3). However, this can only be achieved through education (P2, P3, MP12):

> *"We also need to see a cultural change, so we need to move towards like I said earlier a society where people believe that distracted driving is as taboo as drink driving" (P9).*

Summary:

In the long-term a cultural and attitude change, similar to drink driving and wearing seatbelts is necessary.

4.12 Research and evaluations

4.12.1 Future research and evaluations

It is clear from this review that research on driver distraction is skewed towards a focus on mobile phone use while driving. There are significant research gaps.

All participants were asked to identify research gaps and provide suggestions for future research. The following themes were identified: 1) better understanding of the influence of organisational cultures and management attitudes towards distracted driving measures; 2) better understanding of the level of distraction caused by out-of-vehicle distractions; 3) identifying and understanding level of distraction caused by infotainment systems; 4) understanding the impact of positioning of infotainment systems and other technology in the vehicle on driver distraction; 5) understanding to what extent a vehicles' safety features impact on distraction itself and the outcome if distracted; 6) better understanding of the compound risk of contextual and environmental factors on distracted driving; and 7) identifying the effectiveness of distracted driving messages and what is required to change driver's behaviour. Each of these are outlined in more detail in the Table 4.7 below:

Table 4.7: Future research topics

Identified Research Theme	Research topics
Theme 1: The influence of organisational cultures and management attitudes towards distracted driving measures:	• Awareness and understanding of the level of accountability by executive management for their commercial fleet drivers, and whether enforcement of law on executives for failing to provide a safe workplace (for example corporate manslaughter) impacts on corporate culture and attitudes towards treating a vehicle as a workplace (for example: will senior managers treat a vehicle as a workplace the same as they treat a factory floor if enforced by law?). • Evaluation of the impact of public reporting on distracted driving by commercial fleet drivers and the impact of 'leading by example' of executive management on the level of distracted driving by commercial drivers. • Exploration of the differences across government departments, non-government agencies and private enterprise on attitudes towards driver safety, with a focus on distracted driving; possibly through review of the reporting frameworks with a focus on variables such as productivity, efficiency, environment and the interaction with driver safety.
Theme 2: The level of distraction caused by out-of-vehicle distractions	• The level of distraction caused by speed cameras, road signs and billboards. Identification of a methodology to identify level of distraction by billboards, level of distraction caused by billboards, level of distraction by type and position of billboards, including the environmental context of billboards.
Theme 3: Level of distraction caused by infotainment systems and in-vehicle safety technology	• More research on infotainment systems - the type and level of driver distraction that's caused by those systems, and then based on that to identify countermeasures to that • To develop a rating system, similar to the ANCAP rating system, that could be used to determine the safeness or the safety level of any vehicles in vehicle – that is promising. • More discussion and collaboration needed with manufacturers to ensure that new in-vehicle technology does not become a

Identified Research Theme	Research topics
	distraction • Identifying between different vehicle types and try to measure which is more or less distracting • To what extent distracted driving can be prevented by technological solutions
Theme 4: Impact of positioning of infotainment systems and other technology in the vehicle on driver distraction	• Research on visual display units in terms of size and position. What is the optimum size, level of brightness and graphics, and position in terms of visual field and level of driver distraction?
Theme 5: Safety features of the vehicle	• Development of electronic tools and devices that will immobilise specific applications when a vehicle is driven. • Understanding the level of awareness, knowledge and understanding a vehicles' safety features by the driver, and research into whether, who and how many people will switch the in-vehicle technology off and to what extent drivers rely on them. • Understanding to what extent some of these safety features distract the driver. • Understanding to what extent drivers rely on these features to keep them safe and lead to complacency. • To what extent technological solutions can prevent driver distraction. • Currently there is some evidence, primarily derived from simulator research studies, that distraction prevention systems (i.e. workload managers) have some potential safety benefits. However, future research in on-road studies is needed to confirm whether these potential benefits are realised in external environments. • Further development of the HMI distraction rating project and the ANCAP rating project for in-vehicle technology.
Theme 6: Risk identification and calculation of distracted driving	• Research and calculation of compound risk of distraction. Calculating the compounding of risk of distraction in various conditions. • Research into identifying devising crash risks using proper methodological methods that control for confounding variables. • Driver distraction among specific groups, for example delivery drivers.
Theme 7: The effectiveness of distracted driving messages:	• Research into the effectiveness of awareness campaigns to reduce distracted driving. What is the most effective medium? How should the message be delivered and to whom? What is the right message? How can we measure the effect of the message? • What is required to change drivers behaviour? To what extent can we influence and change behaviour and how can it be done.

4.12.2 Methodological complexities

The participants identified several methodological complexities and issues related to research in this space as well what is needed in the future to ensure robust research and evaluations:

- Currently it appears that distracted driving might be underreported by law enforcement and other agencies. Incidents and offences involving mobile phones or distracted driving in the broader sense is reported as something else which creates difficulties when administrative data is used.
- A better identification and reporting of mobile phone offence data, crashes caused by distraction, and distracted driving in the work-related space is necessary.
- There are evaluations on the benefits of different safety vehicle technologies, but they are not evaluating how that technology reduces distraction, they are evaluating how the technology reduces trauma resulting from distraction and other things.
- Evaluations are often conducted after the program has been designed and implemented. However, a better approach is to build the evaluation framework into the program.
- It is very difficult to effectively measure distraction. Currently it is primarily conducted through naturalistic driving studies, however running a pilot with a control element to test and evaluate or a randomised control trial might provide a more accurate finding.

4.13 Summary

In 2020 Australia recorded 19,793,497 motor vehicles for road use in 2020, of these 74.1% were passenger vehicles, with almost 70% registered in the major cities. Distraction is estimated to contribute to X% of crashes in Australia. However, as the interviewees indicated, distracted driving is no one thing with no one cause. Distractions can be in-vehicle distractions such as passengers and drivers themselves, technology brought into the vehicle and technology built into the vehicle, as well as out-of-vehicle distractions. While the driver has some control over the in-vehicle distractions, there is less over the out-of-vehicle distractions. Some of the in-vehicle distractions cannot be avoided, such as passengers, while others can, such as the use of a mobile phone or a visual display unit. Handheld mobile phone use and the use of a visual display unit are clearly legislated under the enforcement legislation as being banned. Hands-free mobile-phone use while driving is allowed under strict circumstances.

Enforcing the ban on handheld mobile phone while driving is resource-intensive for policing agencies and is not necessarily effective. Mobile phone detection cameras can overcome some resourcing issues and show promise as an enforcement tool, but there is some suggestion that they may not necessarily be an effective deterrent. Increasingly, drivers divert to using mobile phone hands-free, which is legal, however, as participants indicated, hands-free mobile phone use while driving is not less distracting or dangerous. To reduce all mobile phone use while driving requires an attitude change. People do not understand the risk, and particularly hands-free use, because it is legal, they think it is not unsafe.

While distraction includes anything that distracts a driver from the primary driving task, it is difficult to define in enforcement legislation. Distracted driving has for some researchers and policy makers become erroneously synonymous with mobile use and the interaction with those devices. However, as indicated in the interviews, driver distractions are broader than mobile phone use. While there are some sections in the enforcement legislation that can be applied to distracted driving, these sections are not clearly defined, often leaving it open to interpretation for individual police officers and making it only possible to enforce after an incident has occurred.

Participants indicated that some of the in-vehicle technology, which is becoming more common in new vehicles, can also lead to distraction. These in-vehicle technologies are categorised into infotainment systems and in-vehicle safety technology. Infotainment systems are increasingly marketed as safety features, and because they are legal and built in drivers do not consider them a safety issue. However, they still require cognitive space and a manual task from the driver which takes them away from the driving task. Additionally, some systems are complex to operate. Participants reported that in-vehicle safety technology can distract the driver when alarms ring or a vehicle auto-corrects. There are also some concerns that this technology can lead to over-confidence that the vehicle will keep the driver safe when distracted, allowing the driver to think that they can undertake another task while driving. It can also cause concerns when the driver changes to a 'less smart' vehicle as they need to adapt to driving without these features.

Deterring and addressing distracted driving requires a multi-faceted approach. Interviewees indicated that enforcement alone does not work. Strategies, awareness campaigns and education are imperative, and the focus on distracted driving, particularly mobile phone use, is increasing. However, there other options to address distracted driving. Under workplace health and safety legislation in each State and Territory, vehicles are considered a workplace. However, some workplaces appear to be lagging in recognising that fact. Mobile phone use while driving is inversely related to productivity, and some employers are slow to recognise a change is necessary. In addition, rideshare operators, taxi drivers and delivery drivers are often sole operators and do not necessarily fall under the relevant workplace health and safety laws.

There is also an opportunity to address distracted driving with motor vehicle manufacturers and retailers. Closer collaboration between all stakeholders and more regulation or oversight by third parties for motor vehicle manufacturers regarding infotainment systems (the amount and placement, to minimise distraction) is necessary. There is also a role to play for motor vehicle retailers. Participants indicated that they should educate buyers and ensure they understand the build-in technology safety features of their vehicles at the point of sale.

Furthermore, there are other entities that could be relied upon to reduce distracted driving. For example, insurance companies could review their policies and premiums for those drivers that have been caught with a distracted driving offence, similarly to Alberta in Canada, stricter enforcement of applying 'duty of care' by employers or ensuring when contracts are procured clause about distracted driving is included. However, what is needed on the long-term is cultural and attitude change, similar to drink driving and seatbelts.

5. Future directions

Overall, research in the distracted driving space uses a range of research methodologies and has occurred in a range of countries. Most of the studies used quantitative methodologies (e.g. Murphy & Greene, 2017; Rowe et al., 2016). There is scope to improve our understanding of driver distraction using qualitative approaches to augment the quantitative work. While most of the studies occurred within the USA (e.g. Fitch et al., 2015; Stavrinos, Mosley, et al., 2016), a significant proportion have occurred within the Australian context (e.g. Moore & Brown, 2019; Samsa, 2015). One exception to this is research regarding legislation and enforcement of distracted driving within Australia. This is a significant gap as Australia is a world leader in road policing approaches and is trialling innovative methods of mobile phone enforcement. Given this, the diverse nature of distracted driving, and the unique Australian driving context, suggests the need to continue to undertake research into distracted driving within Australia.

Although a significant amount of research has identified high levels of distracted driving (e.g. Woods-Fry et al., 2018), there is a need to continue this research in order to understand longitudinal trends. Additionally, much of the research has focused on mobile phone distraction (e.g. Žuraulis et al., 2018). However, given the wide range of factors that distract drivers, further research is needed on other forms of distractions such as technology, talking with passengers and intrapersonal distractions.

A significant proportion of research is focused on technological distractions. However, as shown in section 3.4.1 of this report, there are a wide range of technologies that can be used by drivers and the effects of these on driver distraction is variable (Tippey et al., 2017). Given that technologies may be used within a vehicle to make drivers safer by warning them of hazards, and that some drivers may find these warnings distracting, there is a need to identify an optimum balance between driver warnings and safety. The interviews with stakeholders also suggested that there is a need for research regarding the effect of infotainment systems on driver distraction as well as the positioning of these systems and other technologies within the vehicle.

The research in some areas of driver distraction is inconclusive. This is the case with billboards or roadside signage. Given this, there is need to explore which elements of roadside signage are distracting or the best way to design billboards to limit distraction. The interviews with stakeholders supported the need for research in this area as well as other distractions that result from out of the vehicle.

This review classed a number of population groups such as those with ADHD or traumatic brain injuries within the ‘intrapersonal factors’ category. Some of these groups, such as those with ADHD, appear more likely to be distracted while driving (e.g. Randell et al., 2015; Shaw et al., 2019), although, this may change depending on whether an individual is taking medication.

The interviews with stakeholders suggested the need to consider other types of groups including professional drivers such as delivery and rideshare drivers. Further research is needed to identify the effects of distraction on different sub-populations such these and the ways to counter the effects of these distractions to enhance the safety of these individuals as well as the others who travel with them or are on the road with them.

Likewise, there has been some research into the effects of personality on distracted driving (e.g. Braitman & Braitman, 2017; Fountas et al., 2019; Johansson & Fyhri, 2017). However, there are a large number of personality characteristics. The impact of these on distracted driving, and interventions that target distracted driving, needs further investigation.

Self-regulation, or the ability to manage your interaction with distracting influences or mind-wandering, requires further investigation. It appears that low self-control leads to higher levels of texting while driving (Meldrum et al., 2019) and vice versa (Quisenberry, 2015). While it appears that very few drivers self-regulate (Oviedo-Trespalacios, Haque, et al., 2019), research has shown that drivers engage less frequently in a secondary task when they are able to foresee a demanding driving situation (Wandtner et al., 2016).

There does appear to be scope to develop interventions and successfully apply them within a professional driver population (e.g. Rana et al., 2018). Work obligations have been identified as a significant factor with mobile phone use while driving (Engelberg et al., 2015; Hill et al., 2018). The interviews identified that there are more legal levers (such as workplace health and safety legislation) that can be used for professional drivers that will encourage them to reduce their distracted driving. One example of how legislation can extend the responsibility for road safety from the specific professional driver to the employer is the HVNL that has been passed in most Australian states (National Heavy Vehicle Regulator, 2020). Additionally, as noted by the stakeholders, there is a need for research into the effectiveness of public awareness campaigns in the distracted driving space.

Given that the use of theory is associated with more successful interventions (Glanz & Bishop, 2010), there is a need for more theory-driven research. As noted in sections 2.3.3 and 3.4.8 of this report, there are wide range of theories used within the driver distraction research space including the General Theory of Crime (Quisenberry, 2015), Attitude Functional Theory (Wang, 2016), Stages of Change Model (Sinelnikov & Wells, 2017) and Deterrence Theory (Truelove et al., 2019). As noted, the Theory of Planned

Behaviour has been used the most frequently (e.g. Chen, Donmez, Hoekstra-Atwood, & Marulanda, 2016; Oviedo-Trespalacios, King, et al., 2019). This is in addition to the major approaches used in the field: the Human Factors approach (e.g. Nguyen-Phuoc, Oviedo-Trespalacios, Su, De Gruyter, & Nguyen, 2020; Zahabi, Pankok, et al., 2020) and the STC approach (e.g. Parnell et al., 2019; Young & Salmon, 2015). STC researchers suggest that driver-centric approaches to road safety are frequently piecemeal and ineffective and that ecological validity in research design is critical. Future research should continue to use a range of appropriate theories and frameworks to help us both understand distracted driving and develop interventions to counteract it.

Research is needed regarding approaches that seek to reduce distracted driving (or types of distracted driving) through a more holistic approach. This could include gaining an understanding of how policy professionals make decisions regarding distracted driving, collaborations between regulators and private industry, evaluating vehicle standards and examining workplace health and safety approaches.

There is research and policy based work continuing to occur within the distracted driving field. Appendix B lists the key researchers and the organisations that employ them. Additionally, there is collaborative work taking place between the Australian and Queensland governments using an ecosystem approach to minimise distracted driving and its effects.

Distracted driving is a significant road safety issue that occurs in many forms. The research focus to date has been on mobile phones and technological interventions more broadly. However, as noted in this report, distractions can occur in many forms. The effect of driver distraction on various sub-populations differs and further research is needed to clarify these effects as well as the way intrapersonal factors such as personality interact with distraction. Self-regulation and interventions may be helpful in counteracting the negative effects of distracted driving. However, further theory-based research is required.

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7. List of Australian legislation

Australian Capital Territory

Road Transport (Safety and Traffic Management) Act 1999: https://www.legislation.act.gov.au/DownloadFile/a/1999-80/current/PDF/1999-80.PDF

Road Transport (Road Rules) Regulation 2017: https://www.legislation.act.gov.au/View/sl/2017-43/current/PDF/2017-43.PDF

New South Wales

Road Transport Act 2013: https://www.legislation.nsw.gov.au/view/whole/html/inforce/current/act-2013-018

Road Rules 2014: https://www.legislation.nsw.gov.au/view/whole/html/inforce/current/sl-2014-0758#sec.299

Road Transport Regulation 2017: https://www.legislation.nsw.gov.au/view/html/inforce/current/sl-2017-0450#sec.40

Penalties: https://www.rms.nsw.gov.au/documents/roads/safety-rules/demerits-general.pdf

Northern Territory

Traffic Act 1987: https://legislation.nt.gov.au/en/Legislation/TRAFFIC-ACT-1987

Traffic Regulations 1999: https://legislation.nt.gov.au/Legislation/TRAFFIC-REGULATIONS-1999

Traffic Regulations, Schedule 3: https://legislation.nt.gov.au/en/Legislation/TRAFFIC-REGULATIONS-SCHEDULE-3-ARRs-1999

South Australia

Motor vehicles act 1959: https://www.legislation.sa.gov.au/LZ/C/A/MOTOR%20VEHICLES%20ACT%201959/CURRENT/1959.53.AUTH.PDF

Road Traffic Act 1961: https://www.legislation.sa.gov.au/lz/c/a/road%20traffic%20act%201961.aspx

Australian Road Rules: https://www.legislation.sa.gov.au/LZ/C/R/Australian%20Road%20Rules.aspx

Road Traffic Regulations 2014: https://www.legislation.sa.gov.au/LZ/C/R/Road%20Traffic%20(Road%20Rules%20-%20Ancillary%20and%20Miscellaneous%20Provisions)%20Regulations%202014.aspx

Penalties: https://lawhandbook.sa.gov.au/media/Traffic%20Offences%20and%20Penalties%20as%20at%20May%202014.pdf

Tasmania

Traffic Act 1925: https://www.legislation.tas.gov.au/view/whole/html/inforce/current/act-1925-038

Road Rules 2019: https://www.legislation.tas.gov.au/view/whole/html/inforce/current/sr-2019-061

Queensland:

Transport Operations Act 1995: https://www.legislation.qld.gov.au/view/html/inforce/current/act-1995-009

Transport Operations Regulation 2009: https://www.legislation.qld.gov.au/view/html/inforce/current/sl-2009-0194

Transport Operations Regulation 2010: https://www.legislation.qld.gov.au/view/pdf/inforce/2019-04-01/sl-2010-0206

Victoria

Road Safety Act 1986: https://content.legislation.vic.gov.au/sites/default/files/2020-12/86-127aa203%20authorised_0.pdf

Road Rules 2017: https://content.legislation.vic.gov.au/sites/default/files/2020-12/17-41sra010%20authorised.pdf

Road Safety (Drivers) Regulation 2019: https://content.legislation.vic.gov.au/sites/default/files/2020-12/19-100sra006%20authorised.pdf

Western Australia

Road Traffic Act 1974: https://www.legislation.wa.gov.au/legislation/prod/filestore.nsf/FileURL/mrdoc_43537.htm/$FILE/Road%20Traffic%20Act%201974%20-%20%5B14-n0-00%5D.html?OpenElement

Road Traffic Code 2000: https://www.legislation.wa.gov.au/legislation/prod/filestore.nsf/FileURL/mrdoc_43465.htm/$FILE/Road%20Traffic%20Code%202000%20-%20%5B05-r0-00%5D.html?OpenElement

8. Appendices

Please see separate Appendices document.

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