ROAD SAFETY IMPLICATIONS OF IN-VEHICLE DRIVER DISTRACTION

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1 A BRIEF STATEMENT OF THE ISSUE

Any activity that distracts the driver from the primary driving task has the potential to compromise safety and increase crash risk. While distraction can also derive from objects or events external to the vehicle, this paper focuses upon the primary sources of driver distraction from within the vehicle. There is increasing evidence that in-vehicle sources of distraction are a major contributor to road crashes.

2 AN ASSESSMENT OF THE ROAD SAFETY ISSUE

2.1 What is driver distraction?

Driver distraction occurs when a driver's attention is voluntarily or involuntarily diverted away from the driving task by an event, object or activity to the extent that the driver is no longer able to perform the driving task adequately or safely (Young & Regan 2005). Distractions can include visual stimuli (e.g. a mobile phone display screen), auditory stimuli (e.g. a car radio), internally generated stimuli (e.g. daydreaming), olfactory stimuli (e.g. the smell of a hamburger), and stimuli associated with the performance of physical activities (e.g. tuning a radio without looking at it). One or more of these stimulus sources can compete simultaneously for attention whilst driving, for example when a driver looks at mobile phone control buttons whilst physically dialling them.

The diversion of attention away from the driving task will not always degrade driving performance: Humans can satisfactorily perform two tasks simultaneously if the tasks demand only limited attention (Gladstones et al. 1989). Factors such as how well practised are the tasks and the time-sharing strategies that are used to perform them influence the total supply of attention available. In addition, the tasks must be as dissimilar as possible, as the human brain is better able to perform these concurrently (Wickens 1992).

Driving a car (a visual/manual task) and having a conversation with a passenger (an auditory/verbal task) are dissimilar tasks. If the traffic is light and the conversation is simple, the two tasks can be combined with relative ease. If an unexpected traffic event occurs, however, the driver may stop talking because the combined attentional demands of the tasks are too high. Conversely, if the conversation becomes too complex, driving performance may suffer. The degree to which a driver is distracted also depends on 'tactical behaviours' (e.g. deciding to adopt longer headways when talking to a passenger) and 'strategic behaviours' (e.g. deciding not to have a mobile phone in the car (Lee & Strayer 2004).

2.2 The role of in-vehicle driver distraction in crashes

The extent to which distraction is a road safety problem in Australia is a function of both the prevalence of distraction while driving and the increased crash risk associated with various sources of distraction.

Prevalence of distracting activities

While there has been no systematic investigation of the prevalence of drivers engaging in potentially distracting activities while driving in Australia, limited survey evidence shows that around one-third of mobile phone users regularly use hand-held phones while driving and that 58% of young drivers admit to *reading* text messages and 37% to *sending* text messages while driving (Telstra 2003; Telstra 2004). A recent observational study also found that approximately 2% of Melbourne drivers were observed using a hand-held phone while driving (Taylor et al. 2003). However, no other Australian data are available regarding drivers' exposure to other sources of distraction (e.g. entertainment systems, satellite navigation, etc.).

Impact of driver distraction

Of the limited number of studies that have examined the impact of various sources of distraction on crashes and crash risk, most have focused on mobile phones – commonly showing that phone usage while driving is associated with around a four-fold crash risk (McEvoy et al. 2005; Redelmeier & Tibshirani 1997). In addition, US and New Zealand crash-based studies have found that using entertainment systems (e.g. radio and CD player) accounts for between 5% and 11.4% of all distraction-related crashes (Gordon 2005; Stutts et al. 2001), eating and drinking for between 1.7% and 4.2% (Glaze & Ellis 2003; Stutts et al. 2001), of such crashes, and interacting with passengers between 8.7% and 10.9% of distraction crashes (Gordon 2005; Stutts et al. 2001), Interacting with an email system while driving has also been found to lead to a 3.5% to 38.5% increase in crashes in a simulated road environment (Lee et al. 2001).

The number of crashes in Australia for which distraction is a contributing factor is not currently known, due particularly to limitations in collecting valid data of this sort via Police crash reports. In New Zealand, where more detailed Police crash report forms are used, it is estimated that 10% of crashes involve some form of distraction as a contributing factor (Gordon 2005),

Early analysis of crash data (Wang et al. 1996) from the US indicated that about 25% of all crashes were a result of inattention, with about half of these thought to be attributable to distraction. The findings of the more recent '100-Car Naturalistic Driving Study' suggest that distraction may be a contributing factor in up to 38% of crashes (Klauer et al. 2005). Overseas findings relating to increased crash risks and high prevalence of crashes associated with distraction give reason to believe that distraction is also a significant contributing factor to crashes in Australia.

3 CURRENT POLICIES AND PRACTICES IN AUSTRALASIAN JURISDICTIONS

The current Australian Road Rules contain two rules regarding the use of in-vehicle devices and technologies by drivers while driving:

- **Australian Road Rule 300** states that: 'The driver of a vehicle (except emergency and police vehicles) must not use a hand-held mobile phone while the vehicle is moving, or is stationary but not parked, unless the driver is exempt from this rule under another law of this jurisdiction' (p. 221). A failure to obey this rule can result in a loss of demerit points (3 points in Victoria and NSW and 1 point in WA) and a fine ($141 fine in Victoria, $225 in NSW and $100 in WA).

- **Australian Road Rule 299** states that: 'A driver must not drive a motor vehicle that has a television receiver or visual display unit in or on the vehicle operating while the vehicle is moving, or is stationary but not parked, if any part of the image on the screen is visible to the driver from the normal driving position or is likely to distract another driver (p. 220). This rule does not apply if the visual display unit is, or is part of, a driver's aid (e.g. closed-circuit television security cameras, dispatch system, navigational or intelligent highway and vehicle system equipment, rear-view screens, ticket-issuing machines, or a vehicle monitoring device).

Despite the absence of any further laws in Australia, many vehicle manufacturers recognise the dangers associated with using certain features of advanced driver assistance systems while driving: for example, some vehicle manufacturers 'lock-out' some navigation functions, particularly the destination entry function, when the vehicle is in motion (Farber et al. 2000).

In New Zealand, **Land Transport Rule: Vehicle Equipment 2004** requires that any television screen fitted in a motor vehicle must not be wholly or partly visible to the driver from his or her normal driving position while the vehicle is in motion – the main exceptions to this rule relating to screens that convey only information about the navigation, safe operation and control of the vehicle.

4 A REVIEW OF THE DRIVER DISTRACTION RESEARCH

4.1 Mobile phones

There is a vast body of literature examining the detrimental impact of mobile phone usage on driving performance (Goodman et al. 1997; Horberry et al. 2006; RoSPA 2002). These are reviewed in more detail elsewhere in this series (Symmonds & Langford 2005).

4.2 Text messaging

A recent Australian survey has found that 58% of young drivers aged 17 to 29 years admit to *reading* text messages and 37% to *sending* text messages while driving (McEvoy et al. 2005). Despite this prevalence, very little research has been conducted on the distracting effects of sending or receiving text messages while driving. A recent Australian study found that retrieving and, in particular, sending text messages adversely affects young novice drivers' driving performance (Hosking et al. 2005). Sending and retrieving text messages increased by 400% the amount of time drivers spent with their eyes off the road. Lane position variability also increased and drivers made 28% more lane excursions and 140% more incorrect lane changes when retrieving and sending text messages. The results also revealed that drivers attempted to compensate for these impairments in their driving by increasing the distance between themselves and the vehicle ahead but did not, however, reduce their speed.

4.3 In-vehicle navigation systems

In-vehicle navigation systems to guide drivers along the most direct route to a particular destination, are available in Australia in many luxury vehicles and can also be purchased off-the-shelf as portable devices. A particular concern with the use of route guidance systems relates to entering destination information while driving. Various methods exist for making these entries: selecting the required destination from a scrolling list of suburb and street names; manually typing in the number, street and suburb of the destination letter by letter; or using voice input to enter the destination details (Tijerina et al. 2000). Research (Tijerina et al. 1998) has revealed that visual and manual destination entries are associated with longer completion times, longer eyes-off-road times, more frequent glances at the device, and a greater number of lane exceedances compared to voice-activated input systems. Later simulator research (Tsimhoni et al. 2004) also concluded

that route guidance systems with voice recognition technology are a more viable and safer option than systems that require visual or manual entry.

A route guidance system also instructs the driver en route as to the best course to take, using a visual display, a computer-generated voice message, or both. In the case of visual displays, information can be presented either as an electronic route map (similar to a conventional map), or as a turn-by-turn display (usually left and right arrows at each turn point). Systems that provide turn-by turn instructions, rather than presenting complex map displays, are less distracting to the driver and present the most useable means of navigation, especially when they are accompanied by voice guidance (Dingus et al. 1995). This combination has also been shown to be less cognitively demanding than using a conventional paper map, resulting in less abrupt braking manoeuvres and lower workload ratings (Dingus et al. 1995).

4.4 In-vehicle email and Internet facilities

Email and Internet facilities are predicted to become an important element of car 'infotainment' systems, to enable the driver to download traffic updates and weather reports to improve traffic flow, obtain information on parking availability and to access emails and web-based information (Burns, & Lansdown 2000). However, the distraction associated with their use while driving is a concern for researchers, car manufacturers and designers.

Two studies have examined the effects on driving performance of retrieving, reading and responding to email messages. When a driving simulator was used to examine the effects of a speech-based email system on drivers' attention (Lee et al. 2001), it was found that reaction time to the braking lead vehicle was 30% longer than when not interacting with the system. Moreover, this 30% increase in reaction time translated into a 3.5% to 38.5% increase in collisions and 27.3% to 80.7% increase in collision velocity. Interaction with the speech-based email system also increased drivers' workload levels and this was highest for the complex email system. In a follow-up study (Jamson et al. 2004), it was found that drivers adopted longer headways to compensate for the increased workload associated with a speech-based email task, but drivers were again slower to brake in response to a braking lead vehicle and made less corrective steering movements when distracted. Interacting with an email system was less distracting, however, when drivers had control over when the emails were opened.

4.5 Radios and compact disk (CD) players

Despite the prevalence of car radios in Australia, surprisingly little research has directly examined their impact on drivers. Overseas research suggests that simply listening to radio broadcasts while driving can impair driving performance, resulting in more lane deviations, particularly under complex driving conditions (Jancke et al. 1994). On the one hand, it has been found that manually tuning the radio using a turn dial is less distracting than dialling or talking on a mobile phone or operating an in-vehicle navigation system (California Highway Patrol 1987; Horberry et al. 2006; McKnight, & McKnight 1993; Strayer et al. 2001). On the other hand, studies have found that tuning a radio degrades driving performance more than holding a simple conversation on a mobile phone, particularly when driving in adverse conditions (e.g. in wet, slippery conditions) and particularly for novice drivers (Briem & Hedman 1995; Wikman et al. 1998).

In-car CD players are another potential source of distraction. In one study, participants made more lane deviations and glances away from the road and took the longest amount of time to complete the trials when operating the CD player (e.g. inserting and ejecting CDs and selecting tracks), than when eating or dialling numbers on a mobile phone (Jenness et al. 2002). However, recent evidence suggests that the use of voice-activation may minimise the distraction associated with using CD players while driving (Gaertner et al. 2002).

4.6 Television, video and DVD

Rear seat television/video/DVD systems are currently among one of the best selling in-car devices on the market in the United States (Technical Insights 2001). These systems are now also available in many new Australian cars. No research, to the knowledge of the authors, has examined the influence of these systems on driver performance. Although legislation is already in place in Australia that prohibits television and video/DVD systems to be mounted in the vehicle where the driver can view them while they are driving, it is likely that televisions and video/DVD systems could distract drivers if they try to 'listen in' to programs.

4.7 Non-technology based distraction

Drivers often engage in a number of non technology-based activities, such as eating, drinking, smoking and interacting with passengers, which have the potential to distract them from the driving task and increase their crash risk. A study by the American Automobile Association revealed that a greater proportion of drivers involved in traffic accidents are distracted by eating or drinking (1.7%) than by talking on a mobile phone (1.5%) (Stutts et al. 2001). Another study (Jenness et al. 2002) found that eating a cheeseburger was as distracting as using a voice-activated dialling system, but less distracting than continuously operating a CD player. Several studies have also found that smoking while driving increases the risk of being involved in a crash (Brison 1990; Christie 1991; Violanti & Marshall 1996). The association between smoking and increased crash risk could be the result of three factors: distraction caused by smoking, behavioural differences between smokers and non-smokers, and carbon-monoxide toxicity.

The distracting effects of passengers are less well understood due to a lack of direct research. However, anecdotal evidence suggests that passengers can indeed be a distraction under certain circumstances. Research on teenage passengers has revealed that the presence of passengers increases crash risk, particularly for younger drivers, and this is believed to be the result of distraction and/or social influences (e.g. peer pressure) that arise from interactions between drivers and passengers (Williams 2001). What is not understood, however, is the relative contribution that these two factors make to the observed increases in crash risk.

An Australian study (Regan & Mitsopoulos 2001) found that some drivers find the presence of passengers distracting to the point where they are less likely to detect traffic light changes or road signs. Overseas research has found that passengers are the source of distraction in around 11% of distraction-related crashes (Stutts et al. 2001) and that drivers spend over 15% of their driving time interacting with passengers (Stutts et al. 2003).

4.8 Factors moderating the effects of driver distraction

The degree to which an object, event or activity distracts a driver is determined by the complex interaction of several factors: the willingness of the driver to engage in the distracting activity, the amount of time the driver spends engaging in the activity; the difficulty of the distracting activity; the demands of the driving task; and driver characteristics (e.g. age and driving experience (Young & Regan 2005). A non-driving task that distracts drivers and degrades driving in one situation may not do so in another situation and, similarly, non-driving tasks may differentially affect drivers from different driving populations.

Research has shown that the design of a device, the complexity and/or emotionality of the secondary task being performed, the complexity of the driving environment and driver characteristics, such as age and driving experience, can all influence the potential for non-driving tasks to distract drivers. Generally, this research has found that as the difficulty of the secondary and/or driving tasks increases, the potential for the task to degrade driving performance also increases. Phone conversations which are complex or emotional have a greater detrimental impact on driving than less complex conversations (Harbluk et al. 2002). Similarly, performing a secondary task while driving in adverse weather conditions or heavy traffic has been shown to impair driving to a greater extent than when driving in good weather or less traffic (Cooper & Zheng 2002; Strayer et al. 2003).

Older drivers and young novice drivers have also been shown to be more susceptible to the distracting effects of engaging in secondary tasks while driving than experienced or middle-aged drivers (Lam 2002; McKnight & McKnight 1993; McPhee et al. 2004; Shinar et al. 2005). Young novice drivers are more vulnerable because they have not yet automated many driving activities, and hence have less spare attentional capacity to devote to secondary tasks. They are also probably less effective in self-regulating their driving performances across tasks. Older drivers, on the other hand, require more glances at mobile phones and other devices to read information, require more time to complete tasks, require more time to move their eyes between the road and displays inside the vehicle, and have less attention to distribute between competing tasks.

5 POLITICAL, SOCIAL AND OTHER FACTORS ASSOCIATED WITH DRIVER DISTRACTION

Traditionally, vehicles have been built for mobility, pleasure and safety. Increasing time and work pressures, however, mean that more drivers are now using their car as a mobile source of information, communication and entertainment. The rate of proliferation of entertainment, information and communication, and driver assistance systems entering the vehicle is likely to increase dramatically in the coming years. The incidence of distraction-related crashes is thus likely to increase unless appropriate countermeasures are developed and implemented.

There is converging evidence that driver distraction degrades driving performance and safety. Australia appears to lag behind other countries in addressing this issue. For example, the current lack of distracted-related crash data in Australia is preventing an accurate assessment of the number of people being killed and injured in crashes as a result of driver distraction.

Australia is also reliant on the automotive industry and its suppliers to develop and apply voluntary safety standards, guidelines and checklists for the ergonomic design of vehicle cockpit systems and interfaces to minimise distraction. A problem with this voluntary approach, however, is that many ergonomic standards, even if industry were aware of them, still allow for some unduly distracting tasks to be carried out by drivers while driving. Further, it does not ensure that all systems, features and services – both factory-fitted and aftermarket devices - are safely integrated into the driver-vehicle system.

While there is evidence that automobile manufacturers are voluntarily taking steps to limit distraction deriving from factory-fitted systems in vehicle cockpits, it is not known what steps, if any, are being taken to limit distraction by the designers, developers and suppliers of aftermarket systems sold in Australia.

In addition, the Australian Design Rules (ADRs) appear to be inadequate in preventing some systems and services, which have the potential to distract drivers from being installed in new vehicles. Australian States and Territories also have no established approval processes for ensuring that aftermarket products installed in vehicles continue to comply with the ADRs that applied at the date of manufacture of a vehicle.

The Australian Road Rules and other State and Territory road safety rules and regulations are currently inadequate in preventing some systems and services, which have potential to distract drivers, from being used by them while driving. The legislation is lagging behind developments in in-vehicle technologies.

Unless countermeasures are developed to limit the adverse effects of driver distraction, it has potential to escalate into a major road safety problem in Australia. Appendix A highlights potential areas for countermeasure development (Regan 2005).

6 CONCLUSION AND RECOMMENDATIONS

As an initial point, this paper has attempted to clarify the notion of in-vehicle driver distraction thus: driver distraction occurs when a driver's attention is voluntarily or involuntarily diverted away from the driving task by an event, object or activity to the extent that the driver is no longer able to perform the driving task adequately or safely (Young & Regan 2005). This represents an important starting point to exploring this issue and might well be considered as a possible standard definition for further research activities The paper has also shown that driver distraction currently is a major contributor to road trauma and furthermore, it is likely that that the prevalence of distraction as a risk factor will increase as more new technologies enter the vehicle. It is critical, therefore, that policies and programs are developed and implemented in Australia and New Zealand to manage existing and emerging risks associated with driver distraction.

For a more detailed discussion of driver distraction, the reader is referred to a Monash University Accident Research Centre Report (Young et al. 2003).

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APPENDIX A: POTENTIAL DRIVER DISTRACTION COUNTERMEASURES

The following is an extract from a paper by Regan (2005) which highlights potential areas for driver distraction countermeasure development.

Data

Police report forms should be amended to record data about distracting activities. Most new vehicles are equipped with event data recorders which could also be used to automatically record information about the use of telematics systems, for example, what information was displayed and what controls were being operated just before and during a crash. This would help to clarify the role of these devices in crashes.

Regular exposure surveys need to be developed, administered and analysed to determine what, when, where, why, and how drivers engage in distracting activities. These are already undertaken in Australia to monitor a wide range of other risk factors, such as speed.

Education

Governments, Police, motoring clubs and other relevant agencies should conduct education and publicity campaigns to raise public awareness of the relative dangers associated with engaging in distracting activities, how to minimise the effects of distraction, and the penalties associated with engaging in distracting activities where these exist. As a matter of priority, it is important that the Australian public be made aware that text messaging is potentially more dangerous than using a hand-held phone, and that hands-free phones are just as risky as hand-held phones. The immediate focus should be on those groups most vulnerable to the effects of distraction.

Training

Learner drivers need to be trained in how to safely manage distraction. In particular, it needs to be determined at what stage in their training it is best to start exposing learner drivers to distracting activities, such as talking to passengers. Learner drivers also need training in how to optimally self-regulate their driving to reduce the effects of distraction and the optimal modes in which to program and interact with systems - both on-board systems and portable devices carried into the vehicle. Learner drivers need to be made self-aware of, and calibrated, through training, on the effects of distraction on their driving performance and passengers need to be trained in how to act as co-pilots by behaving in a manner which minimises distraction. The focus should be on team training, not just driver training.

Legislation

There is currently very little regulation in Australia governing the design and use of vehicle technologies that have potential to distract the driver. There is a need to review the existing legislation and, where necessary, to create new legislation to limit driver exposure to distracting activities.

Vehicle design

One of the most effective ways to reduce driver distraction deriving from technologies is to ensure that the human machine interface within the vehicle is designed ergonomically – by vehicle manufacturers and the manufacturers of portable devices brought into the vehicle.

In Australia there is a reliance on industry to develop and apply voluntary safety standards for the ergonomic design of cockpit technologies. The problem with this voluntary approach is that many ergonomic standards, even if industry were aware of them, still allow for some unduly distracting tasks to be carried out by drivers while driving and do not ensure that all features of in-vehicle telematics devices are safely integrated into the driver-vehicle system.

One way to resolve this problem is for governments to enter into a Memorandum of Understanding with industry that ensures that systems entering the market will meet certain minimum requirements. It is important that such an approach involves consultation with all relevant stakeholders - drivers, vehicle manufacturers, aftermarket system suppliers, information service providers and road authorities.

Road design

Distractions deriving from outside the vehicle are significant in number and type, yet very little is being done around the world to address this issue. There is a need to develop a taxonomy of those objects, events and activities that are potential sources of distraction outside the vehicle and to determine to what extent drivers are exposed to these sources. There is a critical need, as more traffic information is displayed inside the vehicle cockpit, for vehicle manufacturers to enter into dialogue with traffic engineers - to ensure that there are no incompatibilities in the design, timing and number of traffic messages and signals impinging on the driver from within and outside the vehicle. Road safety audits, routinely undertaken in this country, should include criteria for the identification and ergonomic assessment of traffic management activities, objects and events that could distract drivers and degrade driving performance. As for vehicle design, there is a need for Memoranda of Understanding with industry, and between different tiers of government, to ensure that the traffic management system is designed ergonomically to limit the adverse effects of distraction.

Research

There are a number of priority areas for research on driver distraction. These have been reviewed elsewhere (Young & Regan 2005). Notable is the relative absence of research on distraction deriving from outside the vehicle and the effects of distraction on the performance and safety of pedestrians, motorcycle riders and other road users.

Enforcement

Intelligent transport system technologies now exist that could significantly enhance the ability of Police to enforce traffic laws. For example, it should be possible to configure mobile phones so that they can only be used if the vehicle is travelling below a particular speed, or when stationary. It is also important to survey Police to assess their experience and views regarding their current ability to detect and penalise drivers who engage in distracting activities that are known to compromise their safety and that of other road users.

Employers

Almost half of the crashes on Australasian roads occur when driving vehicles for work purposes. Guidance for employers to raise awareness among their staff of the dangers of engaging in distracting activities is therefore critical. The guidelines should explain to employers their legal responsibilities and potential liabilities, methods for collecting and analysing data on the role of distraction in incidents and crashes, and policies that could be adopted by them and by employees to limit the adverse effects of distraction. This should include information that stimulates employers to purchase vehicle types and technologies that maximise safety and minimise distraction.

Licensing

Finally, handbooks for learner drivers can draw attention to the relative risks associated with engaging in distracting activities. Knowledge tests should include items pertaining to the relative risks associated with these activities and strategies for reducing their impact on driving. The graduated licensing system should be used to systematically expose young drivers to distracting activities that are known to compromise safety and to test for their ability to manage them.