Driver Distraction

Prepared for IAM RoadSmart by Dr Neale Kinnear and Professor Alan Stevens

TRL, Crowthorne House, Nine Mile Ride, Wokingham, Berks, UK, RG40 3GA.

1 Introduction

This report for the Institute of Advanced Motorists (IAM) summarises recent research and knowledge from scientific studies about distracted driving. The report defines what it means to be 'distracted' when driving, discusses the impact of distraction on driver behaviour and safety, and what can be done to reduce distracted driving. The focus of distraction discussed here relates to how drivers engage with technology when driving.

The report begins with a background to driver distraction, followed by discussion about what is actually meant by driver distraction. It is then considered why humans cannot successfully do two things at the same time, particularly within the context of driving. The subsequent section summarises the scientific research findings to date with regard to driver distraction and technology, and how this affects different types of road user. Recommendations for how driver distraction can be mitigated in the real world and a summary conclude the report. Responses to common questions raised by drivers are presented in Appendix A.

2 Background

Being distracted can make drivers less aware of other road users such as pedestrians, cyclists and road workers and less observant of road rules such as speed limits and junction controls. The emergence of mobile and in-vehicle technology in particular has prompted much recent concern about driver distraction and its impact on driver behaviour and safety. In Britain, the Department for Transport (DfT) reports that in 2013 there were 2,995 cases where distraction in the vehicle is listed as a contributory factor, making up 3% of all accidents, and 1,627 where distraction outside the vehicle was a contributory factor, making up 1% of all accidents. Of these, 84 and 27 were fatal accidents, making up 6% and 2% of all fatal accidents respectively. These figures are likely to be underestimates given the difficulty in determining contributory factors after accidents have occurred, and the often transitory nature of distraction.

The specific influence of technology and electronic devices on distraction-related accidents is difficult to determine as there is a lack of reliable data. Although there are numerous reports containing the frequency of use of mobile phones and other electronic devices in road traffic, determining the true relationship between levels of use and accident risk is difficult.

Official accident data from across Europe indicates how varied the measured contribution of distraction to road accidents is, with estimates ranging from a few percent to over half. It is probable that various definitions of distraction and inattention are used when collecting data and this is likely to explain some of the variance in estimates; in addition some countries simply don't collect data on distraction at all. It is also worth noting that the increase of mobile communication and in-vehicle technologies into the mass market is a relatively recent phenomenon and will have varied market penetration from country to country. It is possible that studies are relying on data that may not reflect current conditions and conditions that are not comparable between countries.

Even in-depth accident investigation studies have relied upon broad definitions of distraction and inattention as contributory factors. It is not known whether this is because there are few instances of these events occurring or whether it is due to difficulties in recording such instances because of the lack of any retrospective evidence. For example, it is often difficult to attribute the cause of an accident to a distracting event that occurred prior to the crash and is no longer present.

3 What actually is 'distraction' when driving?

Drivers do much more than control the vehicle when driving. Video observation research reveals them engaging in various secondary activities including:

- Adjusting an entertainment system or climate control
- Consulting maps
- Eating / drinking / smoking
- Interacting with passengers
- Looking at roadside objects / signs / advertising
- Reading and writing
- Adjusting clothing and undertaking body care
- Text messaging, internet, social media and talking on a mobile phone

Driver distraction occurs when a driver diverts their attention away from the activities needed for safe driving. By "safe driving" we mean exercising sufficient awareness of the environment and control of the vehicle to maintain a reasonable safety margin allowing for unexpected events. This requires continuous monitoring of the road, infrastructure and traffic environment including the road ahead and the behaviour of other road users. Distracted driving is the state that occurs when ***attention is given to a non-driving related activity, typically to the detriment of driving performance***[1]. Diversion of attention might be due to some event, activity, object or person, within or outside the vehicle.

Inattention is a broader term than distraction. A driver can be inattentive due to distraction (misdirected attention) OR due to being insufficiently attentive (e.g. fatigued or unmotivated) such that a gap emerges between the requirements for safe driving and the attention a driver gives to driving. Giving insufficient attention to the task of driving is rather different from misdirecting it (i.e. being distracted), although driving performance will suffer and the overall risk of a crash increases in both cases.

3.1 Types of distractions

Driver distraction can be classified into the following four sub-categories, depending on what the source of distraction is:

Cognitive or mental distraction occurs when the driver's mind is engaged with other tasks not necessary for safe driving, and that compete with mental or cognitive resources needed for driving.

Visual distraction occurs when a driver takes their eyes off the road. Typically this is caused when the driver looks away from the road to engage in a secondary activity either inside (e.g. radio, telephone, sat-nav) or outside (e.g. signs, advertisements) of the vehicle.

Auditory distraction occurs when a driver is subjected to noise that diverts attention from activities necessary for safe driving. Auditory distraction is likely to be combined with other distractions such as looking to establish the source (e.g. to locate a ringing telephone) or paying attention to a phone conversation impacting on cognitive resources. Audible vehicle warnings meanwhile may offer a positive form of 'attention-grabbing' when they highlight an essential safety risk (e.g. seat belt warning or lane departure warning).

[1] Engström et al. (2013) – see Sources section for full reference

Manual distraction occurs when the driver takes their hands (either one or both) off the vehicle controls to attend to an activity that is not required for safe driving. The most common examples are eating, drinking and interacting with portable electronic devices (e.g. texting).

These four sub-categories are not mutually exclusive and often drivers experience more than one type of distraction at the same time. How safe or unsafe the distraction becomes also depends on its intensity, the driving situation (e.g. driving on a bendy rural road versus stopped at traffic lights) and its timing (e.g. coinciding with an unexpected event versus not).

Table 1 highlights some common distracting activities and, as an example, crudely identifies their impact on different types of distraction and the length of time for which a driver is likely to be distracted. This demonstrates how different distractions cannot necessarily be targeted by a single mitigation approach.

Table 1: Examples of distraction and their effect of types of distraction (Distraction effect key: H (red)=high; M (orange)=medium; L (green)=Low)

Distraction example	Cognitive	Visual	Audible	Manual	Exposure time
Mobile phone – Texting	H	H	L	H	M
Mobile phone – Dialling	M	H	L	H	L
Mobile phone – Conversation	H	L	H	L	H
Sat-nav (following route)	M	M	L	L	M
Eating and smoking	L	M	L	H	M
External signage or advertising	M	H	L	L	L
Speech-to-text or Voice control	H	M	M	L	L

3.2 Distraction and safety

The many factors which determine how much risk is associated with different distractions, in part, explains the diversity of historical scientific findings on the subject (see section entitled "The research to date"). The reported size of the effect of distraction on crash risk can vary considerably but a frequently-cited study[2] suggests that phone use while driving is associated with a fourfold increase in crash risk and another widely quoted study[3] found that certain aspects of driving performance in a simulator were impaired more by having a mobile phone conversation (hands-free or hand-held) than having a blood alcohol concentration at the (then) UK legal limit (80mg of alcohol per 100ml of blood)[4].

[2] Redelmeier & Tibshirani (1997)

[3] Burns et al. (2002)

[4] Since December 2014 the legal blood alcohol concentration limit in Scotland is 50mg of alcohol per 100ml of blood.

However, the impact of distraction on safety depends on the duration of the distraction and how frequently it happens (i.e. the length of time for which the driver is exposed to the additional risk). For example, tuning the radio may cause visual, auditory and manual distraction, but for only a very short period of time; engaging in a hands-free telephone conversation does not require so much visual attention but the cognitive and auditory distraction is likely to extend for a significantly longer period of time (i.e. for the length of the call).

What is clear from research is that drivers knowingly engage in activities that they consider distracting. For example, surveys[5] suggest that the majority of drivers are concerned about driver distraction, rate certain activities (such as reading and writing a text message and having a phone conversation) as being highly distracting when driving, yet also report undertaking these activities when driving on a regular (weekly) basis. Drivers are clearly aware that certain distracting activities affect their driving, but how accurately they are judging the relationship with crash risk is unknown. It is possible that drivers overestimate their ability to multi-task and their behaviour is being driven by other social and emotional motivations, such as the innate desire for communication and social interaction.

Factors involved in distraction related crash risk

Timing – coinciding with an unexpected event is more critical in a high workload situation, such as when negotiating a junction

Intensity – texting requires more resource than listening to the radio

Resumability – the extent to which tasks can be dropped and re-started efficiently

Frequency – actions repeated more often are more likely to coincide with a critical event

Duration – duration of the distraction will increase the probability of the distraction coinciding with a critical situation

Hang-over effect – any lingering cognitive or emotional distraction beyond task completion.

4 Why humans cannot do two things at the same time

4.1 Driving is a complex task

To understand distraction we must first understand how humans process information and their limits. Cognitive psychology is the study of internal mental processes such as learning, memory and skilled performance. Through decades of study psychologists know a great deal about these internal mental processes. Specifically, the limitations of mental performance are well understood; for example we understand the amount of information people can generally hold in their short-term memory, and the way people process the information around them when trying to perform more than one task at once.

One relevant concept here is that we know different parts of the brain do different things. The mental processes used to perform complex skills are reliant on various areas of the brain, or combinations of them. Driving is a complex skill and therefore draws on many mental processes and parts of the brain. A brief consideration of even the simplest journey by car will confirm this; to reach your destination a driver needs to remember the route (memory – short or long term depending on whether they already know the route), they need to maintain control of their vehicle (physical and perceptual skill), interact safely with other road users (perceptual and cognitive skill involving anticipation and understanding of other road users' intentions) and do

[5] For example, RAC (2014) and Lansdown (2012)

all this while adhering to road rules (memory), interacting with other road users (social understanding), and controlling any stress or emotion that may arise from the inevitable frustration and threat present in a modern driving environment (inhibiting emotions, dealing with stress caused by delays, other road user actions etc.). In short, when driving, a person must engage almost all of their mental faculties (in other words, it is not simply about physically controlling the car) so it is not surprising that attention-grabbing distractions can interfere with successful and safe completion of the driving task.

4.2 Cognitive limits – multitasking is a myth

Research has confirmed that tasks almost always interfere with other tasks carried out at the same time. The brain never actually focuses on two tasks at the same time, it switches back and forth between them – true 'multi-tasking' is a myth.

If you do more than one thing at the same time, your performance suffers as you struggle to divide your attention. Split attention can be detrimental to the quality and accuracy of your performance on either task; it has also been shown to interfere with learning.

As driving is so complex and requires various cognitive processes, taking on another task when driving can mean that a driver is unable to pay sufficient attention to all the activities required for safe driving. This can lead to a processing failure resulting in loss of control, putting the driver and other road users in physical danger.

Example: Experienced drivers become 'like novices' at reading the road when completing a secondary task

Hazard anticipation (sometimes called 'hazard perception' after the video-based test used to measure it in the GB Driving Theory Test) is a critical skill for safe driving. Another way of thinking about hazard anticipation is that it is 'reading the road'. It has been shown in numerous studies that higher hazard anticpation skill is related to having fewer accidents.

An experimental study by McKenna and Farrand (1999) examined the effect of a conversation-like task on hazard anticipation times using experienced and novice drivers.

When both groups of drivers took a hazard perception test on its own, experienced drivers scored much better than novices, as expected. However, when taking a hazard perception test AND carrying out a conversation-like task at the same time, experienced drivers' scores reduced even more than novice scores did, with both groups performing at a similar level.

This experiment is an example of how a simple conversation-like task, mimicking a phone conversation, can impact on an acquired skill needed for safe driving such as hazard anticipation.

4.3 Driver behaviour and safety margins

Various simple models of driver behaviour have been proposed in which drivers adapt their behaviour and allocation of attention in order to maintain a "safety margin" and thus avoid crashes. These models suggest that drivers aim to drive within an acceptable range of task demand that feels comfortable, leaving a margin for error which the driver is prepared to accept. The physical and mental demand of driving is dependent on many factors in the driver's environment. If demand is high and approaches a driver's capability to control the vehicle then feelings of anxiety or fear for both safety and prosecution (e.g. if breaking the speed limit) are likely to cause a driver to take action (e.g. reduce their speed).

While a driver can often control the sense of demand by altering their speed, drivers may also take on tasks, such as speaking on a mobile phone, when the driving context is unchallenging (low task demand) or dump tasks when driving requires extra attention (high task demand). The effect of the extra demand caused by mobile phone conversations has been demonstrated with drivers found to reduce their speed and increase their following distance in order to reduce overall demand when engaged in this secondary task.

Of course, drivers may have erroneous expectations of the driving environment, may overestimate their abilities, or have strong motivations to engage in an additional (non-driving) task. Differences between novice and experienced drivers' behaviours and particularly their allocation of attention suggest that appropriate attention allocation is a skill acquired through repeated practice at and exposure to driving. However, as already shown (box above) both inexperienced and experienced drivers are affected by performing non-driving related tasks when driving.

5 The research to date

5.1 Technology and distraction

5.1.1 A brief history

In-car radios were, perhaps, the first form of new technology to be widely used while driving a road vehicle. In-car entertainment systems have become virtually ubiquitous and fitted as standard by vehicle manufacturers. With the development of portable information and communication devices, drivers may also

bring a plethora of personal equipment into a vehicle, some of which can even connect to the vehicle (for example via Bluetooth and Wifi).

In-vehicle devices such as information and communication systems can greatly assist the driver (for example by indicating suitable routes) but each new technology that enters the market has the potential to influence driving behaviour, and may increase or decrease distraction; it is difficult to predict the precise impact of new technologies in advance.

Observational Study of Mobile Phone Use

In 2014, 1.6 per cent of all drivers in England and Scotland were observed using a hand-held mobile phone whilst driving according to a DfT study. Drivers were more likely to be observed with a mobile phone in their hand rather than holding it to their ear (1.1 % in hand and 0.5% to ear).

This suggests that while holding the phone in their hand, drivers are using the speaker-phone function while calling (perhaps to look less conspicuous when engaged in what is essentially still a hand-held call) or that they are engaged in other smartphone activities (e.g. texting, internet, social media).

Drivers interact with the technology using a 'Human Machine Interface', or HMI, and behind the interface is the logic and software of the interaction which contributes greatly to its look and feel. Designing or choosing an HMI that is appropriate for the context of use can have a decisive effect on the safety, effectiveness and ease of use of technology and services for individuals and for widely different groups of users.

One key conclusion of early research in laboratories and with driving simulators was that using a mobile phone was distracting and that text messaging causes visual as well as manual distraction in addition to cognitive distraction. Therefore, this behaviour is considered even more dangerous than simply using the phone to make calls.

Such research findings led to the introduction of laws during the 2000s in the UK and elsewhere (e.g. the Netherlands) to restrict hand-held mobile phone usage, and to educational campaigns to raise awareness about the risks of distracted driving. There is limited evidence for the effectiveness of these approaches but drivers continue to use their mobile devices while driving, and it remains a key concern for road safety. One of the reasons has been the growing functionality of mobile phones as smartphone market penetration rose rapidly and drivers became accustomed to doing more with their phones. Numerous laboratory and simulator studies have concluded that concurrent use of a mobile phone or smartphone while driving impacts negatively on the performance of both the phone task and driving. How this relates to safety in the real world has been more difficult to determine.

Measurements made in laboratory settings and driving simulators may not be representative of real driving behaviour. This is because in real driving contexts drivers can choose when to interact (or not) with devices – and can modify their driving style to compensate to some extent for other demands on their attention.

5.1.2 Naturalistic studies

A "naturalistic" driving study aims to unobtrusively record driver behaviour. Analysis of video and other data collected during a participant's driving can be used to identify safety-related events, although the interpretation of results can be problematic and controversial.

Recent "naturalistic" driving studies have shown that driver distraction from new technologies is a much more complex problem than initially thought. In large studies in the USA, tasks necessitating glances away from the road, such as text messaging and dialling, have been confirmed to be highly distracting but the risks associated

with conversing on a mobile phone are mixed and dependent on crash types[6]. Drivers make behaviour modifications (possibly unconsciously) when engaging in a mobile phone conversation while driving; for example they reduce speed, increase distance to the vehicle in front, stay in lane and increase focus on the forward road. These behaviours appear to increase the safety margin for rear-end collisions, although it is likely that the safety margin for unexpected events that occur in the driver's periphery is consequently reduced.

"An off road glance is only perfectly safe when the safety margins adopted are sufficient to protect the driver if the situation changes rapidly during the glance"

(Victor et al., 2014)

In general, naturalistic studies suggest that conversing on a mobile phone is not as risky as locating the phone, dialling the phone or texting and that the critical factors in this differentiation are the time the eyes are off the road and the safety margin adopted by the driver. Clearly a driver not looking at the forward road scene is unable to properly control their vehicle and the longer they look away the more their awareness of the external situation reduces. It is not surprising, therefore, that research shows that long glances away from the forward roadway strongly increase crash risk.

It is worth noting that phone conversations tend to last a lot longer than texting or dialling. While a driver can mitigate some of their risk (for example for rear end collisions) when driving and conversing on a mobile phone, the longer they are less engaged with driving and their surroundings, the more chance there is of something happening outside of their control, due to something they have failed to anticipate. For this reason, conversing on a mobile phone while driving is still considered to be a road safety risk overall.

The case of the mobile phone highlights why the use of technology when driving must be considered as task specific rather than device specific. The use of a mobile phone while driving can involve tasks such as locating the phone, answering a call, finding a contact, dialling a number, reading a text, writing a text, playing a game, accessing the internet, map reading and satellite navigation. Each of these sub-tasks of mobile phone use will require varying forms of physical, auditory, visual and cognitive resources, and impact driving behaviour and safety differently. Aside from a complete ban on electronic devices while driving, distraction can only be resolved with consideration of each task individually.

5.1.3 Future technologies

In the last few years vehicles have become available offering Head Up Displays (HUDs), speech-to-text and voice command functions. The impact of these on distraction in practice is largely unknown but is an increasing area for research. Some in-depth experimental studies in the USA suggest that the cognitive distraction caused by certain voice-based systems can exceed traditional forms of engagement with technology and may in fact have the unintended consequence of increasing driver distraction[7]. Such findings highlight the importance of device design and development of the HMI (Human Machine Interface).

A new class of technology dubbed "wearables" is also likely to affect driver behaviour and distraction. For example, smart glasses are multifunctional computers which are worn on the head and typically display visual information to the user through lenses mounted in or near the eye line. These could reduce driver distraction in comparison with conventional displays or may present information in a more compelling manner, resulting in additional distraction.

[6] Victor et al. (2014); Fitch et al., (2013); Klauer et al., (2006; 2010; 2014); Hickman et al. (2010); Olson et al., (2009)

[7] Strayer et al. (2013; 2014)

Another technology trend is that of "black box" data collection (typically for insurance or fleet management purposes) and this could be extended to identify what systems were activated and what the driver is doing. Such data would be of use in crash reconstruction, although knowledge that data on driver and other factors were being collected might influence driver behaviour.

5.2 Distraction and types of road users

5.2.1 Young drivers

Young and inexperienced drivers are at greater crash risk due to a lack of mature visual search patterns, poor calibration of expected risk with actual risk, over-confidence, and an inability to anticipate hazards effectively. Young drivers are also the most likely cohort of drivers to own and use mobile communications technology and other electronic devices.

Recent studies[8] with young and novice drivers suggest that when looking away from the road for more than two seconds due to engagement with a mobile communication device there was a greater risk of a crash or near-crash event. For each additional second the driver looked away, the risk of a crash or near-crash event increased. Results also suggest that multiple short glances (e.g. <1s) are more beneficial than longer single glances. These studies have also noted that long glances away from the road for more than two seconds are rare but strongly associated with the use of mobile electronic devices, and that young drivers were more likely than older drivers to look away from the road for longer periods of time.

5.2.2 Older Drivers

In general, research suggests that age related decline in visual perception and cognitive executive functions affect older drivers' driving performance. However, older drivers appear to compensate for such limitations by choosing when and where they drive and also how they drive. A TRL study for the IAM[9] found that while older drivers took around a second longer to respond to a pedestrian walking out from behind a parked car than did younger drivers (in a simulated scenario), because of their slower initial speed they stopped further from the pedestrian than younger drivers. Possibly due to age related decline, studies[10] appear to indicate that the effect of mobile phone use while driving is exaggerated for older drivers when compared with other age groups and that older drivers demonstrate greater difficulty when following route guidance technologies.

5.2.3 Professional Drivers

Professional drivers are often required to engage with more in-vehicle equipment than private drivers, spend long periods of time in their vehicles and can be under time pressure. Employers are increasingly recognising that they have a duty of care towards their employees and the public, and that it makes business as well as safety sense to have strict no-distraction policies for technologies such as mobile phones when driving.

Most of the evidence for distraction of professional drivers comes from naturalistic studies of heavy goods vehicle drivers in the USA. One study[11] reported that drivers were performing tasks unrelated to driving during 56.5% of safety-critical events. In addition, drivers who texted while driving were 23 times more likely to be involved in a safety-critical event than drivers who did not. However, drivers who talked on a mobile phone (hands-free or handheld) while driving were no more likely to be involved in a safety critical event than those who did not. There is evidence that drivers self-regulate the demand of the driving task when engaging in a

[8] Foss & Goodwin (2014); Klauer et al. (2014); Simons-Morton et al. (2014)

[9] Reed et al. (2012)

[10] For example, Aksan et al. (2013); Cooper et al. (2003); Dingus et al., (1997); Fofanova & Vollrath (2011)

[11] Olson et al. (2009)

phone conversation by manipulating their speed, following-distance and focus on the forward roadway. The main difference proposed to offset the increased demand of the phone conversation task (and risk) for commercial drivers has been found to be increased visual attention to the forward roadway when engaged in conversations on the phone.

5.2.4 Cyclists

There are very few experimental studies of distraction when cycling although surveys indicate that the use of portable electronic devices when cycling is a growing trend. Experimental studies[12] indicate that the effects of mobile phone use on cycling behaviour are similar to the effects of mobile phone use on driving behaviour. When talking or texting on a mobile phone while cycling bicyclists travel at slower speeds, miss more information from the periphery and swerve more within the bike path.

5.2.5 Pedestrians

There is only a small body of research detailing the distracting effects of portable electronic devices on pedestrian behaviour. Nevertheless, secondary task use of devices such as mobile phones appears to have similar effects for pedestrians as it does for drivers and bicyclists, particularly with regard to reduced peripheral attention. These studies suggest that successful crossing behaviour is compromised when engaged with another activity, with texting on a mobile phone in particular increasing the likelihood of being hit by a vehicle in a simulated environment.

6 Recommendations for reducing distraction

This section considers how to address distraction in a real-world context. It discusses some important considerations and possible mitigation strategies involving various stakeholders. There are different national and local approaches to mitigate distraction ranging from guidelines and advice, to bans on specific activities or functions (such as texting or hand-held phone use). To increase safety there appears to be a need for an array of countermeasures and a need for cooperation between different stakeholders.

6.1 Measuring and understanding the impact of distraction on safety

There are still many questions around distraction and its impact on road safety and with developments in vehicle technology and information technology more generally, there are always new opportunities for unintended impacts.

There is a particular need to better understand the role of distraction in road traffic crashes and this could involve review and development of existing reporting systems and analysis of on-board vehicle data.

Standard definitions

Driver inattention: "…inattention occurs when the driver's allocation of resources to activities does not match the demands of activities required for the control of safety margins."

Driver distraction: "…where the driver allocates resources to a non-safety critical activity while the resources allocated to activities critical for safe driving do not match the demands of these activities."

Activities critical for safe driving: "…those activities required for the control of safety margins…"

(Engström et al., 2013)

[12] de Waard et al. (2010; 2011; 2014)

Recommendations:

- Adopt agreed standard definitions.
- Continue research on distraction particularly the impact of new technologies on safety, using standardised measures of real driver behaviour and crash data where possible.
- Improve analysis and understanding of the role of distraction in crashes.
- Monitor public opinion, attitudes and behaviour regarding the issue of driver distraction on a regular basis.

6.2 Laws and enforcement

There is little international consensus on how to decrease the impact of driver distraction through legislation. The most general laws, as in the UK, address careless driving and allow authorities to reprimand drivers who pose a risk.

Although the more specific laws banning the use of handheld phones have not led to a significant decrease in the number of crashes caused by distraction, many governments are still investigating how to refine or expand these laws. Others, such as Sweden, have taken a broader approach favouring to encourage and enforce personal responsibility for driving safely rather than a specific technology-related law.

Enforcement of existing driver distraction laws may be a key issue in reducing mobile device use in particular. Deterrence theory would suggest that the probability of detection and certainty of prosecution may be a greater dis-incentive to distracted driving than the legal penalty.

Enforcement can be problematic due to the difficulties in identifying distraction from outside the vehicle. Authorities also cite that miniaturisation of devices make detection difficult.

Recommendations:

- Support the general law approach such as driving without care and attention/careless driving.
- Provide guidance (possibly in the Highway Code and for new drivers) concerning interpretation and specific technology examples (which can be readily updated).
- Enforcement of mobile phone laws needs to be highly visible and publicised to maximise its effect on driver behaviour

6.3 Guidelines for technology

The ease of use of technology in a vehicle is dependent on the design of the controls and the interaction of all the various devices used by the driver (navigation, vehicle information displays, climate control buttons etc.) including portable devices such as smartphones.

There is a wide range of international standards covering visual and audible driver interfaces and dialogue management and much of this knowledge has been incorporated into design guidelines and codes of practice on how to develop in-car systems that minimise distraction.

The European Statement of Principles (ESoP), backed by the European Commission, is an example of a set of high-level design guidelines which vehicle manufacturers find useful as part of their design process and which do not constrain innovation. These guidelines represent a consensus that (unlike laws) can be more rapidly updated as technologies evolve. Supporting good human machine interface (HMI) design without being overly-prescriptive or technology-specific is likely to be helpful.

Recommendation:

- Support continued updating of HMI guidelines as an important tool for governments and the automotive industry to mitigate driver distraction.
- Support industry to develop their own best practice and explore mechanisms to ensure these meet the government-backed guidelines (e.g. through certification or consumer testing).

6.4 Technical approaches to restrict distraction

Technical solutions restricting smartphone functions within vehicles are available, for example by apps on the phone. They become active when the phone's motion exceeds some threshold. Other systems are integrated into the vehicle and affect all cell phones in the vehicle through a small transmitter. These solutions can, for example, block incoming calls, texts and emails while in motion or when moving in a specific geographic area. Each system has a different strategy for addressing the "passenger problem" – whether and how to allow calls by someone in motion who is not a driver, such as a passenger in a car or a rider on a bus or train.

Such systems can be demonstrated to work technically but there is little information on their overall effectiveness in practice. Such approaches may be more likely to work in a fleet or organisational context where the fleet owner can have such equipment installed and periodically can check how effective it is.

A related technical approach is that of "workload management" such that the vehicle collects sensor information to estimate the driver's current workload and then manages tasks and information such that the driver is less likely to become overloaded. For example, a text message might be delayed until the driver has left a busy road junction.

Recommendation:

- Support research to determine effectiveness of technological solutions.
- Publicise the availability of systems and approaches to restrict the functionality of potentially distracting in-vehicle technologies and encourage use and evaluation by fleet operators.
- Make vehicles to support drivers and avoid distraction: in-vehicle warnings and intervention-based systems can mitigate distraction – their uptake as standard may be a faster route to risk reduction than modifying driver behaviour.

6.5 Driving for work policies

Fleet managers and employers can have a substantial influence on the safety of their employees/drivers through policies, practices, instructions, training and feedback. A number of organisations have produced corporate guidelines, policies and advice on driver distraction. This can be supported and justified both in terms of safety and business benefits.

Governments and companies can influence change by setting an example, including specific requirements on minimum safety levels in their vehicle purchase and supply procurement policies. In the US, government employees are banned from texting while driving and when they are inviting tenders for transport or other services, they can do so only to providers who can demonstrate suitable policies and practices supporting safe driving.

Recommendation:

- The risk associated with distracted driving and the use of mobile phones and electronic devices should clearly be reflected in driving for work policies. Employers should ensure that the policy is clearly articulated and broadly communicated so that employees are aware of the existence of the policies.
- Government and employers should set minimum safety standards for procurement of vehicles and service providers.

6.6 Education and training

In general, drivers are aware of the risks associated with distracting activities. There is a particular issue with young and inexperienced drivers who have not developed the risk awareness and risk management skills that experienced drivers employ when interacting with in-vehicle devices. Experienced drivers typically adjust their behaviour to the requirements of traffic situations, nevertheless, they too have cognitive processing limitations. It is uncertain whether vulnerable road users (i.e. children, pedestrians and cyclists) are accurately appraising the greater risk of engaging with traffic when distracted.

Simply instructing drivers and other road users to not be distracted is unlikely to be sufficient and their use of electronic devices cannot be expected to be lower than what is deemed as socially acceptable.

Technology will continue to develop and working with technology manufacturers and drivers (and other road users) to identify the safest way to interact will likely be a more fruitful route within the educational approach. This might begin with in-school road safety education, being built upon during driver licensing, possibly alongside legislation that prevents the development of undesirable habitual technology use when driving, instead encouraging a responsible approach to engagement.

Recommendations:

- Review and strengthen the advice in the Highway Code and the learning to drive competency framework regarding distracted driving.
- Provide core messages at the early stages of road skills development (e.g. when providing road safety messages for pedestrian and cycling behaviour to children).
- Develop educational and training interventions specifically to guide the use of emerging technology in vehicles.
- Education and training should be carefully developed and evaluated to ensure no harm is being done (e.g. unintended consequences).

7 Summary

It is widely accepted within the scientific community that humans cannot conduct multiple tasks at the same time without adverse effects on the performance of those tasks; this is due to the need to share their limited attentional resources and switch between tasks. When specifically studying driving, numerous experimental studies overwhelmingly demonstrate that driving performance (as measured by things like speed management, lane discipline and hazard perception) is impaired when a driver is also using a mobile electronic device or in-vehicle technologies (or performs tasks that mimic. However, the relationship with safety on the road is a more complex picture with some real-world studies showing that drivers' adapt their behaviour when speaking on the phone and driving (for example, they slow down, stay in lane, increase distance to other vehicles and increase focus on the road ahead). Studies suggest that this change in behaviour is effective at increasing the safety margin to certain crash types (i.e. rear end crashes); however during the length of a phone call it is likely that the driver is much less likely to anticipate hazards and unexpected events in their periphery.

Adapting behaviour is an indication of drivers' coping mechanisms for dealing with the added attentional demands of using technology, in order to maintain their safety margins. These changes are (possibly non-conscious) responses to the increased demand being placed upon their limited cognitive resources.

Overall the research suggests that the impact of distraction on safety is task-dependent rather than device dependent; for example, texting appears to be more dangerous than conversing on a mobile phone while driving. It seems that this may be related to a dynamic combination of 'eyes off the road' time necessary to

conduct the task and the safety margins with which a driver can afford themselves. Any mismatch in this process (e.g. failure to correctly appraise safety margins) will increase the risk of a crash.

Essentially though, all non-driving related tasks that require our attention will reduce the attention being paid to driving safely. With technology now a key part of our day-to-day lives it is important to consider how the research knowledge collected to date can inform strategies for reducing distraction and increasing safety on the roads. The recommendations made here suggest that the input and engagement of multiple stakeholders will be necessary.

Appendix A

Common questions

Isn't talking on the phone just the same as talking to a passenger?

- No. Passengers are more aware of the driving context and are known to modify their interaction depending on the traffic situation. For example, they are more likely to understand why a response is delayed or a conversation is interrupted.
- Research has shown that it is more demanding to have a conversation on the phone than with a passenger. Conversations on a phone tend to be less effective and the sound quality can often require more attention.

Car radios are not critical for driving but they have been in cars for years without any known safety problems?

- Even tuning the radio is distracting to some degree, but doesn't usually last very long, and doesn't require a high level of cognitive engagement. The evidence suggests that phone conversations do and tend to last for longer periods of time than things like tuning a radio.
- Any non-safety critical technology that requires the driver to engage with it for a long period of time or take their eyes off the road is distracting and will increase crash risk. In addition to speaking on the phone, that could involve typing directions into a sat-nav, finding music on a music player, texting or social media.

I am an experienced driver and I know when it is safe to use my phone.

- Even experienced drivers overestimate their abilities. It has been shown that experienced drivers can sometimes be *more* affected by distractions – they lose the benefits of their experience by being distracted and fail to anticipate hazards they would usually 'see early'.

Young drivers have better reactions and can easily do other things while driving?

- The limits of human attention apply to everyone, regardless of age. Young drivers may have better reactions than older drivers, but we know that young, and particularly novice, drivers are not good at accurately judging their own abilities or the risks on the road. The result of this is smaller safety margins when things go wrong.
- Young people are also used to having unlimited access to their electronic equipment such as smartphones and may be less inhibited to respond when someone calls or sends them a messages.

I use devices when driving almost every day and I have never had an accident.

- In general, your risk of being in an accident increases when you engage in a non-driving activity while driving, according to the evidence. It does not mean you *will* crash, but you are more likely to be involved in a crash.
- The performance of your driving is also likely to suffer without you realising – for example you may be less aware of other drivers' actions and may make bad decisions. Other drivers are likely to notice.
- Consider other road users, you are putting them at risk too.

Surely I can just slow down when I use electronic devices?

- Even if you do, it is unlikely that you will completely offset the safety deficit. Travelling at a lower speed will help, but the distracting effects may limit other attentional requirements like peripheral vision and hazard anticipation.
- In addition, you may make sudden changes in speed to which other drivers may find it difficult to react
- All drivers tend to overestimate their skill – you are unlikely to be able to know for sure if you are slowing down enough.

Isn't driving 'automatic'?

- No it is not – this is a common misperception – for example the skill of 'reading the road' or 'hazard anticipation' has been shown to be especially badly affected by having a phone conversation – even in experienced drivers.
- The bottom line is that whenever people do more than one thing at once, they inevitably perform one of those things (and often both of those things) worse than if they performed either task by itself.

I need to use my phone for work.

- Companies who change their policy to move away from phone use while driving tend to do so on the basis of caring about the health and safety of employees; companies also have a legal obligation to reduce risk.
- Many companies now accept that it looks more professional to have a workforce that does not use their phone while driving.

Many modern cars come 'phone-ready' – doesn't this indicate that it is acceptable?

- All modern cars can all be driven quite easily at speeds far in excess of the speed limit. What a car is built to do by manufacturers is not necessarily a good indicator of the safety of that behaviour.

If it is so dangerous why is hands-free phone use not illegal?

- Driving poorly because you are distracted by using a mobile phone can result in the police charging you with failing to have proper control of your vehicle (handheld or hands-free).
- If you had a crash the police could check if you were using your phone (hands-free or handheld) at the time and may choose to prosecute you – you could be responsible for causing a crash and potentially injuring or killing another person.

Can I use my phone when stationary at traffic lights?

- You may consider this a lower risk situation but the Government advice is that the rules are the same if you're stopped at traffic lights or queuing in traffic.
- It's also illegal to use a hand-held phone or similar device when supervising a learner driver or rider.

Sources

Aksan, N., Dawson, J. D., Emerson, J. L., Yu, L., Uc, E. Y., Anderson, S. W., & Rizzo, M. (2013). Naturalistic distraction and driving safety in older drivers. Human Factors, 55(4), 841–853.

Basacik, D., & Stevens, A. (2008). Scoping study of driver distraction. London: Department for Transport. Road Safety Research Report No. 95. October 2008. ISBN 978 1 906581 24 4.

Burns, P. C., Parkes, A., Burton, S., Smith, R. K., & Burch, D. (2002). How dangerous is driving with a mobile phone? Benchmarking the impairment to alcohol. TRL report 547. Crowthorne: TRL

Caird, J. K., Johnston, K. A., Willness, C. R., Asbridge, M., & Steel, P. (2014). A meta-analysis of the effects of texting on driving. Accident Analysis & Prevention, 71, 311-318.

Cooper, P. J., Zheng, Y., Richard, C., Vavrik, J., Heinrichs, B., & Siegmund, G. (2003). The impact of hands-free message reception/response on driving task performance. Accident Analysis & Prevention, 35(1), 23-35.

de Waard, D., Schepers, P., Ormel, W., & Brookhuis, K. (2010). Mobile phone use while cycling: Incidence and effects on behaviour and safety. Ergonomics, 53(1), 30-42.

de Waard, D., Edlinger, K., & Brookhuis, K. (2011). Effects of listening to music, and of using a handheld and handsfree telephone on cycling behaviour. Transportation research part F: traffic psychology and behaviour, 14(6), 626-637.

De Waard, D., Lewis-Evans, B., Jelijs, B., Tucha, O., & Brookhuis, K. (2014). The effects of operating a touch screen smartphone and other common activities performed while bicycling on cycling behaviour. Transportation research part F: traffic psychology and behaviour, 22, 196-206.

DfT (2014) Seatbelt and mobile phone use surveys: 2014 https://www.gov.uk/government/statistics/seatbelt-and-mobile-phone-use-surveys-2014

Dingus, T. A., Klauer, S. G., Neale, V. L., Petersen, A., Lee, S. E., Sudweeks, J., Perez, M. A., Hankey, J., Ramsey, D., Gupta, S., Bucher, C., Doerzaph, Z. R., Jermeland, J., and Knipling, R. R. (2006). "The 100-Car Naturalistic Driving Study, Phase II - Results of the 100-Car Field Experiment" DOT HS 810 593. National Highway Traffic Safety Administration, USDOT.

Driver distraction - the role and impact of governments. February 2013 SBD Report ARD/CON/519

Engström, J., Monk, C. A., Hanowski, R. J., Horrey, W. J., Lee, J. D., McGehee, D. V. & Yang, C. Y. D. (2013). A conceptual framework and taxonomy for understanding and categorizing driver inattention. Brussels, Belgium: European Commission.

European Commission (2008) ESoP. European Statement of Principles on the Design of Human Machine Interface. European Commission Information Society and Media Directorate-General – G4 ICT for Transport. Available at:

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:216:0001:0042:EN:PDF

Farrand, P., & McKenna, F. P. (2001). Risk perception in novice drivers: The relationship between questionnaire measures and response latency. Transportation research part F: traffic psychology and behaviour, 4(3), 201-212.

Federal Motor Carrier Safety Administration. The Large Truck Crash Causation Study Summary Report. 2005. Available at: http://ai.fmcsa.dot.gov/ltccs/default.asp. Accessed June 5, 2011.

Fofanova, J., & Vollrath, M. (2011). Distraction while driving: The case of older drivers. Transportation research part F: traffic psychology and behaviour, 14(6), 638-648.

Foss, R. D., & Goodwin, A. H. (2014). Distracted driver behaviors and distracting conditions among adolescent drivers: findings from a naturalistic driving study. Journal of Adolescent Health, 54(5), S50-S60.

Fuller, R. (2011). Driver control theory: from task difficulty homeostasis to risk allostasis. In Porter, B. (Ed.), Handbook of Traffic Psychology. London: Academic Press.

Hickman, J. S., Hanowski, R. J., & Bocanegra, J. (2010). "Distraction in commercial trucks and buses: Assessing prevalence and risk in conjunction with crashes and near-crashes." Report No. FMCSA-RRR-10-049. Washington D.C.: Federal Motor Carrier Safety Administration.

Horswill, M. S., & McKenna, F. P. (1999). The effect of interference on dynamic risk-taking judgments. British journal of psychology, 90(2), 189-199.

Hyman, I. E. Jr., Boss, S. M., Wise, B. W., McKenzie, K. E. & Caggiano, J. M. (2010). Did You See the Unicycling Clown? Inattentional Blindness while Walking and Talking on a Cell Phone. Journal of Applied Cognitive Psychology, Vol. 24, 597-607.

Klauer, S. G., Dingus, T. A., Neale, V. L., Sudweeks, J. D., & Ramsey, D. J. (2006). The Impact of Driver Inattention on Near-Crash/Crash Risk: An Analysis Using the 100-Car Naturalistic Driving Study Data. Report No. DOT HS 810 594, National Highway Traffic Safety Administration, Washington, D. C.

Klauer, S. G., Guo, F., Simons-Morton, B. G., Ouimet, M. C., Lee, S. E., & Dingus, T. A. (2014). Distracted driving and risk of road crashes among novice and experienced drivers. New England journal of medicine, 370(1), 54-59.

Lansdown, T. C. (2012). Individual differences and propensity to engage with in-vehicle distractions–A self-report survey. Transportation research part F: traffic psychology and behaviour, 15(1), 1-8.

McKenna, F. P., & Farrand, P. (1999). The role of automaticity in driving. In Behavioural Research In Road Safety IX. PA3524/99.

Olson, R.L., Hanowski, R.J., Hickman, J.S., & Bocanegra, J. (2009). "Driver Distraction in Commercial Vehicle Operations." Report No. FMCSA-RRR-09-042. Washington D.C.: Federal Motor Carrier Safety Administration.

Penumaka, A. P., Savino, G., Baldanzini, N., & Pierini, M. (2014). In-depth investigations of PTW-car accidents caused by human errors. Safety Science, 68, 212-221.

RAC (2014). RAC Report on Motoring 2014: Britain on the road.
http://www.rac.co.uk/pdfs/report-on-motoring/rac-rom-2014-v16-compressed

Redelmeier, D. A. and R. J. Tibshirani (1997). "Association between cellular-telephone calls and motor vehicle collisions." New England Journal of Medicine 336 (7), 453-458.

Reed, N., & Robbins, R. (2008). The effect of text messaging on driver behaviour: a simulator study. PPR 367 TRL Published Project Report.

Reed, N., Kinnear, N., & Weaver, L. (2012). Why do older drivers have more 'failed to look' crashes? A simulator based study. PPR635. Crowthorne: TRL

Regan, M. A., Hallett, C., & Gordon, C. P. (2011). Driver distraction and driver inattention: Definition, relationship and taxonomy. Accident Analysis & Prevention, 43(5), 1771-1781.

Regan, M. A., & Strayer, D. L. (2014). Towards an understanding of driver inattention: taxonomy and theory. Annals of advances in automotive medicine, 58, 5.

Sayer, J.R., Devonshire, J.M., & Flanagan, C.A. (2007). Naturalistic driving performance during secondary tasks. Available at:
http://drivingassessment.uiowa.edu/DA2007/PDF/039 SayerDevonshire.pdf

Schwebel, D. C., Stavrinos, D., Byington, K. W., Davis, T., O'Neal, E. E. & Jong, D. (2012). Distraction and pedestrian safety: How Talking on the Phone, Texting, And Listening to Music Impact Crossing the Street. Journal of Accident Analysis & Prevention, Vol. 45, 266-271.

Simons-Morton, B. G., Guo, F., Klauer, S. G., Ehsani, J. P., & Pradhan, A. K. (2014). Keep your eyes on the road: Young driver crash risk increases according to duration of distraction. Journal of Adolescent Health, 54(5), S61-S67.

Stavrinos, D., Byington, K.W. & Schwebel, D.C., (2011). Distracted walking: cell phones increase injury risk for college pedestrians. Journal of Safety Research 42, 101–107.

Strayer, D. L., Watson, J. M., & Drews, F. A. (2011). 2 Cognitive Distraction While Multitasking in the Automobile. Psychology of Learning and Motivation-Advances in Research and Theory, 54, 29.

Strayer, D. L., Cooper, J. M., Turrill, J., Coleman, J.R., Medeiros-Ward, N., & Biondi, F. (2013). Measuring cognitive distraction in the automobile. Washington: AAA Foundation for Traffic Safety

Strayer, D. L., Turrill, J., Coleman, J.R., Ortiz, E.V. & Cooper, J. M. (2014). Measuring cognitive distraction in the automobile II: Assessing in-vehicle voice-based interactive technologies. Washington: AAA Foundation for Traffic Safety

Victor, T., Dozza, M., Bärgman, J., Boda, C. N., Engström, J., & Markkula, G. (2014). Analysis of Naturalistic Driving Study Data: Safer Glances, Driver Inattention, and Crash Risk. SHRP2: National Academy of Sciences