Synthesis title:

Driver Distraction

Category: Drivers

Other Relevant Topics:

- Driver Inattention
- Driver Attitudes
- Driver Behaviour
- Technology

Keywords:

Driver distraction, Driver inattention, Driver attitudes, Driver behaviour, Technology, Mobile phones, Smartphones, IVIS

About the Road Safety Observatory

The Road Safety Observatory aims to provide free and easy access to independent road safety research and information for anyone working in road safety and for members of the public. It provides summaries and reviews of research on a wide range of road safety issues, along with links to original road safety research reports.

The Road Safety Observatory was created as consultations with relevant parties uncovered a strong demand for easier access to road safety research and information in a format that can be understood by both the public and professionals. This is important for identifying the casualty reduction benefits of different interventions, covering engineering programmes on infrastructure and vehicles, educational material, enforcement and the development of new policy measures.

The Road Safety Observatory was designed and developed by an Independent Programme Board consisting of key road safety organisations, including:

- Department for Transport
- The Royal Society for the Prevention of Accidents (RoSPA)
- Road Safety GB
- Parliamentary Advisory Council for Transport Safety (PACTS)
- RoadSafe
- RAC Foundation

By bringing together many of the key road safety governmental and non-governmental organisations, the Observatory hopes to provide one coherent view of key road safety evidence.

The Observatory originally existed as a standalone website, but is now an information hub on the RoSPA website which we hope makes it easy for anyone to access comprehensive reviews of road safety topics.

All of the research reviews produced for the original Road Safety Observatory were submitted to an Evidence Review Panel (which was independent of the programme Board), which reviewed and approved all the research material before it was published to ensure that the Key Facts, Summaries and Research Findings truly reflected the messages in underlying research, including where there may have been contradictions. The Panel also ensured that the papers were free from bias and independent of Government policies or the policies of the individual organisations on the Programme Board.

The Programme Board is not liable for the content of these reviews. The reviews are intended to be free from bias and independent of Government policies and the policies of the individual organisations on the Programme Board. Therefore, they may not always represent the views of all the individual organisations that comprise the Programme Board.

Please be aware that the Road Safety Observatory is not currently being updated; the research and information you will read throughout this paper has not been updated since 2017. If you have any enquiries about the Road Safety Observatory or road safety in general, please contact **help@rospa.com** or call **0121 248 2000**.

How do I use this paper?

This paper consists of an extensive evidence review of key research and information around a key road safety topic. The paper is split into sections to make it easy to find the level of detail you require. The sections are as follows:

Key Facts	A small number of bullet points providing the key facts about the topic, extracted from the findings of the full research review.
Summary	A short discussion of the key aspects of the topic to be aware of, research findings from the review, and how any pertinent issues can be tackled.
Methodology	A description of how the review was put together, including the dates during which the research was compiled, the search terms used to find relevant research papers, and the selection criteria used.
Key Statistics	A range of the most important figures surrounding the topic.
Research Findings	A large number of summaries of key research findings, split into relevant subtopics.
References	A list of all the research reports on which the review has been based. It includes the title, author(s), date, methodology, objectives and key findings of each report, plus a hyperlink to the report itself on its external website.

The programme board would like to extend its warm thanks and appreciation to the many people who contributed to the development of the project, including the individuals and organisations who participated in the initial consultations in 2010.

Key Facts

- According to STATS19, 2,886 (or 3%) of collisions involving injuries (fatal, serious and slight) in 2016 in GB involved some form of distraction from within the vehicle (RRCGB, DfT, 2017). This is likely to be an underrepresentation due to the difficulties in coding distraction as a contributory factor after the event.

- The most recent observational count of mobile phone use whilst driving found that 1.6% of drivers in England and Scotland were observed using a hand-held mobile phone whilst driving (DfT, 2015). Drivers were more likely to be holding the phone in their hand (1.1%) rather than holding it to their ear (0.5%). A higher proportion of drivers were observed using a hand-held mobile phone when stationary (2.3%) than in moving traffic (1.6%).

- An observational study conducted by Sullman (2012) on UK public roads found 14.4% of drivers to be involved in some form of concurrent distraction. Talking to passenger(s) was the most common distraction (7.4%), followed by mobile phone use (2.2%), smoking (2.2%) and eating (1.1%).

- The RAC report that 75% of motorists regularly observe other drivers speaking on their mobile phone while driving, although only 8% of drivers admit doing it themselves. Meanwhile, 53% of drivers report seeing other drivers texting or checking social media, with only 7% of drivers admitting doing it themselves (however, 15% of younger drivers aged between 17 and 24 admitted it) (RAC, 2014).

- Although experimental research has shown that phone conversations impair driving performance, it is difficult to quantify the risk of this impairment because the reference is usually to 'normal' driving without using a phone. 'Worse than normal driving' does not necessarily equate to increased collision risk. Burns et al. (2006) therefore compared the impairment caused by using hands-free and hand-held mobile phone to driving while intoxicated at the drink drive limit – a level of impairment related to crash involvement. This simulator study found that certain aspects of driving performance were impaired more by having a mobile phone conversation (hands-free or hand-held) than having a blood alcohol level of 80mg/100ml.

- The 100-Car naturalistic driving study found that nearly 80 percent of all crashes and 65 percent of all near-crashes involved driver inattention (due to distraction, fatigue, or just looking away) just prior to (i.e. within 3 seconds) the onset of the conflict (Dingus et al., 2006).

- Many years of research have gone into studying driver distraction but difficulties arise when trying to compare studies because of a lack of a common definition, or differences in the types of additional tasks researched.

- There is still some debate regarding the relationship between driver distraction and driver inattention, although there appears to be some consensus that driver distraction is just one of a number of processes that can lead to driver inattention.

- Driver distraction can be further defined as occurring due to attention being diverted by driving related tasks (e.g. sat nav) or non-driving related tasks (e.g. mobile phone use). It can also be defined as internal to the car or external to the car, and further defined by the type of attention necessary (e.g. visual, auditory, biomechanical, cognitive)

Summary

- This review sought to summarise the key findings from literature in the domain of driver distraction. With the proliferation of mobile communications and in-vehicle technologies in recent times, the use of technology while driving has developed to be of primary interest within this domain. As such, there is a deliberate focus towards the distracting effects of technology throughout the review.

- Distraction is considered to be a major risk factor in driving incidents. However, the exact extent of driver distraction as causal factor in accident rates can be difficult to measure due to variations in definitions of driver distraction and data collection methods (Stevens & Minton, 2001; Beanland, Fitzharris, Young & Lenné, 2013).

- According to STATS19, 2,886 (or 3%) of collisions involving injuries (fatal, serious and slight) in 2016 in GB involved some form of distraction from within the vehicle (RRCGB, DfT, 2017). This is likely to be an underrepresentation due to the difficulties in coding distraction as a contributory factor after the event.

- The most recent observational count of mobile phone use whilst driving found that 1.6% of drivers in England and Scotland were observed using a hand-held mobile phone whilst driving (DfT, 2015). Drivers were more likely to be holding the phone in their hand (1.1%) rather than holding it to their ear (0.5%). A higher proportion of drivers were observed using a hand-held mobile phone when stationary (2.3%) than in moving traffic (1.6%).

Defining distraction and inattention

- Driver distraction is a commonly used term, however, it is important to define what is meant by driver distraction for the following reasons:
    - To enable accurate crash causation data to be collected;
    - To develop common measures of driver distraction;
    - To enable comparison of crash and experimental data sources.
- Due to various definitions of distraction being used historically, many studies are not comparable and confusion regarding whether studies are measuring driver distraction or inattention is common (Lee, Young & Regan, 2008).

- Various studies have therefore sought to define driver distraction through either:

    1. Analysis of definitions used within published literature (e.g. Lee et al., 2008; Pettit, Burnett & Stevens, 2005), or;

    2. Studies of contributing factors in road crashes (e.g. Hoel, Jaffard and Van Elslande, 2010; Treat, 1980)

    3. Workshops with experts in the subject area (e.g. Basacik & Stevens, 2008; Hedlund, Simpson & Mayhew, 2006).

- It has been suggested that for future research to be consistent and comparable the following definition of driver distraction by Regan et al. (2011) should be used (Foley, Young, Angell & Domeyer, 2013):

  "Driver distraction is the diversion of attention away from activities critical for safe driving toward a competing activity, which may result in insufficient or no attention to activities critical for safe driving." (p1776)

- Defining driver inattention has not received the same amount of scrutiny as defining driver distraction. This is possibly because it has often been confused with driver distraction.

- There has been debate regarding whether driver inattention and driver distraction are separate components, or whether driver distraction is a form of driver inattention (see Regan et al., 2011 for a summary of this debate)

- The latter perspective appears to be the more prominent in recent models of driver inattention (e.g. Engström et al., 2013; Regan et al., 2011) and offer the following definitions:

    - "insufficient, or no attention, to activities critical for safe driving." (Regan et al., 2011, p1775)

    - inattention occurs when the driver's allocation of resources to activities does not match the demands of the activities required for the control of safety margins" (Engström et al., 2013. p25)

- Driver inattention as defined by Engström et al. (2013) therefore represents attention as all encompassing, representing attentional failures as part of a driver-vehicle-environment system rather than inattention resulting from driver failure alone. Driver distraction is therefore just one form of misdirected attention.

Technology and driving

- Drivers have access to a wide range of technologies in the vehicle cockpit. They can be either specific to the driving task, such as a navigation system, or more general in purpose, such as a smartphone. Furthermore, these technologies can either be integrated into the vehicle, such as heads-up display (HUD) or a nomadic technology brought into the vehicle by the driver or a passenger, such as a music player.

- The availability of distracting technologies within the vehicle increases year-on-year. However, there is no clear evidence regarding whether drivers are experiencing more or less distraction today than they have historically. One may speculate that this may be due to improvements in the usability of technologies and increased driver awareness of the appropriate use of technologies, and/or that drivers are adapting their behaviour to the increased attentional demand required when engaging with technology.

- A wide range of technologies have been subject to investigation, including (but not limited to): mobile phones (including smartphones); satellite navigation systems; entertainment systems; heads-up displays; and smartglasses. These studies usually seek to quantify the probability of and/or the consequences of being distracted by a particular technology in safety critical situations. With the exception of some high-profile studies (e.g. 100-Car study), relatively little research has examined how drivers use technologies in a more naturalistic setting. This limitation in the body of literature goes some way to explaining why there is a disconnect in the frequency of technology related accident rates and predicted risk increase from using said technologies.

- Experimental evidence suggests that:

    - Texting whilst driving leads to slower reaction times to sudden events, longer glances away from the road and poorer lane control.

    - Both handheld and speech-based texting causes distraction, as does engagement with social media via a smartphone.

    - Hand-held and hands-free mobile phone conversations impact on driving performance to levels somewhat equivalent to that measured when drivers are intoxicated to the level of the drink drive limit in England and Wales.

    - Entertainment and Head-Up Display (HUD) in-vehicle technologies also have the potential to impact on driver performance, although the effects are likely to be device specific.

    - Smartglasses have demonstrated some potential in reducing the level of distraction resulting from engaging in another activity (such as sending and receiving messages), but it does not negate the inevitable distraction effects of engaging in a non-driving related task that requires attentional resources.

    - Drivers appear to engage with satellite navigation devices during periods of low demand, or adapt their driving environment to reduce overall demand (e.g. reducing speed or distance to the vehicle in front) (Metz, Schoch, Just & Kuhn, 2014).

- Humans have limited attentional capabilities to employ when performing the driving task.

- It is possible when driving to allocate attentional resources to activities that are not critical for safe driving; these activities may be driving or non-driving related.

- Technologies that are both driving and non-driving related may have motivational properties that can draw on a driver's attentional resources (e.g. emotional motivation to answer the phone or read a text, or motivation to re-route a satnav device to avoid congestion).

- Experimental evidence suggests that where drivers engage in additional tasks, their driving performance is impaired. There is some evidence to suggest that drivers adapt their behaviour to reduce demand when undertaking additional tasks, although this does not appear to negate the impairment completely and drivers are therefore likely to be at greater risk of being involved in a collision when the attentional demands exceed the resources required for the driver-vehicle-environment system.

Methodology

This synthesis was compiled between January 2015 and February 2015. A detailed description of the methodology used to produce this review is provided in the Methodology section of the Observatory website at http://www.roadsafetyobservatory.com/Introduction/Methods .

Review of research literature

The foundations of the synthesis were previous published reviews of driver distraction and inattention from the last decade. To supplement these reviews searches were carried out on the pre-defined research (and data) repositories. Search terms used to identify relevant papers included:

Primary terms	AND	AND
Distract* OR	Driver	Crash OR
Inattent* OR		Collision OR
Attent*		Prevent* OR
		Risk OR
		Technology OR
		Smartphone OR
		Phone OR
		Mobile phone OR
		Statistic* OR
		Data OR
		Satnav OR
		GPS OR
		Navigation OR
		IVIS

As driver distraction has been subject to extensive review, a search of the literature for driver distraction was restricted to 2004 onwards. This ensured that the synthesis took account of most literature published since the proliferation of technology such as mobile and smart phones. The initial search returned a large number of abstracts. For the purpose of this review the authors relied upon recent reviews, knowledge of existing studies and prominent new literature found from the search.

Literature included in the review were examined using the selection criteria below.

Selection criteria

All the research articles included here were considered by the authors to meet minimum standards for both relevance and quality. Articles included met at least the 'medium' relevance and quality criteria, or higher. The definitions used are as follows:

For relevance

- 'High'= refers to data or theory on a metric clearly relevant to the topic under investigation
- 'Medium'= refers to data or theory on a metric that is probably relevant to the UK (e.g. driver distraction experiment, but not necessarily focused on reducing collisions)
- 'Low'= does not refer to data or theory relevant to the topic under investigation

For quality

- 'High'= from a high-quality peer-reviewed publication, with clear and appropriate methods
- 'Medium'= from an academic source (e.g. book chapter, conference) but without peer-review, and/or possessing some methodological weakness (e.g. some possible confounding factors)
- 'Low'= from a more 'general' source (e.g. conference, trade paper) and/or clearly being methodologically weak or inappropriate (e.g. failing to address random variability by use of appropriate statistical techniques)

Some of the research used in this review derives from outside of the UK, but has been included because it is relevant to the topic.

Research findings

This review sought to summarise the key findings from literature in the domain of driver distraction. With the proliferation of mobile communications and in-vehicle technologies in recent times, the use of technology while driving has developed to be of primary interest within this domain. As such, there is a deliberate focus towards the distracting effects of technology throughout the review.

The key findings of the review are given below. Further details of the studies reviewed, including their methodology and key findings, and links to the reports can be found in the References section.

Introduction

- Drivers have access to a wide range of technologies in the vehicle cockpit. They can be either specific to the driving task, such as a navigation system, or more general in purpose, such as a smartphone. Furthermore, these technologies can either be integrated into the vehicle, such as heads-up display (HUD) or a nomadic technology brought into the vehicle by the driver or a passenger, such as a music player.

- The availability of distracting technologies within the vehicle increases year-on-year. However, there is no clear evidence regarding whether drivers are experiencing more or less distraction today than they have historically. One may speculate that this may be due to improvements in the usability of technologies and increased driver awareness of the appropriate use of technologies, and/or that drivers are adapting their behaviour to the increased attentional demand required when engaging with technology.

- The consequences of specific technologies for driver distraction have been studied in a range of naturalistic and laboratory based environments. A wide range of technologies have been subject to investigation, including (but not limited to): mobile phones (including smartphones); satellite navigation systems; entertainment systems; heads-up displays; and smartglasses (see later sections in this review for more information). These studies usually seek to quantify the probability of and/or the consequences of being distracted by a particular technology in safety critical situations. With the exception of some high profile studies (e.g. 100-Car Study, Dingus et al., 2006), relatively little research has examined how drivers use technologies in a more naturalistic setting. This limitation in the body of literature goes some way to explaining why there is a disconnect in the frequency of technology related accident rates and predicted risk increase from using said technologies.

- There is a large degree of overlap between many forms of technology, especially multi-function technologies such as smartphones. Similarly, there is overlap with the types of attentional demands required by technologies (e.g. cognitive, visual, auditory, biomechanical).

- This review discusses the nature of driver distraction and examines the evidence available to ascertain the extent to which in-vehicle information systems (IVIS) and technologies might distract drivers from the primary driving task.

The prevalence of driver distraction and its consequences

- Distraction is considered to be a major risk factor in driving incidents. However, the exact extent of driver distraction as causal factor in accident rates can be difficult to measure due to variations in definitions of driver distraction and data collection methods (Stevens & Minton, 2001; Beanland, Fitzharris, Young & Lenné, 2013).

- According to STATS19, 2,995 (or 3%) of collisions involving injuries (fatal, serious and slight) in 2013 in GB involved some form of distraction from within the vehicle (STATS19, Department for Transport). This is likely to be an underrepresentation due to the difficulties in coding distraction as a contributory factor after the event.

- The most recent observational count of mobile phone use whilst driving found that 1.6% of drivers in England and Scotland were observed using a hand-held mobile phone whilst driving (DfT, 2015). Drivers were more likely to be holding the phone in their hand (1.1%) rather than holding it to their ear (0.5%). A higher proportion of drivers were observed using a hand-held mobile phone when stationary (2.3%) than in moving traffic (1.6%).

- An observational study conducted by Sullman (2012) on UK public roads found 14.4% of drivers to be involved in some form of concurrent distraction. Talking to passenger(s) was the most common distraction (7.4%), followed by mobile phone use (2.2%), smoking (2.2%) and eating (1.1%).

- The RAC report that 75% of motorists regularly observe other drivers speaking on their mobile phone while driving, although only 8% of drivers admit doing it themselves. Meanwhile, 53% of drivers report seeing other drivers texting or checking social media, with only 7% of drivers admitting doing it themselves (however, 15% of younger drivers aged between 17 and 24 admitted it) (RAC, 2014).

Defining driver distraction

- Driver distraction is a commonly used term, however, it is important to define what is meant by driver distraction for the following reasons:
    - To enable accurate crash causation data to be collected;
    - To develop common measures of driver distraction;
    - To enable comparison of crash and experimental data sources.
- Due to various definitions of distraction being used historically, many studies are not comparable and confusion regarding whether studies are measuring driver distraction or inattention is common (Lee, Young & Regan, 2008). See the section below for clarification of the difference between driver distraction and driver inattention.
- Various studies have therefore sought to define driver distraction through either:
    1. Analysis of definitions used within published literature (e.g. Lee et al., 2008; Pettitt, Burnett & Stevens, 2005), or;
    2. Studies of contributing factors in road crashes (e.g. Hoel, Jaffard and Van Elslande, 2010; Treat, 1980)
    3. Workshops with experts in the subject area (e.g. Basacik & Stevens, 2008; Hedlund, Simpson & Mayhew, 2006).

1. Definitions from syntheses of published literature

- From an assessment of published literature on the topic, Lee at al. (2008, p34) define that driver distraction is "…the diversion of attention away from activities critical for safe driving toward a competing activity".
- Pettitt et al.'s (2005) definition of driver distraction meanwhile details the factors involved:
    - Impact – Delay by the driver in the recognition of information necessary to safely maintain the lateral and longitudinal control of the vehicle (the driving task)
    - Agent - Due to some event, activity, object or person, within or outside the vehicle
    - Mechanism - That compels or tends to induce the driver's shifting attention away from fundamental driving tasks
    - Type - By compromising the driver's auditory, biomechanical, cognitive or visual faculties, or combinations thereof

2. *Definitions from studies of contributing factors in road crashes*

- Treat (1980, p21) define driver distraction as, "…whenever a driver is delayed in the recognition of information needed to safely accomplish the driving task, because some event, activity, object, or person within [or outside] his vehicle, compelled or tended to induce the driver's shifting of attention away from the driving task".

- Hoel et al. (2010, p576) define driver distraction as occurring, "…from interference between a driving task and an external stimulation without link with driving (e.g., guide a vehicle and tune the radio). This secondary task can be gestural or visuo-cognitive".

3. *Definitions from workshops with experts in the subject area*

- Basacik & Stevens (2008, p44) expert group agreed that distraction is the "diversion of attention away from activities required for safe driving due to some event, activity, object or person, within or outside the vehicle." It was also agreed that:

    - Distraction excludes driver fatigue, impairment, daydreaming and general internal thoughts

    - Activities required for safe driving implies controlling the car within the environment to maintain a suitable safety margin

    - Distraction is a continuous variable where the allocation of attention to a distractor might lead to a shortfall in attention to activities required for safe driving

    - Driver distraction does not necessarily always lead to a crash, but it will still be unsafe. All other things being equal, reducing distraction improves the chance of a driver dealing appropriately with an unexpected situation

- Hedlund et al.'s (2006) expert working group meanwhile defined distraction as, "a diversion of attention from driving, because the driver is temporarily focusing on an object, person, task or event not related to driving, which reduces the driver's awareness, decision making ability and/or performance, leading to an increased risk of corrective actions, near-crashes, or crashes".

- In summary, definitions of distraction to date tend to contain the following elements (Regan et al., 2011):

    - A diversion away from driving, or safe driving;

    - Attention diverted toward a competing activity, inside or outside the vehicle, which may or may not be driving related;

- The competing activity may or may not compel or induce the driver to divert their attention toward it; and

- There is an implicit, or explicit, assumption that safe driving is adversely effected.

- It has been suggested that for future research to be consistent and comparable the following definition of driver distraction by Regan et al. (2011) should be used (Foley, Young, Angell & Domeyer, 2013):

  "Driver distraction is the diversion of attention away from activities critical for safe driving toward a competing activity, which may result in insufficient or no attention to activities critical for safe driving." (p1776)

Driver inattention

- Defining driver inattention has not received the same amount of scrutiny as defining driver distraction. This is possibly because it has often been confused with driver distraction.

- There has been debate regarding whether driver inattention and driver distraction are separate components, or whether driver distraction is a form of driver inattention (see Regan et al., 2011 for a summary of this debate)

- Some believe that inattention relates to internalised thoughts (e.g. mind wandering) while distraction relates to external competing activities (Caird & Dewar, 2007; Hoel et al., 2010; Lee et al., 2008).

- Others note that inattention simply relates to not paying attention to activities deemed necessary for safe driving and that distraction may lead to driver inattention, and is therefore a subset of driver inattention (Engström et al., 2013; Pettitt et al., 2005; Regan et al., 2011; Regan & Strayer, 2014).

- The latter perspective appears to be the more prominent in recent models of driver inattention (e.g. Engström et al., 2013; Regan et al., 2011) and offer the following definitions:

  - "insufficient, or no attention, to activities critical for safe driving." (Regan et al., 2011, p1775)

  - inattention occurs when the driver's allocation of resources to activities does not match the demands of the activities required for the control of safety margins" (Engström et al., 2013. p25)

- Driver inattention as defined by Engström et al. (2013) therefore represents attention as all encompassing, representing attentional failures as part of a driver-vehicle-environment system rather than inattention resulting from driver failure alone.

- Driver inattention is the result of a mismatch between the selection and allocation of attention to activities necessary for safe driving. That is, a driver has selected things to focus their attention on, and allocated proportions of their limited attentional capabilities, such that they are unable to maintain a suitable safety margin in light of the evolving demands of the driving environment (see Engström et al., 2013 for more detailed discussion).

Modern taxonomies of inattention

- A taxonomy is a meaningful categorisation of a process that is based on some underlying theory or data. It helps to categorise a factor like driver distraction within a context that can help when designing studies, interventions and crash analysis data collection and categorisation.

- A good summary of historical taxonomies is provided by Regan et al. (2011). It is summarised that previous taxonomies have suffered from a lack of agreement regarding definitions and the debate surrounding the relationship between inattention and distraction.

- Regan and Strayer (2014) point out that two recent taxonomies (Regan et al., 2011; Engström et al., 2013) are however complementary, despite one being developed from the bottom-up (crash data) and one developed from the top-down (attentional and driver behaviour theory).

- Engström et al.'s taxonomy was developed from analysis of theoretical research including attentional theory, cognitive research and driver behaviour theory. Regan et al.'s taxonomy was largely informed by working back from in-depth crash analysis and causation factors.

- Engström et al.'s taxonomy is based on 12 key principles:

1. Attention is an adaptive behaviour that must be managed by the driver; that is, the driver manages attentional demands through their behaviour, like increasing or reducing speed.

2. Safe driving relies on correctly applying our limited attentional resources to the right activities at the right time.

3. Activities undertaken when driving are on a continuum ranging from essential driving-related to entirely non-driving related.

4. Driving occurs in a dynamic environment and attentional demands are constantly changing.

5. Activation and selectivity – where activation is the amount of attention allocated and selectivity is the distribution of that attention to activities the driver undertakes.

6. Factors that will influence activation are both internal (e.g. attentional effort) and external (e.g. demand of the driving environment)

7. Factors influencing selectivity are also internal (e.g. goals, self-regulation) and external (e.g. intensity, size, contrast of stimuli in the environment)

8. Attention when driving will require both automatic and controlled processing.

9. Some elements of attention are related to the identification of hazards and becoming a safer driver, as evidenced by the differences between novice and experienced drivers.

10. Interference occurs when two or more activities compete for limited attentional resources.

11. Humans have cognitive limitations and when two tasks compete for attention drivers will compensate (e.g. by reducing their speed).

12. An attentional mis-match may simply occur when a driver fails to attend to something critical because it was hidden or disguised from them (e.g. vision blocked by the A-pillar, insufficient lighting when dark).

- Engstöm et al.'s taxonomy defines that inattention occurs either as a result of 'insufficient attention' or as a result of 'misdirected attention'. Driver distraction is a sub-set of 'misdirected attention', and is therefore only one of a number of processes that can lead to driver inattention.

- Engstöm et al.'s taxonomy also provides a theoretical context to driver inattention within our overall understanding of driver behaviour. Drivers adapt their behaviour to the demands of the driving task, which can help explain why some naturalistic studies do not find mobile phone use to result in increased crash risk to the extent that laboratory studies might initially suggest (e.g. Olsen, Hanowski, Hickman & Bocanegra, 2009; Hickman, Hanowski & Bocanegra, 2010). For example, a driver cruising on the motorway who decides to make a telephone call may (consciously or unconsciously) lower their speed and increase the gap to the car in front to offset the demand of attention required for the telephone call, that is limiting the attention available for the driving task.

- Regan and Strayer (2014) believe that Engstöm et al.'s taxonomy is compatible with Regan et al.'s (2011) taxonomy. Regan et al.'s taxonomy is developed from consideration of previous taxonomies and crash data. They describe a theoretical framework that aims to provide a structure from which research (e.g. crash data analysis) can be designed.

- They define the following categories as processes that can lead to driver inattention:

Category	Definition
Driver Restricted Attention (DRA)	Insufficient or no attention to activities critical for safe driving brought about by something that physically prevents (due to biological factors) the driver detecting (and hence attending to) information critical for safe driving
Driver Misprioritised Attention (DMPA)	Insufficient or no attention to activities critical for safe driving brought about by the driver focusing attention on one aspect of driving to the exclusion of another, which is more critical for safe driving
Driver Neglected Attention (DNA)	Insufficient or no attention to activities critical for safe driving brought about by the driver neglecting to attend to activities critical for safe driving
Driver Cursory Attention (DCA)	Insufficient or no attention to activities critical for safe driving brought about by the driver giving cursory or hurried attention to activities critical for safe driving
Driver Diverted Attention (DDA) – includes both driving related (DDA-DR) and non-driving related (DDA-NDR)	The diversion of attention away from activities critical for safe driving toward a driving-related competing activity, which may result in inattention

- To date the authors are only aware of one study that has applied either of these taxonomies in scientific study. Beanland et al. (2013) used data from the Australian National Crash In-Depth Study (ANCIS) to code crashes in which at least one party was admitted to hospital with a crash-related injury. In coding the crash descriptions to Regan et al.'s taxonomy Beanland et al. further categorised Driver Diverted Attention (driver distraction) to include the following:
    - Relationship with the driving task (driving or non-driving related, as per the original taxonomy);
    - Origin of distractor (driver's mind, in-vehicle, external to vehicle);

    - Sensory modality of the distractor (visual, auditory, physical, cognitive);
    - Diversion of attention (voluntary or involuntary).

- Beanland et al. note that application of Regan et al.'s taxonomy was at times difficult due to the data not being available to distinguish between categories. It may be that data collection methods need to be revised to fit with modern taxonomies in order to test their validity.

Summary of defining distraction

- Many years of research have gone into studying driver distraction but difficulties arise when trying to compare studies because of a lack of a common definition, or differences in the types of tasks researched.
- Several studies have tried to address this using various methodologies with some consensus beginning to emerge.
- There is still some debate regarding the relationship between driver distraction and driver inattention, although again there appears to be some consensus that driver distraction is just one of a number of processes that can lead to driver inattention.
- Driver distraction can however be further defined as occurring due to attention being diverted by driving related tasks (e.g. sat nav) or non-driving related tasks (e.g. mobile phone use). It can also be defined as internal to the car or external to the car, and further defined by the type of attention necessary (e.g. visual, auditory, physical, cognitive)
- As in-vehicle and communications technologies develop these taxonomies may need to be updated to take account of new forms of driver inattention.

Driver distraction caused by technology

A range of technologies can lead to driver distraction. A selection of the most commonly researched technologies is listed below. Note, where a piece of research examined more than one type of technology they will be referenced under each relevant heading to aid readers only interested in one particular type of technology.

Mobile phones – also known as cell phones or smartphones. Common research topics include using a mobile phone for verbal or text based communication, the effects of different control interfaces/methods (physical keyboards, touchscreens, voice control); and the consequences of using smartphones to access non-driving related information such as entertainment, social networking, etc.

- Texting whilst driving has been shown to reduce driving performance in a range of studies. Reed and Robbins (2008) showed that when young drivers sent and received text messages on a handheld mobile phone whilst driving a simulator they were slower to react to trigger stimuli, more likely to miss these stimuli, and had poorer vehicle control.

- The performance decrements of retrieving and sending text messages on young driver performance when using a handheld phone were similarly measured by Hosking, Young and Regan (2006) at Monash University. A sample of twenty young adults (18-21) completed two drives which contained eight critical events (e.g. avoiding a pedestrian, changing lane in accordance with traffic signs). During the drive participants sent and retrieved text messages. Drivers spent four times as long looking away from the road, missed instructions to change lanes and had poorer lane control.

- Similar results were found when a sample of young drivers was asked to interact with a social networking site on their handheld smartphones whilst driving in a simulator (Basacik, Reed & Robbins, 2011).

- A meta-analysis conducted by Caird et al. (2014) showed that reading and writing texts compromises a wide range of driving behaviours (i.e. stimuli detection accuracy and speed, collisions, headway, speed, and lane positioning).

- According to Crisler, et al. (2008) an advantage of manual texting over verbal conversations on a mobile phone is drivers have greater control over when and where they choose to text; verbal conversations can make a driver feel obliged to continue, even when they sense it is distracting them from the main driving task.

- He et. al. (2014) compared speech-based texting whilst driving with handheld texting and showed that speech based systems distract less than handheld but still caused significant distraction.

- Owens, McLaughlin, and Sudweeks (2011) found that driver performance when receiving text messages was not different to baseline when using their test vehicle's factory-fitted text-to-speech functionality. However, performance decreased when sending a text message using a handheld mobile phone and also decreased when sending a text message when using the text-to-speech functionality. Therefore, we can infer that even though sending a text message using the speech-to-text functionality was a verbal task, it still interfered with the driving task which was primarily visual.

- Few attempts have been made to relate the effects of mobile phone use on driver performance to other sources of driver distraction. A notable exception is the work of Burns, Parkes, Burton, Smith and Burch (2002) who tested twenty participants in a driving simulator by comparing their driving performance when conducting hands-free and handheld conversations on a mobile phone with their performance

whilst under the influence of alcohol (completed with no concurrent phone task). Results showed that performance was compromised when conversing using a handheld and hands-free mobile phone and was in some respects worse than being intoxicated to the (then) UK drink drive limit of having a blood alcohol level of 80mg/100ml.

- Similarly, Leung, Croft, Jackson, Howard and McKenzie (2012) showed that hands-free and handheld conversations impair driving performance. Evan a simple conversation impaired driving performance, while complex conversations impaired performance about as much as being roughly at the US legal limit of having a blood alcohol level of 80mg/100ml.

Entertainment – examples of entertainment related technologies include radio, music players, CD players, MP3 players, DVD players, etc. Research on these technologies is relatively uncommon in recent years.

- Horberry, Anderson, Regan, Triggs and Brown (2006) compared driving performance levels in a driving simulator when drivers completed one of two tasks: manipulation of the vehicle's entertainment system or a hands-free conversation. Whilst results showed that both tasks interfered with driving performance, manipulation of the vehicle's entertainment system impaired driver performance the most.

- Head-up displays (HUDs) – a projection system which displays information over the drivers' windscreen. The information is usually transparent and is designed to reduce the time a driver must divert their visual attention from the forward roadway by locating information close to the priority areas of the visual field.

- A large quantity of research on HUDs originates from the aviation domain, however, caution must be exercised when generalising from aviation to driving as the two domains are distinct. Gish and Staplin (1995) point out that background complexity differs between the domains (open sky vs. road scenes). Aviation HUDs tend to display information which visually integrates with the scene (or *conformal symbology*, e.g. runway outlines, etc.) whereas driving HUDs are likely to offer a wider variety of less integrated information (e.g. speed, text messages, etc.). Aviation HUD research usually studies the performance of highly trained pilots who's performance may differ from the general driving population. Gish and Staplin's review of HUDs in driving conclude that there is no robust evidence that HUDs produce advantages in driver performance. However, they concede that limitations of previous research (failures in accounting for the interaction of workload, display complexity, etc.) may be masking the degree to which HUDs could reduce or increase distraction.

- Jakus, Dicke and Sodnik (2014) asked participants to navigate to a destination in a driving simulator using an HUD, auditory display, or a combination of both systems (multi-modal). Results showed faster system interactions when using the HUD modality and in the multi-modal configuration. All three systems affected driving performance to an equal level; however, drivers preferred the multi-modal system.

- More recent research by Burnett and Donkor (2011) considered this cognitive capture effect and how it relates to HUD complexity. They conducted a simulator trial with eighteen drivers that were asked to retrieve information from an HUD whilst also undertaking a peripheral detection task (PDT). The complexity of the HUD was manipulated to understand how complexity affected performance. Their results showed driving performance and PDT performance worsened (reactions were slower and less accurate) as the HUD complexity increased.

Smartglasses – recent advances in processing and battery technologies have resulted in a new wave of development of wearable smart technologies, and in particular smartglasses. Smartglasses are multi-function wearable computers, worn on the head, and typically display visual information to the user through lenses mounted in the eye line.

- In recent years there has been a dramatic increase in the development of smartglasses systems, with the most widely recognised being Google Glass. Google Glass was released relatively recently before being withdrawn from sale (February 2013 to January 2015).

- Tippey, Sivaraj, Ardoin, Roady, and Ferris (2014) conducted a small scale preliminary study which compared texting while driving using Google Glass, voice-to-text, handheld texting and baseline. The seven participants who completed the trial were asked to read and respond to text messages whilst driving a medium fidelity driving simulator. The texting tasks required reading brief questions (no more than three lines of text) and responding with simple answers. The data revealed handheld texting reduced performance the most, followed by voice-to-text and then Google Glass. In fact Google Glass was observed to produce driving performance equivalent to baseline. This is broadly in line with cognitive interference hypothesis as whilst the texting tasks required some simple processing, it was likely not enough to significantly tax executive function.

- Sawyer, Finomore, Calvo and Hancock (2014) tasked drivers with responding to text messages using hands-free smartphone and Google Glass. Sawyer et. al. tested forty undergraduate college students using a driving simulator by asking them to send and receive messages whilst driving. Experimenters would interrupt participants during their text messaging with an emergency braking event; changes in reaction performance against baseline (drive only) were observed. Results of this study showed that Google Glass led to less driver distraction;

however, it did not eliminate it. Whilst the results of this study were positive for Google Glass as an IVIS, the authors do sound a note of caution: “Even if Glass reduces the attentional resources necessary to multitask while reading and replying to messages, it cannot minimize the impact of information that unduly occupies a driver’s mind (e.g., an emergency at home).” A passive cost of Google Glass was observed by Sawyer et. al. where performance was poorer during the drive only condition (when wearing an inactive Google Glass) than when driving using an inactive smartphone. This could be due to the glass being novel and simply wearing it was cognitively distracting; perhaps participants were considering how comfortable the Glass was, or pondering how it might affect their driving experience if they were in common use.

- Beckers et al. (2014) investigated the distraction of entering a destination when using Google Glass and a smartphone as navigation devices. Whilst driving a simulator, twenty four young drivers were tasked with entering destinations into Google Glass (verbally) and a Samsung Galaxy S4 (both verbally and handheld). Results showed that all methods distracted from the main driving task, however, both voice interfaces distracted less than the manual method. Furthermore, Google Glass had a higher error rate when entering a destination (users gave the correct command but Google Glass failed to respond correctly), but this was offset by its shorter task completion time leading to similar performance levels for both devices.

Satellite navigation

- Metz, Schoch, Just and Kuhn (2014) compared driving behaviour whilst using a manually operated portable satnav and an integrated navigation system as part of the euroFOT project. Data from 99 drivers was collected from over 1,000,000 km of public roads. Drivers were shown to prefer manually interacting with both systems when exposed to low driving demand, and if required to manually interact with a system in higher demand settings, they adapt their speed and following distances to support safer driving. No evidence was found that the using either navigation device lead to an increase in dangerous situations.

- Broadly speaking, the research suggests voice interfaces distract less than manual ones, however, they can still significantly distract a driver from the task at hand. Maciej and Vollrath (2009) used a proxy of driving, the Lane Change Task, to measure how driver performance was affected by the use of several hands-free or handheld IVIS, including a navigation system. Speech interfaces showed a mild improvement over manual interfaces, suggesting that whilst speech interfaces are less distracting, they are not yet able to significantly reduce cognitive demand.

- Navigation devices (including smartphones operating as navigation systems) can also be distracting. Harms and Patten (2003) measured driver distraction by use of the peripheral-detection task (PDT) method when drivers were engaged in a route navigation task. Drivers completed two routes, one from memory, one by following a navigation system. The navigation system either delivered visual information only, verbal information only, or both visual and verbal (participants only experienced one of these conditions). They observed no change in driving performance in any condition, suggesting drivers did not divert attention to the navigation tasks to an extent that would result in impairment. However, they were slower and slightly less accurate when reacting to the PDT task during the visual and verbal navigation condition and only slightly less accurate during the visual only condition. Verbal only did not change PDT performance.

Summary

- Humans have limited attentional capabilities to employ when performing the driving task.

- It is possible when driving to allocate attentional resources to activities that are not critical for safe driving; these activities may be driving or non-driving related.

- Technologies that are both driving and non-driving related may have motivational properties that can draw on a driver's attentional resources (e.g. emotional motivation to answer the phone or read a text, or motivation to re-route a satnav device to avoid congestion).

- Experimental evidence suggests that where drivers engage in additional tasks, their driving performance is impaired.

- There is some evidence to suggest that drivers adapt their behaviour to reduce demand when undertaking additional tasks, although this does not appear to negate the impairment completely and drivers are therefore likely to be at greater risk of being involved in a collision when the attentional demands required for the driver-vehicle-environment breakdown.

How effective?

- **Enforcement**: The law is very clear on the consequences of the use of handheld phones, satnavs and 2-way radios by drivers, however it is less clear about the acceptable use of hands-free phones, satnavs and 2-way radios. There is no formal guidance on the legal consequences of driving whilst distracted, although it is likely this would be seen as a form of driving without due care and attention, or dangerous driving. https://www.gov.uk/using-mobile-phones-when-driving-the-law

    - **Handheld**: It states that "It's illegal to ride a motorcycle or drive using hand-held phones or similar devices." If drivers are given a fixed penalty notice they will fine of £100 and three penalty points. New drivers (up to two years after gaining a full licence) will lose their licence and be given six penalty points. The only times when it is permissible to use your phone when driving is to call 999 or 112 in an emergency, of if your vehicle is parked.

    - **Hands-free**: You can use hands-free phones, sat navs and 2-way radios when you're driving or riding. But if the police think you're distracted and not in control of your vehicle you could still get stopped and penalised.

- **Publicity/Education**: Public awareness of the hazards of using your mobile phone whilst driving have been increased through information campaigns. However, these campaigns tend to be focused on a single source of distraction, and this is usually mobile phones, rather than the broader issue of driver distraction.

    - The THINK! Campaign offers a good summary of the issues surrounding driver driving whilst using a mobile and in particular advice on how to avoid being distracted by a mobile phone. http://think.direct.gov.uk/mobile-phones.html

    - **The facts:**

        - Studies show that drivers using a hands-free or handheld mobile phone are slower at recognising and reacting to hazards.

        - Even careful drivers can be distracted by a call or text – and a split-second lapse in concentration could result in a crash.

- **The law:**
    - It's illegal to use a handheld mobile when driving.
    - This includes using your mobile phone to follow a map, read a text or check social media. This applies even if you're stopped at traffic lights or queuing in traffic.
    - You can only use a handheld phone if you are safely parked or need to call 999 or 112 in an emergency and it's unsafe or impractical to stop.
    - If you're caught using a handheld phone while driving, you'll get 3 penalty points on your licence and a fine of £100. Points on your licence will result in higher insurance costs.
    - If you get just 6 points in the first two years after passing your test, you will lose your licence.
    - You may use a hands-free phone while driving but you can still be prosecuted if you're not in proper control of your vehicle. The penalties are same as being caught using a handheld phone.
    - The penalties for driving carelessly or dangerously when using a handheld or hands-free phone can include disqualification, a large fine and up to two years imprisonment
- **The advice:**
    - Switch off before you drive off
    - Even if you're using a hands-free phone you should avoid making or answering calls when driving
    - All phone calls distract drivers' attention from the road.
    - Park safely before using your mobile phone
    - Do not park on the hard shoulder of the motorway.
    - Don't call other people when they're driving
    - If you call someone and they tell you they are driving, ask them to call you back when they have parked up safely.

- The effectiveness of the 2007 THINK! campaign to raise awareness of the change in legislation regarding the use of mobile phones whilst driving was measured (Post evaluation of June 2009 Mobile Phone campaign, 2009; http://webarchive.nationalarchives.gov.uk/20100202120215/http://think.dft.gov.uk/pdf/332982/332986/0906-mobiles-post.pdf)
    - 1,998 interviews were conducted with those aged 15+ in England and Wales in 2009.
    - Two thirds of respondents (61%) recalled seeing or hearing something about using mobile phones whilst driving in any campaign source. Over half had seen a TV ad (54%), while fewer had heard something on a radio ad (16%).
    - Overall campaign awareness – steady decline since the high level of awareness achieved at the original post stage of research conducted in April 2007
- **Driving for work:** Those who drive for work are under particular pressures to use their mobile phones whilst driving. ROSPA recognise this and have produced an informative document to address this issue called “Driving for work: Mobile phones” (http://www.rospa.com/rospaweb/docs/advice-services/road-safety/employers/work-mobile-phones.pdf)
    - HSE Guidelines for employers, ‘Driving at Work’, state that “health and safety law applies to on-the-road work activities as to all work activities and the risks should be effectively managed within a health and safety system”.
    - Research indicates that drivers who use their mobile phones are also four times more likely to crash, injuring or killing themselves and/or other people.
    - What employers should do: Expect safe driving; Consult staff; Raise awareness; Avoid using a mobile phone; Lead by example; Review work practices; Review and investigate crashes and incidents; Provide training; Liaise with police; Monitor compliance; Liaise with other organisations.

- **General countermeasures**: In addition to the countermeasures listed above (see THINK! campaign above and ROSPA “Driving for work: Mobile Phones”) several documents have been published by a range of organisation offering general guidance on dealing with driver distraction.
    - The Monash University Accident Research Centre published a review entitled “Driver distraction: a review of the literature” (https://www.monash.edu/muarc/research/our-publications/muarc206) which not only provides a summary of driver distraction literature, but also lists countermeasures for reducing driver distraction which includes information on research, legislation and enforcement, vehicle design and enforcement.
        - A good deal is already known about the risks associated with engaging whilst driving in various distracting activities. It is important that these are brought to the attention of drivers and passengers. As a matter of priority, it is important to make the motoring public aware that hands-free mobile phones can be just as distracting as hand-held phones.
        - As with the use of mobile phones, drivers must be educated and trained in the optimal manner in which to interact with existing and emerging on-board technologies and services accessed through portable devices in order to minimise distraction.
        - Where flexibility exists in the manner in which these devices can be operated (there are, for example, many ways to tune and select a radio station), user manuals and tutorials provided by vehicle manufacturers and service providers should highlight the most ergonomic and least distracting methods for doing so.
    - In the USA, the National Highway Traffic Safety Administration (NHTSA) have published “strategies to reduce distracted and fatigued driving – countermeasures” The effectiveness of a range of countermeasures are described. (http://safety.transportation.org/doc/Drowsy%20Rev1-3.pdf)
        - The standard behavioral countermeasures of laws, enforcement, and sanctions, which are used successfully for alcohol impairment, safety belt use, aggressive driving, and speeding, are unlikely to be effective for distracted or drowsy drivers. One exception is for young drivers: some graduated driver licensing provisions help reduce distractions by limiting the number of passengers or restricting cell phone use.

- 1. Laws and enforcement

Countermeasure	Effectiveness	Use	Cost	Time
1.1 Cell phone laws	Uncertain	Low	Varies	Short
1.2 GDL requirements for beginning drivers	Proven	High	Low	Medium
1.3 General fatigue and distraction laws	Unknown	High	Varies	Short

- 2. Communications and outreach

Countermeasure	Effectiveness	Use	Cost	Time
2.1 Fatigued or drowsy driving	Unknown	Unknown	Medium	Medium
2.2 Distracted driving	Unknown	Unknown	Medium	Medium

- 3. Other countermeasures

Countermeasure	Effectiveness	Use	Cost	Time
3.1 Employer programs	Unknown	Unknown	Low	Short
3.2 Medical conditions and medications	Unknown	Unknown	Variable	Medium

- Another source of general countermeasures was published in the USA by the Governs Highway Safety Assosciation (GHSA) in 2011. This document entitled “Distracted Driving: What research shows and what states can do” http://www.ghsa.org/html/files/pubs/sfdist11execsum.pdf
  - **Are there effective countermeasures for distracted driving?** Laws banning hand-held cell phone use reduced use by about half when they were first implemented. Hand-held cell phone use increased subsequently but the laws appear to have had some long-term effect. A high-visibility cell phone and texting law enforcement campaign reduced cell phone use immediately after the campaign. Longer-term effects are not yet known.There is no evidence that cell phone or texting bans have reduced crashes. Distracted driving communications campaigns and company policies and programs are widely used but have not been evaluated.

- **What can states do to reduce distracted driving?** States can and should take four steps that will help reduce distracted driving immediately and in the future. 1 - Continue to implement effective low-cost roadway distracted driving countermeasures such as edgeline and centerline rumble strips. 2 - Record distracted driving in crash reports to the extent possible, to assist in evaluating distracted driving laws and programs. 3 - Monitor the impact of existing hand-held cell phone bans prior to enacting new laws. States that have not already passed handheld bans should wait until more definitive research and data are available on these laws' effectiveness. 4 - Evaluate other distracted driving laws and programs. Evaluation will provide the information states need on which countermeasures are effective and which are not.

- **What should others do to reduce distracted driving?** Employers: Consider distracted driving policies and programs for their employees. Evaluate the effects of their distracted driving policies and programs on employee knowledge, behavior, crashes, and economic costs (injuries, lost time, etc.).Automobile industry: Continue to develop, test, and implement measures to manage driver workload and to warn drivers of risky situations. Federal government: Help states evaluate the effects of distracted driving programs. Continue tracking driver cell phone use and texting in the National Occupant Protection Use Survey (NOPUS). Work with states to improve data collection on driver distractions involved in crashes. Continue to develop and conduct national communications campaigns on distracted driving.

- PRAISE is a project co-funded by the European Commission and implemented by ETSC on Preventing Road Accidents and Injuries for the Safety of Employees (PRAISE). It makes recommendations for managing driver distraction, recommendations for how employers should deal with the risk, as well as proposals for national and European level strategies for driver distraction (http://archive.etsc.eu/documents/PRAISE_Thematic_Report_Moving%20In%20Vehicle%20Distraction_21_December%202010.pdf)

    - **Managing the risk**: Adopt a policy for managing distracted driving

- **Recommendations for employers:** Senior managers to take the lead by respecting the distracted driving policy. Adopt a clear policy against distracted driving / use of mobile phones and other electronic devices while driving for work, including as a minimum: “engine on, phone off” and asking staff to put their phone on voicemail with an appropriate message. Undertake a review of communication strategies and tools in place. Communicate to staff the reasons why policies are in place: hands-free can be as dangerous as hands-held, and having a mobile phone conversation while driving is as bad or even worse than drink driving in terms of risk. Ensure there is a mechanism in place to verify such as a training session to ensure that employees including management level are aware and understand existing driving for work policies.

- **National level**: UK “Kill the Conversation”. Belgium “No Phone at the wheel”. Germany “Who is driving?”.

References

The following references relate to the core research referred to within this synthesis.

Title:	**Seat belt and mobile phone use surveys: England and Scotland, 2014**
Published:	DfT (2015). Seat belt and mobile phone use surveys: England and Scotland, 2014. DfT Statistical Release, available from:
Link: **Free/priced:**	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/406723/seatbelt-and-mobile-use-surveys-2014.pdf Free
Objectives:	In 2014 the Department for Transport and Transport Scotland commissioned mobile phone and seat belt surveys to monitor levels of mobile phone use by drivers and the use of seat belts by vehicle occupants across England and Scotland.
Methodology:	Roadside observation methods were used to collect the data with teams of staff visiting each site. The mobile phone survey was carried out across 60 sites in England within four different areas (South East, Manchester, Newcastle/Durham and Norfolk) and 30 sites in Scotland. Surveys took place in both morning and afternoon sessions.
Key Findings:	• Drivers were more likely to be observed with a mobile phone in their hand rather than holding it to their ear. In 2014, 1.1 per cent of drivers in England and Scotland were observed holding a phone in their hand compared with 0.5 per cent observed holding the phone to their ear. • A higher proportion of drivers in England and Scotland were observed using a hand-held mobile phone when stationary (2.3 per cent) than in moving traffic (1.6 per cent). • The proportion of car drivers observed using a hand-held mobile phone in England in 2014 (1.5 per cent) was relatively unchanged from the 1.4 per cent observed in 2009, when the previous survey was carried out.
Keywords:	Seat belt; mobile phone; driving; observation rates

Title:	**The 100-car naturalistic driving study, Phase II-results of the 100-car field experiment**
Published:	Dingus, T. A., Klauer, S. G., Neale, V. L., Petersen, A., Lee, S. E., Sudweeks, J. D., ... & Knipling, R. R. (2006). The 100-car naturalistic driving study, Phase II-results of the 100-car field experiment (No. HS-810 593).
Link: **Free/priced:**	http://trid.trb.org/view.aspx?id=783477 Free
Objectives:	The 100-Car Naturalistic Driving Study is the first instrumented-vehicle study undertaken with the primary purpose of collecting large-scale, naturalistic driving data.
Methodology:	The 100-Car Naturalistic Driving Study is the first instrumented-vehicle study undertaken with the primary purpose of collecting large-scale, naturalistic driving data. Drivers were given no special instructions, no experimenter was present, and the data collection instrumentation was unobtrusive. In addition, 78 of 100 vehicles were privately owned. The data set includes approximately 2,000,000 vehicle miles, almost 43,000 hours of data, 241 primary and secondary drivers, 12 to 14 months of data collection for each vehicle, and data from a highly capable instrumentation system including 5 channels of video and many vehicle state and kinematic sensors. The resulting database contains many extreme cases of driving behavior and performance, including severe drowsiness, impairment, judgment error, risk taking, willingness to engage in secondary tasks, aggressive driving, and traffic violations.
Key Findings:	The current project specified ten objectives or "goals" that would be addressed through the initial analysis of the event database. This report addresses the first 9 of these goals, which include analyses of rear-end events, lane change events, the role of inattention, and the relationship between levels of severity. Goal 10 is a separate report and addresses the implications for a larger-scale data collection effort.
Keywords:	Attention lapses; Behavior; Crash severity; Data collection; Distraction; Driver errors; Drowsiness; Field studies; Headways; Human factors in crashes; Impaired drivers; Instrumented vehicles; Lane changing; Operating speed; Performance; Reaction time; Rear end collisions; Risk taking; Traffic crashes; Traffic incidents; Traffic violations

Title:	**An observational study of driver distraction in England**
Published:	Sullman, M. J. (2012). An observational study of driver distraction in England. Transportation research part F: traffic psychology and behaviour, 15(3), 272-278.
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S1369847812000022 Purchase or subscription
Objectives:	This study set out to investigate the proportion of UK drivers who engage in some form of distracting behaviour whilst driving.
Methodology:	Data were collected by roadside observation in six urban centres in the South of England. The observations took place on randomly selected roads at three different time periods during two consecutive Tuesdays.
Key Findings:	The data revealed that 14.4% of the 7168 drivers observed were found to be engaged in a distracting activity. The most frequently observed distraction was talking to a passenger, followed by smoking and using a mobile phone. Younger drivers were significantly more likely to be distracted in general and by talking to passengers, while older drivers were less likely to be distracted by adjusting controls or using a mobile phone.
Keywords:	Driver distraction; Distraction; Cell phone; Mobile phone; Crash risk; Observation

Title:	**RAC Report on Motoring 2014**
Published:	RAC (2014). **RAC Report on Motoring 2014. London: RAC House**
Link: **Free/priced:**	http://www.rac.co.uk/advice/reports-on-motoring Free
Objectives:	The 2014 RAC Report on Motoring explores British motorists' general attitudes towards driving. It examines motorists' behaviours, attitudes and beliefs to describe issues of importance to the general driving public.
Methodology:	The RAC Report on Motoring 2014 is based on a large-scale internet survey carried out by Quadrangle on behalf of the RAC. In total, Quadrangle interviewed 1,526 British motorists (i.e. those who hold a current driving licence and drive at least once a month). The survey was conducted in February 2014, with the questionnaire taking around 25 minutes to complete. The sample was nationally representative of age, gender, socio-economic groups, all GB regions, company car drivers and new car buyers.
Key Findings:	The report describe seven key findings: • Cost of fuel is still a top concern for motorists • Drivers have had enough of pot holed roads • Motorists need to brush up on the Highway Code • Drivers tend to speed on motorways • Drivers are concerned that mobile phones are a deadly distraction • Child road safety remains a concern despite falling casualty rates • Motorists feel uncomfortable driving in adverse conditions
Keywords:	Driving; survey; attitudes.

Title:	**In-vehicle distraction and fatal accidents in England and Wales**
Published:	Stevens, A. and Minton, R. (2001) In-vehicle distraction and fatal accidents in England and Wales. Accident Analysis and Prevention, 33, 539–545.
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S0001457500000683 Free
Objectives:	The coding and analysis of a database of police fatal accident reports to investigate the extent to which in-vehicle distraction is a contributory factor in vehicle crashes
Methodology:	Review of police fatal accident reports between 1985 and 1995. Eight different sources of in-vehicle distractions were codified: new technologies; old technologies; entertainment devices; telephones; other vehicle controls; passengers; eating/drinking; other.
Key Findings:	Analysis of accidents occurring over the period 1985–1995 shows that in-vehicle distraction is reported as a contributory factor in about 2% of fatal accidents (although this figure may be a conservative estimate).
Keywords:	Fatal accidents; Telephones; Police narrative; Distraction

Title:	**Defining driver distraction**
Published:	Lee, J. D., Young, K. L., & Regan, M. A. (2008). Defining driver distraction. Driver distraction: Theory, effects and mitigation, 31-40.
Link: **Free/priced:**	http://trid.trb.org/view.aspx?id=884583 Purchase required
Objectives:	This chapter presents an initial attempt at combining several theoretical perspectives to guide design and policy considerations regarding distraction.
Methodology:	This book chapter presents an initial attempt at combining several theoretical perspectives to guide design and policy considerations regarding distraction.
Key Findings:	The chapter begins with a brief discussion of the definitions of distraction and the underlying issues, and suggests the authors' definition. It concludes by describing the role of distraction as a cause of crashes
Keywords:	

Title:	**Defining driver distraction**
Published:	Pettitt, M., Burnett, G. E., & Stevens, A. (2005). Defining driver distraction. In 12th World Congress on Intelligent Transport Systems.
Link: **Free/priced:**	https://trl.co.uk/reports/TRL661 Free
Objectives:	This paper discusses the various issues concerned with the precise definition of the term driver distraction.
Methodology:	This paper reviews those definitions available in the literature and examines the necessary components of a reliable definition with support from accident statistics in a database of work-related road traffic accidents in the Midlands area of the UK.
Key Findings:	It is found that driver distraction should be discussed in terms of four components: the difference between distraction and inattention; the recognition that distraction can be internal and external to the vehicle; that distraction can be categorized into four types; and, the effect of distraction on the driving task. Finally, a proposed, comprehensive definition for driver distraction is provided along with other conclusions.
Keywords:	Driver; distraction; definition; inattention

Title:	**Attentional competition between tasks and ITS implications**
Published:	Hoel, J., Jaffard, M., & Van Elslande, P. (2010). Attentional competition between tasks and its implications. In European Conference on Human Centred Design for Intelligent Transport Systems, 2nd, 2010, Berlin, Germany.
Link: **Free/priced:**	http://conference2010.humanist-vce.eu/document/Proceedings/Poster_Hoel.pdf Free
Objectives:	Attentional processes are necessary for any complex activity, such as driving. The aim of this study is to highlight the involvement of attentional problems and their weight in accident causation, using data from in-depth analysis of accidents.
Methodology:	This study, based on an in-depth analysis of accidents, identified three attentional defaults which are distinguished according to the task that competes with driving activity: • Inattention', resulting from interference between a driving task and personal concerns. • Attentional competition', resulting from interference between several tasks relevant for driving (e.g. guide a vehicle and follow an itinerary). • 'Distraction', resulting from interference between a driving task and an external stimulation without link with driving (e.g. guide a vehicle and tune the radio). This secondary task can be gestural or visuocognitive.
Key Findings:	Inattention is the default the most represented (74.5 per cent) by comparison with attentional competition (19.1 per cent) and distraction (6.4 per cent). Overall, attentional defaults lead mainly to perceptual failures (45 per cent). In more than half of the cases, it requires other factors for a driving error to emerge. The importance of this study of human failures linked to attention defects is that it allows us to define driver's needs and thus identify which systems are the most relevant and, on the other hand, those which lessen attention the capacity required for driving.
Keywords:	Attention; Crash analysis; Crash causes; Driver performance; Driver vehicle interfaces; Human machine systems; Intelligent transportation systems

Title:	**A study of pre-crash factors involved in traffic accidents**
Published:	Treat, J. R. (1980). A study of pre-crash factors involved in traffic accidents. HSRI Research Review.
Link: **Free/priced:**	http://psycnet.apa.org/psycinfo/1981-13775-001 Subscription
Objectives:	The identification of causal factors in traffic accidents to develop a taxonomy direct human causes of traffic accidents.
Methodology:	Examined during a 5-yr period how frequently various human, environmental, and vehicular factors were involved in traffic accidents by studying 13,568 police-reported accidents of which 2,258 were investigated on-scene by technicians and 420 by a multidisciplinary team. Human errors were identified as definite causes in 70.7% of the accidents, environmental factors in 12.4%, and vehicular factors in 4.5%. In 20% of the cases, no definite cause was identified. A taxonomy of direct human causes was developed based on an information-processing model of the driver as a vehicle controller.
Key Findings:	The following categories were established: (1) recognition errors (i.e., perception and comprehension); (2) critical nonperformance (e.g., falling asleep); and (3) nonaccident (e.g., suicide attempt). More specific causes were developed under these categories, such as improper lookout, excessive speed, inattention, and improper evasive action. It is suggested that such findings may help develop effective means of reducing accidents.
Keywords:	

Title:	**Scoping study of driver distraction**
Published:	Basacik, D., & Stevens, A. (2008). Scoping study of driver distraction .Road Safety Research Report No. 95. Department for Transport.
Link: **Free/priced:**	http://webarchive.nationalarchives.gov.uk/20090417002224/http://www.dft.gov.uk/pgr/roadsafety/research/rsrr/theme2/report95.pdf Free
Objectives:	The main objectives of the project were: • to prepare a definition of driver distraction and secure at least UK agreement on its adoption; • to summarise and critically review research on driver distraction from sources both within and outside the vehicle and to identify gaps in knowledge; and • to provide recommendations for future research and for monitoring changes in the impact of driver distraction

Methodology:	Expert workshops were conducted. Members of the workshops were identified as influential professionals working in driver distraction. The core group comprised six of the most influential UK experts (later joined by Professor Mike Regan who has recently edited an international book on driver distraction) who were selected as being research-active in the scientific area of driver distraction: • Professor Oliver Carsten, Leeds University; • Professor Andrew Parkes, TRL; • Associate Professor Mike Regan, MONASH University; • Dr Alan Stevens, TRL; • Dr Terry Lansdown, Heriot-Watt University; • Dr Gary Burnett, Nottingham University; and • Mr Mark Fowkes, MIRA Awider reference group was also given the opportunity to remotely review and comment on outputs from the project. Two workshops were conducted: • Workshop 1 : agreement of definition and discussion of review • Workshop 2: identification of research priorities
Key Findings:	• Estimates of the role of driver distraction in accident causation can vary widely due to the lack of a standardised definition and inconsistencies in accident reporting. Nevertheless, a study of naturalistic driving behaviour found that inattention contributed to 78% of accidents (Neale et al ., 2005). • External distractions (e.g. from outside persons, objects, events) are the most frequently reported cause of distraction-related accidents (Stutts et al., 2001). Nevertheless, research on the effects of distraction by sources external to the vehicle and passengers within the vehicle appears to be scarce. • Driving performance decrements have been shown as a result of distraction by mobile phones, in-vehicle information systems (IVIS), in-car entertainment (ICE) and email systems, as well as advertising billboards, variable message signs (VMS) and other distractors. • Study results indicate that drivers themselves are poor judges of their performance decrements while driving (Horrey et al., 2007). • The lack of a standardised assessment methodology or baseline against which to compare distracted driving performance leads to difficulties in making relative judgements without designing an experiment to include all variables of interest. • The current state of knowledge is not sufficient to confidently identify ‘high- risk’ groups for driver distraction; however, age and gender differences have been found when examining distracted driving

	performance. • Research has been conducted on drivers' attitudes towards engagement with distractors. For example, the results of a Canadian survey (Insurance Bureau of Canada, 2006) suggested that 89% of Canadians were very or somewhat concerned about driver distraction; but 60% of drivers would not agree to stop using their mobile phones while driving. Nevertheless, attitudes can change with time and periodic monitoring may be beneficial
Keywords:	Distraction, definition, workshops

Title:	**International Conference on Distracted Driving: Summary of Proceedings and Recommendations**
Published:	Hedland J, Simpson H, Mayhew D. (2006) International Conference on Distracted Driving: Summary of Proceedings and Recommendations, October 2005. Traffic Injury Research Foundation.
Link: **Free/priced:**	http://www.distracteddriving.ca/english/documents/ENGLISH-DDProceedingsandRecommendations.pdf Free
Objectives:	Summary of conference proceedings.
Methodology:	N/A
Key Findings:	This report integrates and summarizes key information from the presentations as well as the conclusions and recommendations from the workshops. These recommendations, generated by conference participants based on their collective conclusions about distracted driving, are intended to provide guidance to a wide range of stakeholders.
Keywords:	Driving; distraction; guidance; summary

Title:	**Driver distraction and driver inattention: Definition, relationship and taxonomy**
Published:	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.
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S0001457511000893 Paid
Objectives:	Driver distraction and driver inattention are defined and a taxonomy is presented in which driver distraction is distinguished from other forms of driver inattention.
Methodology:	Review based on expert understanding of topical issues in driver distraction research
Key Findings:	Proposes a new taxonomy of drive distraction. Concludes that Driver Inattention means insufficient or no attention to activities critical for safe driving, and that Driver Diverted Attention (which is synonymous with "driver distraction") is just one form of driver inattention. The other forms of driver inattention the authors have labelled tentatively as Driver Restricted Attention, Driver Misprioritised Attention, Driver Neglected Attention and Driver Cursory Attention. Suggested definitions for each of these categories of inattention have been provided. The authors have also attempted to differentiate between different categories of internalised thought and to incorporate them within the taxonomy.
Keywords:	Driver distraction; Driver inattention; Definition; Road safety; Taxonomy

Title:	**Towards Operationalizing Driver Distraction**
Published:	Foley, J., Young, R., Angell, L., & Domeyer, J. (2013). Towards Operationalizing Driver Distraction. In 7th International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design (pp. 17-20).
Link: **Free/priced:**	http://drivingassessment.uiowa.edu/sites/default/files/DA2013/Papers/010_Foley_0.pdf Free
Objectives:	Driver distraction has been the subject of much research interest and scientific inquiry. Operationalizing driver distraction is a complex task—one that is necessary for advancing both science and public policy in this domain. While many operational definitions can be gathered from the literature, gaps are common The goals of this undertaking were initially to reach consensus on three definitions: • Top-level definition of driver distraction • Definition of visual-manual distraction • Definition of auditory-vocal-cognitive distraction
Methodology:	A workshop was conducted with 21 experts in distraction. Before the workshop five key tasks were conducted: • A clear definition of the goals of the project was prepared. • A literature search for existing driver distraction definitions was completed. • A questionnaire to identify the “best” definitions currently in the literature was designed. • The questionnaire was distributed to invited participants, 16 of whom responded with completed questionnaires. • The results of that questionnaire were analysed to identify initial points of consensus before the workshop.
Key Findings:	This workshop procedure achieved several outcomes. It: • Demonstrated that pre-planning and administering the questionnaire prior to the workshop provided a good foundation for discussions leading to rapid consensus. • Achieved the goal of drafting common terminology for driver distraction research • Clarified the Regan definition by defining related subsidiary terms. • Established the benefits of moving beyond a dichotomous (visual-manual vs. cognitive) definition of tasks / resources, thus providing a more useful framework for identifying and coding all types of driver distraction. Succeeded in building agreement among a group of leading researchers in the distraction field.
Keywords:	Distraction; Definition; Workshop.

Title:	**Driver distraction**
Published:	Caird, J. K. & Dewar, R. E. (2007). Driver distraction. In R. E. Dewar and P.L. Olson (eds.). Human factors in traffic safety (2nd Ed.). pp.195-229, Lawyers and Judges Publishing, Tucson AZ, USA, 2007.
Link: **Free/priced:**	http://books.google.co.uk/books/about/Human_Factors_in_Traffic_Safety.html?id=vM-WJbGlf-MC
Objectives:	In this update of the 2002 edition, the authors introduce the field of human factors with daunting traffic accident statistics and encouraging progress made regarding transportation design. Expert contributors to two dozen chapters address all elements of the transportation safety equation: • The Driver • Vehicle • Roadway Environment • Accident Causation and Remediation
Methodology:	n/a
Key Findings:	n/a
Keywords:	n/a

Title:	**A conceptual framework and taxonomy for understanding and categorizing driver inattention**
Published:	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.
Link: **Free/priced:**	http://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0CC8QFjAB&url=http%3A%2F%2Fec.europa.eu%2Finformation_society%2Fnewsroom%2Fcf%2Fdae%2Fdocument.cfm%3Fdoc_id%3D2671&ei=PFUVVamBMdTfaqWqgbgE&usg=AFQjCNHG_tKF-5DR0U4lKTGO7G_Y5sxlyw&sig2=Qx_kvxvIQHQYBNCfYcfVDA&bvm=bv.89381419,d.d2s Free
Objectives:	This documents reports on the results of the Inattention Taxonomy project, which was carried out by the Driver Distraction & Human Machine Interaction (DD & HMI) Working Group, under the framework of the United States and European Union Bilateral Intelligent Transportation Systems Technical Task Force (US-EU Bilateral ITS TF), with the main objective being to define a conceptual framework and taxonomy of driver inattention.

Methodology:	A conceptual framework for driver attention was formulated in terms of a set of key principles. This framework was developed by the Driver Distraction Focus Group, which consisted of the Driver DD & HMI WG plus six US and EU experts. The contributing project members were: US: Chris Monk (NHTSA; co-chair of the DD & HMI WG), Eric Traube (NHTSA), David Yang (FHWA), Dan McGehee (University of Iowa), John Lee (University of Wisconsin), Rich Hanowski (Virginia Tech), Bill Horrey (Liberty Mutual) EU: Johan Engström (Volvo; co-chair of the DD & HMI WG), Alan Stevens (TRL), Mike Regan (then at INRETS, now at University of New South Wales, Australia), Trent Victor (Volvo), Marko Tuukkanen (Nokia). In addition, a Scandinavian mirror group linked to the SAFER competence centre in Gothenburg, Sweden, contributed to the project. The members of this group were Katja Kircher and Christer Ahlström (VTI), Fridulv Sagberg (TÖI) and Jonas Bärgman (Chalmers University of Technology).
Key Findings:	Based on this conceptual framework, a general taxonomy of driver inattention was developed. Driver inattention was broadly divided into two general categories: (1) insufficient attention and (2) misdirected attention, relating to the activation and selective aspects of attention respectively. For each of these categories, a set of sub-processes giving rising to them was defined. The report ends with a discussion of some key implications of the proposed conceptual framework and inattention taxonomy, and how the taxonomy can be used for its intended applications.
Keywords:	Inattention; Distraction; Driving; Taxonomy

Title:	**Towards an understanding of driver inattention: taxonomy and theory**
Published:	Regan, M. A., & Strayer, D. L. (2014). Towards an understanding of driver inattention: taxonomy and theory. Annals of advances in automotive medicine, 58, 5.
Link: **Free/priced:**	http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4001671/ Free
Objectives:	In 2011, Regan, Hallett and Gordon proposed a taxonomy of driver inattention in which driver distraction is conceptualized as just one of several processes that give rise to driver inattention. Since publication of that paper, two other papers have emerged that bear on the taxonomy. In one, the Regan et al taxonomy was used, for the first time, to classify data from an in-depth crash investigation in Australia. In the other, another taxonomy of driver inattention was proposed and described.
Methodology:	This paper revisits the original taxonomy proposed by Regan et al. in light of recent developments in the literature on driver distraction and inattention. This paper is a review of the literature; the precise method of this review is not described.
Key Findings:	Recommendations are made for several lines of research: to further validate the original taxonomy; to understand the impact of each category of inattention in the taxonomy on driving performance, crash type and crash risk; and to revise and align with the original taxonomy existing crash and incident investigation protocols, so that they provide more comprehensive, reliable and consistent information regarding the contribution of inattention to crashes of all types.
Keywords:	Inattention; Driver; Definition; Taxonomy

Title:	**Driver Distraction in Commercial Vehicle Operations.**
Published:	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.
Link: **Free/priced:**	http://www.fmcsa.dot.gov/sites/fmcsa.dot.gov/files/docs/FMCSA-RRR-09-042.pdf Free
Objectives:	This study investigated the impact of driver distraction in commercial motor vehicle (CMV) operations.
Methodology:	Data from two earlier naturalistic studies were combined to create a data set of 203 CMV drivers and 55 trucks from seven trucking fleets operating at 16 locations. A total of 4,452 safety-critical events (i.e., crashes, near-crashes, crash-relevant conflicts, and unintentional lane deviations) were identified in the data set, along with 19,888 baseline (uneventful, routine driving) epochs.
Key Findings:	Key findings were that drivers were engaged in non-driving related tasks in 71 percent of crashes, 46 percent of near-crashes, and 60 percent of all safety-critical events. Also, performing highly complex tasks while driving lead to a significant increase in risk. Eye glance analyses examined driver eye location while performing tasks while operating a CMV. Tasks associated with high odds ratios (increased risk) were also associated with high eyes off forward road times. This suggests that tasks that draw the driver's visual attention away from the forward roadway should be minimized or avoided. Based on the results of the analyses, a number of recommendations are presented that may help address the issue of driver distraction in CMV operations.
Keywords:	CMV, commercial motor vehicle, distraction, naturalistic data, safety-critical events

Title:	**Distraction in commercial trucks and buses: Assessing prevalence and risk in conjunction with crashes and near-crashes.**
Published:	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.
Link: **Free/priced:**	http://ntl.bts.gov/lib/51000/51200/51287/Distraction-in-Commercial-Trucks-and-Buses-report.pdf Free
Objectives:	This project recognised that there is a knowledge gap regarding the operation of trucks (three-axle or more trucks and tractor trailers/tankers) and buses (including transit and motor coaches, but referred to as "buses" hereafter) in regards to distracted driving and, more specifically, cell phone use and texting while driving and sought to fill that knowledge gap.
Methodology:	This research analyzed naturalistic data on commercial trucks (3-axle and tractor trailer/tanker) and buses (transit and motor coaches) over a 1-year period. Two data sets were used: data set A from 207 truck and bus fleets comprising 13,431 vehicles included 1,336 crashes, 15,864 near-crashes, and 173,591 crash-relevant conflicts; and data set B from 183 commercial truck and bus fleets comprising 13,306 vehicles included 1,085 crashes, 8,375 near-crashes, 30,661 crash-relevant conflicts, and 211,171 baseline events (i.e., triggered non-safety critical events).
Key Findings:	Study results document the prevalence of cellular telephone distractions and the risk associated with performing related tasks while driving. Findings include the odds of involvement in a safety-critical event differed as a function of performing different cell phone-related sub-tasks while driving. More specifically, talking/listening on a cell phone while driving was generally found not to impact significantly the odds of involvement in a safety-critical event (and was even found to decrease the odds significantly in some cases), while other cell phone sub-tasks (e.g., texting, dialing, reaching) were found to increase significantly the odds of involvement in a safety-critical event. Analyses examine the likelihood of commercial drivers to use their cell phone under a fleet cell phone policy and State cell phone law.
Keywords:	Buses, cell phone, cell phone policy, commercial motor vehicle, CMV, crash avoidance, distraction, driver behaviour, naturalistic, odds ratio, population attributable risk, trucks

Title:	**Driver inattention and driver distraction in serious casualty crashes: Data from the Australian National Crash In-depth Study**
Published:	Beanland, V., Fitzharris, M., Young, K. L., & Lenné, M. G. (2013). Driver inattention and driver distraction in serious casualty crashes: Data from the Australian National Crash In-depth Study. *Accident Analysis & Prevention*, 54, 99-107.
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S000145751300047X Purchase or subscription required
Objectives:	Driver inattention and driver distraction represent a major problem in road safety. Although both are believed to contribute to increased crash risk, there is currently limited reliable information on their role in crashes.
Methodology:	Used in-depth crash data to assess the prevalence of driver inattention and distraction in serious injury crashes. The study used in-depth data from the Australian National Crash In-depth Study to investigate the role of driver distraction and inattention in serious casualty crashes. The sample included 856 crashes from 2000 to 2011, in which at least one party was admitted to hospital due to crash-related injuries. Coded using a taxonomy of five inattention subtypes: restricted, misprioritised, neglected, cursory and diverted attention (distraction).
Key Findings:	Majority of coded crashes involved inattention, restricted and diverted attention were most prevalent. Most inattention is avoidable.
Keywords:	Crash rates; Distraction; Inattention; In-depth crash investigation; Australian National Crash In-depth Study

Title:	**The effect of text messaging on driver behaviour: a simulator study**
Published:	Reed, N., & Robbins, R. (2008). The effect of text messaging on driver behaviour: a simulator study. PPR 367 TRL Published Project Report.
Link: **Free/priced:**	http://www.racfoundation.org/assets/rac_foundation/content/downloadables/texting%20whilst%20driving%20-%20trl%20-%20180908%20-%20report.pdf Free
Objectives:	To test the impact of text messaging on driver performance in a driving simulator.
Methodology:	Driver performance was recorded when sending and receiving text messages in a driving simulator. Seventeen participants between the ages of 17-24 were recruited for the

	study (8 male; 9 female). All participants described themselves as regular users of text messaging and used phones with standard key pads (i.e. alphanumeric key pads. Other phone types were excluded).
Key Findings:	Writing text messages created a significantly greater impairment than reading text messages. Behaviour in response to the arrival of an ignored text message was unaffected.
Keywords:	Driving, mobile phone, texting, simulator

Title:	**The effects of text messaging on young drivers performance**
Published:	Hosking, S. G., Young, K. L., & Regan, M. A. (2006). The effects of text messaging on young drivers performance. Human Factors, 46, 625-639.
Link: **Free/priced:**	http://www.distraction.gov/downloads/pdfs/effects-of-text-messaging.pdf Free
Objectives:	This project aimed to evaluate, using the advanced driving simulator located at the Monash University Accident Research Centre, the effects of text (SMS) messaging on the driving performance of young novice drivers
Methodology:	Twenty participants drove on a simulated roadway which contained a number of events, including a pedestrian emerging from behind parked cars, traffic lights, cars turning right in front of the driver, a car following episode and a lane change task. The twenty participants were aged between 18 and 21 years (M = 19.1, SD = 1.2) with six months or less of experience driving on a Probationary driver's license.
Key Findings:	The results revealed that retrieving and, in particular, sending text messages had a detrimental effect on a number of safety critical driving measures. When text messaging, drivers' ability to maintain their lateral position on the road and to detect and respond appropriately to traffic signs was significantly reduced. In addition, drivers spent up to 400 percent more time with their eyes off the road when text messaging, than when not text messaging. While there was some evidence that drivers attempted to compensate for being distracted by increasing their following distance when following a lead vehicle, drivers did not reduce their speed while distracted.
Keywords:	Text messaging; young drivers; driver distraction

Title:	**Smartphone use while driving: a simulator study**
Published:	Basacik, D., Reed, N., & Robbins, R. (2012). Smartphone use while driving: a simulator study (No. PPR592).
Link: **Free/priced:**	http://iam.org.uk/images/stories/policy-research/poke-full.pdf Free
Objectives:	This study set out to investigate whether there was an effect of social networking using a smartphone on driving performance.
Methodology:	Twenty-eight young male and female participants took part in the study and drove a driving simulator through the same test scenario twice: once while using a smartphone to interact with a social networking site, and once without this distraction. Twenty-eight participants were recruited from the TRL participant database to take part in the study, with an approximately even split between males and females. They met the following criteria in order to be included in the study: • Participants described themselves as regular users of Facebook on smartphones • Participants had the Facebook app on their smartphone • Participants were current owners of a touchscreen smartphone (iPhone or Android) • Participants were aged between 18 and 25 • Participants drove more than 5000 miles per year • Participants had experience of driving on a motorway • Participants had driven the simulator before • Participants successfully completed a familiarisation drive in the simulator Participants were required to use their own phones for the study.
Key Findings:	Participants' driving performance was impaired by the concurrent smartphone task, and the smartphone task was also affected by driving. When compared with their driving performance without a smartphone: • Participants were more likely to miss the reaction time stimuli while using their phone. • When they did respond, reaction times to visual and auditory stimuli were found to increase by approximately 30% when using a smartphone to send and receive messages on a social networking site. • They were unable to maintain a central lane position and this resulted in an increased number of unintentional lane departures. • They were unable to respond as quickly to a lead vehicle gradually changing speed, thus driving at a more variable time headway. • They spent between 40% and 60% of the time looking down while using a smartphone to write or read messages, compared with about 10% of the time looking down in the same sections of the control drive.

Keywords:	Driving, distraction, young drivers, mobile phone, social networking.

Title:	**A meta-analysis of the effects of texting on driving.**
Published:	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.
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S000145751400178X Paid
Objectives:	To compare a meta-analysis on the body of research on the effects of texting whilst driving.
Methodology:	A meta-analysis. It reviewed 1476 abstracts and 82 met general inclusion criteria. Of these, 28 studies were found to sufficiently compare reading or typing text messages while driving with a control or baseline condition.
Key Findings:	Typing and reading text messages while driving adversely affected eye movements, stimulus detection, reaction time, collisions, lane positioning, speed and headway. Typing text messages alone produced similar decrements as typing and reading, whereas reading alone had smaller decrements over fewer dependent variables. Typing and reading text messages affects drivers' capability to adequately direct attention to the roadway, respond to important traffic events, control a vehicle within a lane and maintain speed and headway.
Keywords:	Texting and driving; Meta-analysis; Traffic safety; Public health; Research synthesis

Title:	**Effect of wireless communication and entertainment devices on simulated driving performance**
Published:	Crisler, M. C., Brooks, J. O., Ogle, J. H., Guirl, C. D., Alluri, P., & Dixon, K. K. (2008). Effect of wireless communication and entertainment devices on simulated driving performance. Transportation Research Record: Journal of the Transportation Research Board, 2069(1), 48-54.
Link: **Free/priced:**	http://trb.metapress.com/content/g6h25p5515677853/ Paid
Objectives:	To analyse the effect of wireless telephone communication using text and voice modalities as well as an Apple iPod on lane keeping, speed, speed variability, lateral speed, and lane position variability.
Methodology:	A driving simulator study where participants (young adult licensed drivers) drove in an unusually curvy simulated driving environment while using wireless devices, controlling an iPod, and participating in conversations and word games. Fourteen licensed drivers (seven male and seven female) completed this study in exchange for class credit in a psychology course. Participants ranged in age from 18 to 22 years. All participants had previous cell phone, text messaging, and iPod experience.
Key Findings:	Lane-keeping performance was robust for voice communication tasks; however, the text messaging and iPod tasks that required significant manual manipulation of the device resulted in significant decrements in lane-keeping performance. In addition, all wireless communication tasks and the iPod task resulted in significant increases in speed variability throughout the driving scenario. Lateral speed increases occurred for all wireless communication tasks other than the cellular phone conversation as well as the iPod task. Increases in lane position variability were observed for the text messaging conditions.
Keywords:	Simulator; voice communication; i-Pod; young drivers

Title:	**Texting while driving: Is speech-based text entry less risky than handheld text entry?.**
Published:	He, J., Chaparro, A., Nguyen, B., Burge, R. J., Crandall, J., Chaparro, B., & Cao, S. (2014). Texting while driving: Is speech-based text entry less risky than handheld text entry?. Accident Analysis & Prevention, 72, 287-295.
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S0001457514002176 Paid
Objectives:	To compare the effect of speech-based versus handheld text entries.
Methodology:	Participants drove a simulator and performed a car following task concurrently with a secondary text-entry task. Thirty-five college-age participants (11 men and 24 women, M = 21.6 years of age, SD = 3.67 years of age) from the community of Wichita State University volunteered to participate in this driving experiment. All participants were screened prior to participation to ensure normal or corrected-to-normal vision. All participants were active drivers with at least 2 years of driving experience (M = 6.34 years; SD = 3.56 years) and were required to own a touch screen smartphone to ensure familiarity with the cell phone used in the experiment.
Key Findings:	Results showed that both speech-based and handheld text entries impaired driving performance relative to the drive-only condition by causing more variation in speed and lane position. Handheld text entry also increased the brake response time and increased variation in headway distance. Text entry using a speech-based cell phone was less detrimental to driving performance than handheld text entry. Nevertheless, the speech-based text entry task still significantly impaired driving compared to the drive-only condition.
Keywords:	Driver distraction; Cellphone; Car following; Texting; Speech-based interaction

Title:	**Driver performance while text messaging using handheld and in-vehicle systems**
Published:	Owens, J. M., McLaughlin, S. B., & Sudweeks, J. (2011). Driver performance while text messaging using handheld and in-vehicle systems. Accident Analysis & Prevention, 43(3), 939-947.
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S0001457510003635 Paid
Objectives:	This study presents an evaluation of driver performance while text messaging via handheld mobile phones and an in-vehicle texting system.
Methodology:	Participants sent and received text messages while driving with an experimenter on a closed-road course, using their personal mobile phones and the vehicle's system. The test vehicle was an instrumented 2010 Mercury Mariner equipped with an OEM in-vehicle system that supports text messaging and voice control of mobile devices via Bluetooth, which was modified to allow text message sending during driving. Twenty participants were tested, 11 younger (19–34) and 9 older (39–51). All participants were regular users of the in-vehicle system, although none had experience with the texting functions.
Key Findings:	Results indicated that handheld text message sending and receiving resulted in higher mental demand, more frequent and longer glances away from the roadway, and degraded steering measures compared to baseline. Using the in-vehicle system to send messages showed less performance degradation, but still had more task-related interior glance time and higher mental demand than baseline; using the system's text-to-speech functionality for incoming messages showed no differences from baseline.
Keywords:	Driving; Text messaging; Distraction; Mobile phone

Title:	**How dangerous is driving with a mobile phone? Benchmarking the impairment to alcohol.**
Published:	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.
Link: **Free/priced:**	https://trl.co.uk/reports/TRL547 Free
Objectives:	This study was designed to quantify the impairment from hands-free and hand-held phone conversations in relation to the decline in driving performance caused by alcohol impairment.
Methodology:	The TRL Driving Simulator was used to provide a realistic driving task in a safe and controlled environment. Twenty healthy experienced drivers were tested in a balanced order on two separate occasions. The drivers were aged 21 to 45 years (mean = 32, SD = 7.8) and were split evenly by gender. Before starting the test drive, participants consumed a drink, which either contained alcohol or a similar looking and tasting placebo drink. The quantity of alcohol was determined from the participant's age and body mass using the adjusted Widmark Formula (the UK legal alcohol limit 80mg / 100ml). The test drive had four conditions: (1) motorway with moderate traffic, (2) car following, (3) curving road, and (4) dual carriageway with traffic lights. During each condition the drivers answered a standard set of questions and conversed with the experimenter over a mobile phone. The independent variables in this repeated measures study were normal driving, alcohol impaired driving, and driving while talking on hands-free or hand-held phone.
Key Findings:	Results showed a clear trend for significantly poorer driving performance (speed control and response time) when using a hand-held phone in comparison to the other conditions. The best performance was for normal driving without phone conversations. Hands-free was better than hand-held. Driving performance under the influence of alcohol was significantly worse than normal driving, yet better than driving while using a phone. Drivers also reported that it was easier to drive drunk than to drive while using a phone. It is concluded that driving behaviour is impaired more during a phone conversation than by having a blood alcohol level at the UK legal limit (80mg / 100ml). (A)
Keywords:	Simulator; alcohol, mobile phone, hands free, handheld

Title:	**A comparison of the effect of mobile phone use and alcohol consumption on driving simulation performance.**
Published:	Leung, S., Croft, R. J., Jackson, M. L., Howard, M. E., & Mckenzie, R. J. (2012). A comparison of the effect of mobile phone use and alcohol consumption on driving simulation performance. Traffic injury prevention, 13(6), 566-574.
Link: **Free/priced:**	http://www.tandfonline.com/doi/pdf/10.1080/15389588.2012.683118 Paid
Objectives:	Compared the effects of a variety of mobile phone usage conditions to different levels of alcohol intoxication on simulated driving performance and psychomotor vigilance.
Methodology:	Participants completed simulated driving tasks on 2 days, separated by a 1-week washout period. On the mobile phone day, participants performed the simulated driving task under each of 4 conditions: no phone usage, a hands-free naturalistic conversation, a hands-free cognitively demanding conversation, and texting. On the alcohol day, participants performed the simulated driving task at four different blood alcohol concentration (BAC) levels: 0.00, 0.04, 0.07, and 0.10. Driving performance was assessed by variables including time within target speed range, time spent speeding, braking reaction time, speed deviation, and lateral lane position deviation. Twelve healthy university students (10 female) aged 23.5 to 30.8 (mean 26.20, standard deviation [SD] 2.58) participated in the study. Participants held a current ull Australian driving license (not a probationary license). Participants were excluded if they had not drunk alcohol before or if they were excessive drinkers (more than 4 standard drinks a day on average or more than 6 standard drinks on any one occasion for men; more than 2 standard drinks a day on average or more than 4 standard drinks on any one occasion for women; National Health and Medical Research Council [NHMRC] 2001). Participants were also excluded if they reported taking psychotropic medication, used illicit drugs more than 5 times a week, or smoked more than 10 cigarettes a day. They also underwent a medical examination by a registered physician to satisfy inclusion/exclusion criteria for the study
Key Findings:	In the BAC 0.07 and 0.10 alcohol conditions, participants spent less time in the target speed range and more time speeding and took longer to brake in the BAC 0.04, 0.07, and 0.10 than in the BAC 0.00 condition. In the mobile phone condition, participants took longer to brake in the natural hands-free conversation, cognitively demanding hands-free conversation and texting conditions and spent less time in the target speed range and more time speeding in the cognitively demanding, hands-free conversation, and texting conditions.

	When comparing the 2 conditions, the naturalistic conversation was comparable to the legally permissible BAC level (0.04), and the cognitively demanding and texting conversations were similar to the BAC 0.07 to 0.10 results.
Keywords:	Simulated driving performance, Alcohol, Mobile phone, Cognition, Distractability

Title:	Driver distraction: the effects of concurrent in-vehicle tasks, road environment complexity and age on driving performance.
Published:	Horberry, T., Anderson, J., Regan, M. A., Triggs, T. J., & Brown, J. (2006). Driver distraction: the effects of concurrent in-vehicle tasks, road environment complexity and age on driving performance. Accident Analysis & Prevention, 38(1), 185-191.
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S0001457505001521 Paid
Objectives:	This paper presents the findings of a simulator study that examined the effects of distraction upon driving performance for drivers in three age groups.
Methodology:	There were two in-vehicle distracter tasks: operating the vehicle entertainment system and conducting a simulated hands-free mobile phone conversation. The effect of visual clutter was examined by requiring participants to drive in simple and complex road environments. Thirty one participants were employed, and each person was tested individually. Of these, 10 were younger drivers (aged under 25 years, mean age 21 years), 11 were mid-age drivers (aged 30–45, mean age 37 years) and 10 were older drivers (aged 60–75 years, mean age 66 years).
Key Findings:	Overall measures of driving performance were collected, together with responses to roadway hazards and subjective measures of driver perceived workload. The two in-vehicle distraction tasks degraded overall driving performance, degraded responses to hazards and increased subjective workload. The performance decrements that occurred as a result of in-vehicle distraction were observed in both the simple and complex highway environments and for drivers in different age groups. One key difference was that older drivers traveled at lower mean speeds in the complex highway environment compared with younger drivers.
Keywords:	Driver distraction; In-vehicle distractions; Environmental complexity; Driving simulation; Driver age; Mobile phones

Title:	**Human factors aspects of using head up displays in automobiles: A review of the literature.**
Published:	Gish, K. W., & Staplin, L. (1995). Human factors aspects of using head up displays in automobiles: A review of the literature. DOT HS 808 320 National Highway Traffic Safety Administration (NHTSA) Washington, DC.
Link: **Free/priced:**	http://www.mvs.net/pdf/Human_Factors_of_HUDs.pdf Free
Objectives:	This document provides an overview of studies investigating the use of HUDs by aviators and drivers, including a summary of HUD research variables, test procedures and study results.
Methodology:	Literature review . The authors do not describe the methodology they employed to identify pertinent articles, but review several dozen important papers in the area.
Key Findings:	The predicted performance advantages of automotive HUDs include increased eyes-on-the-road time and reduced re-accommodation time, particularly for the older driver. To date, the research does not provide robust evidence for operationally significant performance advantages due to HUDS. However, conclusions are equivocal due to the interaction of independent variables such as workload, display complexity and age.
Keywords:	Advanced driver information systems; Advanced driver information systems; Age; Attention; Comprehension; Driver performance; Human factors; Instrument panels; Literature reviews; Test procedures; Visibility

Title:	**A user study of auditory, head-up and multi-modal displays in vehicles**
Published:	Jakus, G., Dicke, C., & Sodnik, J. (2015). A user study of auditory, head-up and multi-modal displays in vehicles. Applied ergonomics, 46, 184-192.
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S0003687014001471 Paid
Objectives:	This paper describes a user study on the interaction with an in-vehicle information system (IVIS). The motivation for conducting this research was to investigate the subjectively and objectively measured impact of using a single- or multi-modal IVIS while driving.
Methodology:	A hierarchical, list-based menu was presented using a windshield projection (head-up display), auditory display and a combination of both interfaces. The users were asked to navigate a vehicle in a driving simulator and simultaneously perform a set of tasks of varying complexity. A total of 30 test subjects (9 female and 21 male) participated in the study. The subjects ranged in age from 21 to 56 years old (*M* = 28.9 years, SD = 3.5 years). All the participants had a valid driving license and an average of 11 years of driving experience. All the participants reported normal or corrected-to-normal sight and hearing.
Key Findings:	The experiment showed that the interaction with visual and audio-visual head-up displays is faster and more efficient than with the audio-only display. All the interfaces had a similar impact on the overall driving performance. There was no significant difference between the visual only and audio-visual displays in terms of their efficiency and safety; however, the majority of test subjects clearly preferred to use the multi-modal interface while driving.
Keywords:	Auditory display; Head-up display; Vehicle

Title:	**Evaluating the impact of Head-Up Display complexity on peripheral detection performance: a driving simulator study.**
Published:	Burnett, G. E., & Donkor, R. A. (2012). Evaluating the impact of Head-Up Display complexity on peripheral detection performance: a driving simulator study. Advances in Transportation Studies, 28.
Link: **Free/priced:**	http://trid.trb.org/view.aspx?id=1277100 Paid
Objectives:	An experiment was conducted in a fixed-based simulator to measure the effects of HUD information complexity on driver behavior and performance.
Methodology:	Eighteen experienced drivers were requested to follow a lead vehicle along a motorway and perform a range of secondary tasks using a HUD (e.g. what is the current vehicle speed). These tasks varied in complexity, based primarily on the number of HUD symbols to search through. In addition, participants were also asked to respond to Peripheral Detection Tasks (PDTs) using steering wheel controls. At times, these PDTs would occur simultaneously with HUD presentation.
Key Findings:	Results showed there was a significant increase in PDT response times and reduction in PDT response accuracy as the number of symbols on the HUDs increased. The clearest negative change arose when progressing from four to seven symbols on the HUD. Moreover, lane-keeping ability significantly deteriorated with increasing HUD complexity. Based on these results, it is recommended that HUDs should ideally have no more than four distinct symbols, but may include five or six symbols depending on other design factors.
Keywords:	Attention; Attention lapses; Automobile drivers; Distraction; Head up displays; Highway safety; Lane changing; Peripheral vision; Reaction time

Title:	**Texting while driving using Google Glass Investigating the combined effect of heads-up display and hands-free input on driving safety and performance**
Published:	Tippey, K. G., Sivaraj, E., Ardoin, W. J., Roady, T., & Ferris, T. K. (2014, September). Texting while driving using Google Glass Investigating the combined effect of heads-up display and hands-free input on driving safety and performance. In Proceedings of the Human Factors and Ergonomics Society Annual Meeting (Vol. 58, No. 1, pp. 2023-2027). SAGE Publications.
Link: **Free/priced:**	http://pro.sagepub.com/content/58/1/2023.short Paid
Objectives:	This preliminary study compared texting with Google Glass to other texting methods in a driving simulation to examine driver behavior and performance. While texting-and-driving is inadvisable, the task of texting may be constructed so that it does not provide information that alters the intent of the driving task, reducing confounding factors in analysis of the device's impact on driving performance.
Methodology:	Data collection and analysis for this student research was completed for 7 male participants (average age 25) from Texas A&M University. All participants reported normal or corrected to normal vision, were familiar with how to text using a smartphone, and had either a valid U.S. or International driver's license. Participants completed a primary and secondary task in a medium-fidelity driving simulator. The primary task was driving in either a low or high workload scenario (varied by road configuration an traffic density). The secondary task required participants to read and respond to text messages on either their personal smartphone or Google Glass.
Key Findings:	The results of this study suggest that Glass performs much closer to baseline than the other technologies. Evidence from this preliminary investigation was used to form a complete study evaluating texting-and-driving with Google Glass. Results from these studies can be used to inform developers of wearable technologies and policymakers tasked with regulating the use of these technologies while driving.
Keywords:	Driving; Distratction; Google Glass; Smartphone; Texting

Title:	**Google Glass A Driver Distraction Cause or Cure?**
Published:	Sawyer, B. D., Finomore, V. S., Calvo, A. A., & Hancock, P. A. (2014). Google Glass A Driver Distraction Cause or Cure?. Human Factors: The Journal of the Human Factors and Ergonomics Society, 0018720814555723.
Link: **Free/priced:**	http://hfs.sagepub.com/content/early/2014/10/15/0018720814555723.abstract Paid
Objectives:	Assessed the driving distraction potential of texting with Google Glass (Glass), a mobile wearable platform capable of receiving and sending short-message-service and other messaging formats.
Methodology:	Asked drivers in a simulator to drive and use either Glass or a smartphone-based messaging interface, then interrupted them with an emergency brake event. Both the response event and subsequent recovery were analyzed. Twenty-four female and 16 male participants (N = 40; mean age = 20.47 years, SD = 4.76) were recruited from the university undergraduate population. On average, participants had been driving 4.54 years (SD = 4.65). All were over 18 years of age, having both a valid driver's license and normal or corrected-to-normal vision.
Key Findings:	Glass-delivered messages served to moderate but did not eliminate distracting cognitive demands. A potential passive cost to drivers merely wearing Glass was also observed. Messaging using either device impaired driving as compared to driving without multitasking
Keywords:	Attention; Mobile; Wearable; SMS; Texting

Title:	**Comparing the Demands of Destination Entry using Google Glass and the Samsung Galaxy S4.**
Published:	Beckers, N., Schreiner, S., Bertrand, P., Reimer, B., Mehler, B., Munger, D., & Dobres, J. (2014, September). Comparing the Demands of Destination Entry using Google Glass and the Samsung Galaxy S4. In Proceedings of the Human Factors and Ergonomics Society Annual Meeting (Vol. 58, No. 1, pp. 2156-2160). SAGE Publications.
Link: **Free/priced:**	http://pro.sagepub.com/content/58/1/2156.short Paid
Objectives:	A driving simulation study assessed the impact of vocally entering an alpha numeric destination into Google Glass relative to voice and touch-entry methods using a handheld Samsung Galaxy S4 smartphone.
Methodology:	Driving performance (standard deviation of lateral lane position and longitudinal velocity) and reaction to a light detection response task (DRT) were recorded for a gender-balanced sample of 24 young adult drivers. Task completion time and subjective workload ratings were also measured.
Key Findings:	Using Google Glass for destination entry had a statistically higher miss rate than using the Samsung Galaxy S4 voice interface, the Google Glass method took less time to complete, and the two methods were given comparable workload ratings by participants. In agreement with previous work, both voice interfaces performed significantly better than touch entry; this was seen in workload ratings, task duration, lateral lane control, and DRT metrics. Finally, irrespective of device or modality, destination entry significantly decreased responsiveness to events in the forward scene (as measured by the DRT reaction time) as compared to the baseline driving.
Keywords:	Driving; Google Glass; Samsung; Simulator; Distraction

Title:	**How do drivers interact with navigation systems in real life conditions?**
Published:	Metz, B., Schoch, S., Just, M., & Kuhn, F. (2014). How do drivers interact with navigation systems in real life conditions?: Results of a field-operational-test on navigation systems. Transportation Research Part F: Traffic Psychology and Behaviour, 24, 146-157.
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S1369847814000497 Paid
Objectives:	As part of the project euroFOT, the impact and usage of navigation systems was studied in a Field-Operational Test (FOT). The usage and handling of two HMI-solutions for navigation systems – one was nomadic and the other integrated – were investigated during daily drives.
Methodology:	For N = 99 drivers, data was recorded whenever drivers used their vehicles during a three month period. During these three months, drivers used an integrated navigation system for a month and a nomadic device for a month. In the third month, they did not use a navigation system at all (baseline).
Key Findings:	Drivers preferred system handling in low demanding driving situations, like standstill or at very low speeds. If system handling occurred while the vehicle was moving, then an adaption of speed and following distance was observed. No increase of critical driving situations, like very close distances, could be found during system inputs. Results indicated that drivers were cautious when they interacted with the navigation systems. They adapted their system handling to the demands of driving and there is no indication that driving safety was jeopardized. These results help to gain a better understanding of how experimental results on driver distraction relate to unobserved driver behavior during daily drives.
Keywords:	Naturalistic driving; Distraction; Navigation system

Title:	**Comparison of manual vs. speech-based interaction with in-vehicle information systems**
Published:	Maciej, J., & Vollrath, M. (2009). Comparison of manual vs. speech-based interaction with in-vehicle information systems. Accident Analysis & Prevention, 41(5), 924-930.
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S0001457509001080 Paid
Objectives:	This study examined whether speech-based interfaces for different in-vehicle-information-systems (IVIS) reduce the distraction caused by these systems.
Methodology:	For three frequently used systems (audio, telephone with name selection, navigation system with address entry and point of interest selection) speech, manual control and driving without IVIS (baseline) were compared. The Lane Change Task was used to assess driving performance. Additionally, gaze behavior and a subjective measure of distraction were analyzed. The subjects were 30 drivers (16 male, 14 female) who had normal or corrected to normal vision. All had a valid driver's license. The age ranged from 19 to 59 with a mean age of 33.2 (SD = 11.9). They were paid 10€ an hour for the two to three hours they took to complete the experiment.
Key Findings:	Speech interfaces improved driving performance, gaze behavior and subjective distraction for all systems with the exception of point-of-interest entry. However, these improvements were overall not strong enough to reach the baseline performance level. Only in easy segments of the driving task the performance level was comparable to baseline. Thus, speech-based IVIS have to be further developed to keep the cognitive complexity at an adequate level which does not disturb driving. However, looking at the benefits, speech control is a must for the car of the future.
Keywords:	Speech-based interface; In-vehicle distractions; Attention; Driving simulation

Title:	**Peripheral detection as a measure of driver distraction. A study of memory-based versus system-based navigation in a built-up area.**
Published:	Harms, L., & Patten, C. (2003). Peripheral detection as a measure of driver distraction. A study of memory-based versus system-based navigation in a built-up area. Transportation Research Part F: Traffic Psychology and Behaviour, 6(1), 23-36.
Link: **Free/priced:**	http://www.sciencedirect.com/science/article/pii/S136984780200044X Paid
Objectives:	The study summarises previous results of secondary-task studies in traffic contexts and investigates the suitability of one secondary-task method, the peripheral detection task (PDT)-method, as a standard procedure for safety testing and evaluation of IVIS. The study was concerned with the effect of navigation messages on PDT-performance (reaction time and hit rate) taking into account also behavioural variables.
Methodology:	Professional drivers served as subjects. They had extensive prior local-knowledge and experience of driving in the built-up area in which the experiment took place. They were required to drive two different routes, one after memory and the other in accordance with navigation messages a standard navigation system installed in the car. In the navigation system condition subjects were subdivided into three groups, receiving either verbal, visual or both visual and verbal (full) navigation messages. Twenty-four male, professional drivers were paid for their participation in the experiment. Eighteen subjects were taxi-drivers in the local area (Linköping) and the other six were professional drivers in the same area. All subjects were highly skilled drivers, familiar with having IT-components in their vehicles and familiar with driving in the built-up area in which they were required to drive. Their reported total annual mileage was 10,000–120,000 km with a mean of 60,000 km. The subjects were aged 30–60 years, fourteen subjects were between 40 and 50, six were younger than 40 and four were older than 50.
Key Findings:	Driving behaviour was virtually uninfluenced by navigation condition (memory versus navigation system) and message modality (full, visual or verbal) whereas PDT-performance, showed some effects of navigation condition on subjects' reaction times and hit rates. Pairwise comparison of message modality within each three groups showed a prolongation in reaction time and a marginally significant decrease in hit rate

	with full navigation messages (combined visual and verbal ones). Visual navigation messages affected only hit rate and no significant differences between navigation conditions were observed for the group presented with verbal messages. The pattern of results suggests that the PDT-method is biased toward visual sources of information from IVIS. As visual information processing is an important component in safe driving, the PDT-method is suitable as a predominant method in a test battery, but for unbiased measurement of distraction, methods less dependent on mode of presentation would be more appropriate.
Keywords:	Driver distraction; In-vehicle information systems; Advanced driver support systems; Navigation systems; Secondary task; PDT; Capacity limitations

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