
Summary:

Inattention at the wheel: Prevalence, consequences, and countermeasures

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A literature review shows that driver inattention contributes to a considerable share of road crashes, with a minimum estimate at 12 % of crashes. Important explanations include too long glances away from the road during driving, and cognitive load resulting in impaired processing of information in the visual field (“looked but failed to see”). Texting on a mobile phone is associated with a very high risk, but causes relatively few crashes, since the prevalence is low. In comparison, adjusting radios or music players contributes to more crashes. A survey among approximately 4100 drivers largely confirm the results of the literature review. In addition, it showed that cognitive distraction (daydreaming, etc.) is one of the most prevalent types of driver inattention, both in driving generally and immediately preceding a crash. Young men have a higher prevalence of inattention during driving compared to other drivers, and they also rate the risk lower. Concerning countermeasures, drivers rate education and in-vehicle technologies as most effective, and phone applications regulating phone use during driving as least effective. Previous research indicates that workplace-based measures has a considerable potential for preventing driver inattention.

This report presents results from a literature review and from an internet survey among a sample of license holders, both focusing on driver inattention and distraction. Although focusing on drivers we should keep in mind that inattention and distraction are possible risk factors for all categories of road users, and that many of the findings therefore are relevant to other groups as well.

Literature review

A search on ISI Web of Science for literature on road safety and driver distraction or inattention published in 2011 or later resulted in about 300 relevant hits. The literature review is based on these publications (either full text or abstract) as well as on other publications collected in previous projects.

We find somewhat differing definitions of inattention and distraction in the literature. A conceptual framework and taxonomy for understanding and categorising driver inattention was recently proposed by a joint EU and US working group on driver distraction and HMI (“Human-Machine Interaction”), under the US-EU Bilateral ITS Task Force. They define driver distraction as “the diversion of attention from activities critical for safe driving to a competing activity”, and driver inattention is described as “mismatches between the driver’s current resource allocation and that demanded by activities critical for safe driving”. We use these definitions with the underlying conceptual framework as a basis for our review and discussion of research on distraction and crash risk. An implication of these definitions is that distraction is seen as one of several factors that may result in inattention.

Distraction can be classified by modality, and a common distinction is between visual, auditory, manual, and cognitive distraction. Taking distraction by using a mobile phone while driving as an example, visual distraction will be looking at the display, auditory distraction listening to a conversation partner, manual distraction dialing a number or text, and cognitive distraction will be concentrating one's thoughts on the contents of the conversation. Although visual distraction (e.g., looking away from the road and traffic) is the most relevant type of distraction among drivers and other road users, the other types of distraction may also have implications for crash risk. For example, some studies show that cognitive distraction, such as daydreaming resulting in a failure to concentrate on traffic, is a contributing factor in several crashes.

Several studies have shown that two seconds seems to be a critical limit for looking away continuously from the roadway, before the risk of safety-critical events increases substantially. However, looking ahead is no guarantee that the driver is attentive. It has been clearly demonstrated that “looked but failed to see” is a common explanation after road crashes. Various aspects of mental load of cognitive distraction may explain this phenomenon.

When discussing distraction and possible countermeasures it is important to consider the source of distraction. One distinction is whether it is external or internal with reference to the vehicle.

Another relevant distinction is between “top-down” (proactive or feedforward) and “bottom-up” (reactive or feedback) control of attention and distraction. Proactive control means searching actively for information or actively engaging in some distracting activity like making a phone call or turning around to fetch something in the backseat. Reactive control means that attention involuntarily or automatically is drawn toward some source of distraction, like a loud sound, a blinking light, or an advertising board. This distinction has important implications for finding effective countermeasures against driver distraction and inattention. Presumably, proactive distraction in the form of conscious decisions to engage in secondary tasks during driving can be influenced by awareness campaigns and information, whereas reactive (involuntary) distraction by events or objects automatically attracting the driver's attention are less likely to be influenced by such measures. On the other hand, reactive distraction may possibly be influenced by designing the road system to comply as far as possible with driver information needs, and to avoid obviously conspicuous but irrelevant information in the road environment.

Knowledge about inattention and distraction as crash risk factors is obtained by different methodological approaches:

- Self-report
- Epidemiological studies and crash investigation
- Simulator and laboratory studies
- Controlled field studies with instrumented vehicles

During the last two decades the development of advanced methods for “naturalistic driving” studies has resulted in unprecedented possibilities of investigating distraction and inattention during actual driving, including crashes, near crashes, and other safety-critical events, and this development has been an impetus for more research on these topics.

A considerable share of driver distraction and inattention research has focused on implications of using mobile telephones during driving, which is obviously a result of the enormous increase in the use of mobile phones in general during the last 25 years. There are, however, other types of distraction that are more prevalent. Several studies have been carried out, both by the present authors and others, to estimate the proportion of crashes in which different sources of distractions have contributed.

How often a given factor contributes to a crash is a function of both the prevalence (exposure) and the risk of the factor. Several studies have used data on exposure and relative risk in order to estimate the proportion of crashes that can be attributed to the various sources of distraction.

Concerning the risk associated with mobile phones during driving, there are some counterintuitive results from naturalistic driving studies, showing a *reduced* crash risk during conversation in a handsfree mobile phone. This finding seems to be at variance with previous assumptions that the mental load associated with the conversation is a risk factor, and with results from epidemiological studies of crashes as well as studies showing driving performance impairment during conversation. There are several possible explanations of these counterintuitive results:

- Drivers compensate for increased risk by driving more carefully when using the telephone (slowing down, increasing headway, and/or looking more ahead). This can reduce the risk for some types of crashes, whereas telephone use may still result in increased risk for other types of crashes. As long as the decreased risk caused by compensatory behaviour is larger than the increased caused by telephoning, the total effect is a decreased risk.
- Most of the naturalistic studies include commercial drivers. A possibility that should be investigated is whether risk associated with telephone use differs between commercial and private drivers.
- Estimates of risk are based on comparison of prevalence of telephone use between safety-critical events and baseline driving. For some of the studies it can be questioned whether baseline epochs are representative of normal driving.
- There are few crashes in these studies, which implies that risk estimates are based primarily on near crashes and other non-crash safety-critical events. Conceivably, the relationship to telephone use may be different for crashes compared to other safety-critical events.
- Most epidemiological and behavioural studies on phone use are older than the naturalistic driving studies, and it could be that the risk associated with telephone conversation may have decreased because drivers have become more conscious about risk and/or more clever in adapting their phone use to the traffic situation. There may also have been a risk reduction resulting from new and better technology, such as integrated systems for handsfree telephone use.

A range of background factors influence the likelihood of a driver becoming inattentive or distracted, such as gender, age, and driving experience. Several studies show that both young (and inexperienced) drivers and older drivers are more likely to be inattentive during driving, but for different reasons. Driver states may also be important preconditions, e.g., relatively stable states like personality, attitudes, or health, and more temporary conditions like sleepiness or drug influence. Sleepiness is obviously a factor leading to inattention and possibly also to cognitive distractions like daydreaming. In this report we discuss research on sleepiness only to the extent that inattention or distraction are explicit research topics.

The literature review summarises research results regarding countermeasures against distracted driving and its consequences. Possible countermeasures are in-vehicle technology (driver alertness monitoring, lane-departure warning, anti-collision systems, etc.), roadway measures (e.g., profiled edge- and centre-lines), avoiding conspicuous sources of distraction in the road environment (regulations regarding advertising boards, traffic sign location and design, etc.), education and training, organizational measures, campaigns, and other information.

Driver survey

A random sample of 20 000 license holders (category B) were invited to fill in an internet survey on driver behaviour, risk assessment, and attitudes regarding distraction and inattention. About 4 300 drivers completed the questionnaire.

The questions covered the following topics:

- Frequency of deliberate involvement in potentially distracting activities (telephoning, texting, internet surfing, eating/drinking, using navigation equipment, adjusting vehicle controls, radio or music player, looking at passenger(s), etc.).
- Assessment of crash risk associated with various distractions, including those mentioned above.
- Crash involvement last five years, and whether distraction (specific factors were listed) contributed to latest crash, if any.
- Comparison of distraction with other risk factors regarding relative contribution to road crashes.
- Attitudes towards countermeasures against distraction, e.g., surveillance of mobile telephone use during driving.
- Background factors (gender, age, place of residence, education, driving experience)

About one half of the drivers reported occasional or frequent use of a mobile phone during driving. The following modes of telephone use were most frequent (ordered from highest to lowest frequency): receiving call, making call, reading message, writing/sending message, checking social media, and other uses. More than one percent send messages often, and two percent read messages. Female drivers reported lower frequency of phone calls than males do.

The reported effect on driving performance is largest for sending or reading messages and smallest for talking on the phone. Among those who use the mobile phone some times during driving, one in five say they never stop the vehicle for making or receiving a call.

Among other distractions, radio tuning or adjusting a music player is the most frequent factor, followed by adjusting in-vehicle equipment. Daydreaming and eating or drinking are also relatively frequent distractions. Most distractions are less frequent among female than among male drivers.

The distraction items were grouped into the following subscales for analysis of relationship to background factors:

- a) Inattention and traffic-related distraction (9 items)

- b) Common secondary tasks, like radio tuning, adjusting vehicle controls, eating/drinking, etc. (6 items)
- c) Telephone calls (2 items)
- d) Particularly demanding and obviously risky secondary tasks, like texting, dressing, reading newspaper or map, etc. (9 items)

We find a statistically significant relationship to age for all four subscales, with the lowest frequency among older drivers. Female drivers had lower frequency than male drivers for subscales b, c, and d.

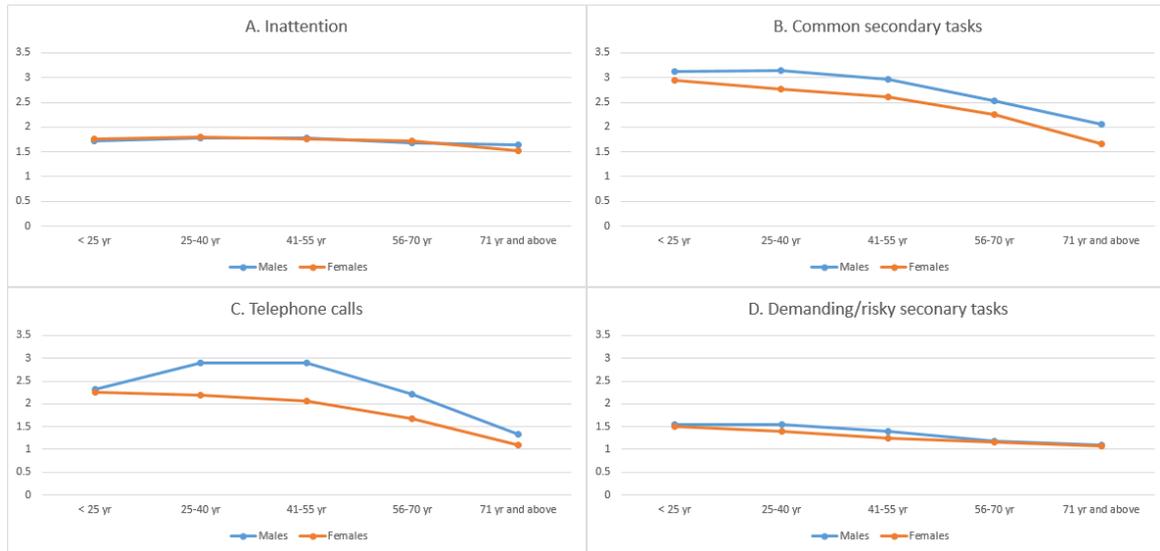


Figure S-1. Self-reported frequency of various categories of inattention and distraction, by gender and age group. Average of subscale scores on a scale from 1='Never' to 6='Very often'.

We further find that drivers' assessment of crash risk associated with various sources of distraction is inversely related to the self-reported frequency of the same distractions. Although the relationships are statistically significant, they are rather weak, indicating that involvement in distracting activities is determined largely by other factors than risk assessment.

The risk assessment scores are higher for female drivers than for males for all distractions.

About five percent report dangerous situations due to their own telephoning occurring several times per month, and as many as 25.5 % report dangerous situations occurring that often due to other drivers using a telephone. One out of 20 drivers has experienced dangerous situations due to radio tuning 'occasionally' or more often. For other in-vehicle equipment few drivers report occurrence of dangerous situations.

About one percent of all crashes occurred while the driver was using the mobile phone. This proportion is slightly higher than in earlier similar studies.

Distraction was reported as a contributing factor in 20.6 % of all crashes. The highest proportion (about 10 %) was found for cognitive distraction (daydreaming or other inner distraction), followed by conversation with passenger(s) and adjusting radio or music player. The share of accidents where a given factor contributes is a function of

the relative crash risk associated with the factor, as well as its prevalence during driving.

Knowledge about laws regulating use of mobile telephones during driving was better among drivers with high education, employed persons, and persons living in urban areas.

The results for ranking of importance of various crash contributing factors showed that speeding was ranked first, and somewhat higher among females than among males. Vehicle technical failure was ranked last. Males ranked drug driving higher than distraction, whereas females ranked distraction relatively higher. Drivers with high education rank inattention and distraction as relatively more frequent crash contributing factors, whereas retired persons and those who drive less rank speed as relatively more important.

Regarding attitudes towards distraction countermeasures, female drivers endorse most countermeasures more strongly than males, and they agree to a lesser extent than males that drivers should be allowed to use their mobile phones as they like. Campaigns are supported most strongly by drivers with high education and least by the employed, the retired, and car owners.

Among five listed countermeasures against distraction and inattention, mobile phone apps for preventing phone use during driving were rated as least effective, and education and in-vehicle technical systems as most effective. Campaigns and increased police enforcement were rated in between. Females believe relatively less than males in effects of education and campaigns, and more in police enforcement. These findings may imply that some countermeasures will affect male and female drivers differently.

In spite of a low confidence in effectiveness of apps, more than half of the drivers say they would probably have installed an app for automatic replies to messages. A considerably lower proportion would have installed an app for blocking incoming calls. Female drivers are generally more positive than males to installing such apps on their mobile phones.

We find a significant but weak relationship between attitudes to restrictive countermeasures and self-reported prevalence of distractions. For example, those who think that using the mobile phone during driving should be up to the driver, to a larger extent report engagement in demanding secondary tasks like texting and reading during driving. We can however not tell whether attitudes determine behaviour or vice versa.

Conclusions

- In this report, driver distraction is considered as one of several factors that may result in driver inattention.
- Driver inattention is a contributing factor in a large proportion of road crashes; a minimum estimate is 12 %. The proportion is higher for severe than for less severe crashes, and higher among young drivers.
- The distractions contributing to the highest share of crashes are conversation with passenger(s), daydreaming or other inner distraction, adjusting in-vehicle equipment, and tuning radio or adjusting music player.

- Texting on a mobile phone is associated with a very high crash risk. Relative risk estimates vary between 22 and 164.
- Some naturalistic studies find *decreased* crash risk during mobile phone conversation. Possible explanations of this counterintuitive finding may be that most studies do not include real crashes, only near-crashes and other safety-critical events, and/or decreased speed and other risk-reducing behaviour adaptation during phone use. A conclusion on this issue has to await further naturalistic studies including more data on driver behaviour adaptation as well as data from real crashes.
- The driver survey showed the following distractions to be most prevalent: using radio or music player, adjusting in-vehicle equipment, cognitive distraction, and eating or drinking. Male drivers report higher prevalence than females for most distractions.
- The following explanations of relationships between inattention and crash risk have been described in the research literature:
 - Looking away from the roadway more than two seconds continuously
 - High mental load resulting in narrowing of attention
 - “Looked but failed to see”
 - Driving performance decrements, e.g., increased reaction time, increased variation in lateral position, too short headway.
- Both prevalence and consequences of distraction and inattention can be reduced by a system-oriented approach, combining road- and vehicle-based measures with information, education and enforcement.
- Survey respondents believe education and in-vehicle technology are most effective countermeasures. Acceptance of restrictive countermeasures is generally low.