Distraction in traffic

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Summary

The mobile phone is symbolic of 'distraction in traffic'. But apart from mobile phone calls, texting, or listening to music, many drivers, cyclists and pedestrians are occupied with all sorts of other activities that may distract them. Examples are: operating the navigation system, eating, drinking, talking to passengers or daydreaming. Road users may also be distracted by striking matters and events outside the vehicle, such as billboards, a low-flying plane, someone on the pavement, or a crash. Distraction negatively affects traffic behaviour. Particularly activities which involve road users taking their eyes off the road for longer stretches of time increase crash risk: among other things, entering a phone number, texting, reaching for objects in the car, and prolonged glances at objects outside the car. Recent American analysis, however, showed that talking on a mobile phone (handsfree or handheld) while driving *did not increase crash risk*; while simulator studies showed that it *did adversely affect driving behaviour*. A possible explanation of these seemingly contradictory results is that drivers compensate for distraction (for example by only having a phone conversation in less demanding traffic situations).

Several measures to prevent distraction in traffic may be taken, such as a legal and enforced ban on handheld phone use, public information and education campaigns or technical facilities that prohibit the use of mobile phones when on the road.

1 What is distraction and why is it a road safety problem?

Distraction may be seen as 'misguided' attention or attention paid to 'the wrong things'. Since our mental capacity is limited, we can only pay attention to part of our environment. A road user should first and foremost be focused on traffic. After all, a traffic situation may become life-threatening in a matter of seconds. Road users may get distracted when their attention is drawn to (striking) matters and events that have little or nothing to do with the traffic task at hand and that are unexpected, e.g. a low-flying plane. They may also be distracted when combining a traffic task and a task of a different order which also needs attention, e.g. reading a text message. In addition, distraction may also be caused by traffic-related tasks, such as operating the navigation system while driving or trying out ways to operate the windscreen wipers. Secondary activities and (non)traffic-related matters and activities may be so demanding that the road user's attention to the traffic task at hand is insufficient. Consequently, (driving) performance deteriorates and crashes may occur.

There are several types of distraction [1] :

- visual distraction, e.g. when road users have their eyes on their smartphone screen instead of on the road;
- auditory distraction, e.g. when a cyclist listens to music through a headphone or earphones, which diverts attention from traffic;
- physical (biomechanical) distraction, e.g. when a road user enters a phone number manually or types a text message;
- cognitive distraction, e.g. when a road user is daydreaming or concentrating on a conversation with a passenger and not on traffic.

Often, different types of distraction occur simultaneously. For example texting while driving involves visual, physical and cognitive distraction. Searching for a different playlist may even involve four simultaneous types of distraction.

Some sources of distraction may, in addition to the different adverse effects, also have positive effects on the traffic task. Music, for example, may relieve stress and aggression and a telephone conversation may help truck drivers stay awake and alert in monotonous traffic circumstances [2] [3].

2 What causes distraction in traffic?

Distraction is often associated with technology-related activities, mobile phone use in particular (such as calling and sending or reading text messages). Road users often use mobile phones to be available during an emergency, out of habit (young people in particular) [4] and possibly even due to telephone addiction (see [5] for example). Other technology-related activities, such as listening to music and operating radio or navigation equipment, may also cause distraction. However, road users may also be distracted by matters unrelated to technology, such as by eating or drinking, by a crying child in the rear seat, by talking to passengers, reaching for certain objects (e.g. sun glasses) or daydreaming. Other things demanding attention are, for example, a noise, a striking person on the pavement, a crash or a (digital) advertising billboard.

Low-demand traffic situations may pave the way to distraction, e.g. when taking a familiar route or driving in monotonous traffic circumstances. The increasing automation of the driving task may also lead to a growing tendency to be occupied with distracting activities. A driving simulator study showed that drivers were more often occupied with non-traffic-related tasks when the driving task was partly automated and still more frequently when the driving task was highly automated [6].

3 How many casualties are caused by distraction in traffic?

Drivers

The exact number of road casualties among distracted drivers is unknown. Dutch police do not systematically register whether a driver was distracted prior to a crash. It was previously estimated that, for car crashes in the Netherlands, the annual number at least amounts to several dozens of fatalities, with an upper limit of well over a hundred [7]. This estimate, however, is based on somewhat older and primarily foreign studies. There are no recent estimates based on Dutch studies. American 2017 crash figures indicate that distraction was involved in 9% of the registered fatalities in motor vehicle crashes, and that 6% of the drivers involved in fatal crashes were distracted [8]. Some of these fatal crashes involved two or more distracted drivers. The percentages are based on statements of the parties concerned (and witnesses) and are therefore probably underestimates of the actual percentages.

Cyclists

Concerning cyclists, the only Dutch data available are self-reported data about road crashes in which distraction might have played a part. Two earlier Dutch studies (dating from 2008 and 2009) indicated that phone use preceded 3 to 4 % of all injury crashes involving cyclists [9] [10]. For these crashes, listening to music was mentioned just as often: 3.5 to 5 %. In more recent Dutch research [11], 19% of the casualties of bicycle crashes treated at accident & emergency departments indicated that the crash was (partly) caused by their distraction. Talking to someone was mentioned in 4% of the cases as contributing to the crash and being deep in thought in 2% of the cases. Notably, telephone use was deemed to be a (concurrent) crash factor in fewer than 1% of the cases in this study. We would rather expect the percentage of bicycle crashes caused by telephone use to be higher, when compared to earlier studies, since a lot more cyclists send text messages or operate their telephone screens nowadays [12]. After all, these activities belong to the category of most dangerous forms of distraction (also see the question *How dangerous is it when drivers are distracted in traffic?* and the question *How does distraction affect cyclist and pedestrian behaviour?*).

Pedestrians

For the Netherlands, no data are available about the number of pedestrian injuries or fatalities as a consequence of distraction while walking. In the United States, the percentage of pedestrians who die in a road crash while using a phone rose from less than 1% in 2004 to 3.6% in 2010 [13].

4 How often are drivers distracted in traffic?

A large number of drivers appear to be engaged in activities which are potentially distracting. Naturalistic Driving research[1] in the US shows that drivers spend approximately 50% of their driving time on distracting activities [14] [15] (also see *Table 2*, third column 'Prevalence' in the question *How dangerous is it when drivers are distracted in traffic?*). In this study, the most frequent distracting activity proved to be talking to passengers: in approximately 15% of the entire driving time. About 6% to 9% of the entire driving time was spent on mobile phone use [14] [15] [16]. Dutch Naturalistic Driving research shows that drivers use their mobile phones in approximately 9% of the entire driving time [17]. Drivers also like to listen to music; well over 90% of drivers regularly listen to music or to the radio in their cars [18]. Drivers can also be engaged in several distracting activities at once. This happens in 11% of the driving time [15].

A Dutch survey also shows that drivers are often engaged in distracting activities [4] (see *Table1*). 66% of the drivers in this study indicated having sometimes used their phones while driving. Mobile phones were mainly used for handsfree calls (46%), for reading or sending text messages (42% and 36% respectively) and for setting navigation (44%). A much smaller number of drivers, viz. 20%, reported having sometimes made handheld calls. Prevalence data are also available, derived from observational studies (see [19] for example). They show the percentage of drivers that were, during one time or another, engaged in distracting activities while driving; the figures are therefore lower than those derived from questionnaire studies which are concerned with the general frequency of distracting activities.

A 2018 observational study showed that drivers made handheld calls three times more often than they operated a smartphone screen[2] (9% and 3% respectively) [19]. Handheld calls were also significantly more frequent than handsfree calls (9% and 2% respectively). This could be because handsfree calls are harder to observe than handheld calls. In addition, 27% of truck drivers and 18% of delivery van drivers proved to use their mobile phones. For car drivers this percentage was 13%.

1. Naturalistic Driving is a research method used to observe natural driving behaviour of road users by means of devices (cameras and sensors) which inconspicuously register vehicle movements, driver behaviour (such as eye, head and hand movements) and external circumstances.
2. Operating a screen was defined as 'texting or such like, in any case visibly occupied with a phone screen'.

Table: 1. Percentage of drivers that indicate having been engaged in different distracting activities [4].

Distraction source	Distracting activity	% of drivers engaged in an activity
Taking on the phone	Handsfree	46
	Handheld	20
Operating a screen	Reading/sending text messages	42/36
	Searching for something on phone/checking one's phone	22
	Taking pictures/recording videos	19
	Setting navigation on phone	44
	Operating phone to play music	21
	Playing games	8

5 How does distraction affect driver behaviour?

Distraction affects a number of essential aspects of driving skills [20]. Drivers zigzag more, for example during telephone calls, operation of screens or sending or reading text messages. In addition, drivers engaged in distracting activities miss all kinds of relevant matters. Taking one's eyes off the road is the main cause, as happens during typing or updating a social network site. However, even when one's eyes are on the road, cognitive distraction, for example on account of a phone call, may result in inattention to relevant matters. The driver looks in the right direction but does not consciously perceive an important object (this phenomenon is known as 'inattentional blindness') [21]. Moreover, distracted drivers are slower to react environment changes. Phoning drivers start braking later in response to a braking vehicle in front of them and eventually brake more forcefully. Distraction also often results in diminished speed and greater distance headways. Thus, road users seem to compensate for the effects of distraction. A recent Dutch driving simulator study of the effect of texting shows that, while texting, drivers do diminish their speed, but simultaneously vary their speed more, zigzag more and check their mirrors less often. Differences between handheld texting (which is prohibited) and texting while using the phone in a holder (which is allowed) were not found [22]. Also see the question *What do regulations about phone use in traffic amount to?*. Distraction proves to result in deteriorated driving behaviour, even after completion of the distracting task. An Australian driving simulator study shows that the detection of peripheral signals, and variation of speed and lateral position are adversely affected during the forty seconds after completion of the distracting task, with the strongest effect in the first ten seconds [23].

6 How dangerous is it when drivers are distracted in traffic?

Some distracting activities seem to increase the risk of being involved in a road crash, especially the risk of rear-end collisions [15]. American Naturalistic Driving (ND) research shows that activities causing visual distraction increase crash risk, entering a telephone number for example, typing or reading text messages (see for example [14] [16] [24]), but also reaching for objects [25], reading or writing [24] [25], and prolonged glances to objects outside the car [14]. Crash risk is higher when drivers are engaged in more than one distracting activity compared to engagement in only one distracting activity [15].

Table 2 presents the risks (the so-called odds ratios) and the percentage of time (prevalence) drivers are engaged in all kinds of distracting activities, as calculated on the basis of the most recent and large-scale American ND study [16]. What is important about this study is that the road crash risk was calculated on the basis of actual road crashes (905 in all) which the participants were involved in, unlike earlier ND studies [24] [25] [26] in which near-crashes were also included. Including near-crashes may, however, bias the results (for more information see [7]). An odds ratio higher than 1 means that an activity involves a higher risk than non-distracted driving does, whereas an odds ratio lower than 1 points to a lower risk. An odds ratio of 2.5 for the activity 'browsing/typing, reading or sending text messages/entering a phone number' in *Table 2* means that the risk of a road crash is 2.5 times higher than when the driver is not distracted. The odds ratio is an estimate. The confidence interval of 95%, presented behind the odds ratio, indicates that it is at least 95% certain that the crash risk of 'browsing/typing, reading or sending text messages/entering a phone number' was larger than 1.7 (the first number) and smaller than 3.9 (the second number). In *Table 2,* the odds ratios that diverge from 1 in a statistically significant way are shown in bold type. Figures that are not in bold type signify that the activity was not shown to increase risk, nor to reduce risk. A prevalence of 12.2% for the activity 'talking to passengers' signifies that drivers talk to passengers for an average of 12.2% of their time behind the wheel. Age also proves to be relevant. When distracted, young drivers have a higher crash risk than middle-aged drivers [27] [28].

Table 2. The odds ratios and prevalence of several activities distracting drivers [16]. The data for these calculations were collected between 2010 and 2013. The odds ratios that diverge from 1 in a statistically significant way are shown in bold type. The figures are higher than 1, which signifies a risk increase compared to undistracted driving. The odds ratios that are not in bold type represent neither a risk increase, nor a risk reduction.

		Odds Ratio (95% confidence interval)	Prevalence
Activity with a mobile phone (not defined whether it was a smartphone)	Browsing on phone (for example finding a contact, searching on the internet) / typing, sending and reading text messages / entering a phone number.	**2.56** (1.68-3.88)	1.8%
	Holding a phone	**2.05** (1.13-3.73)	1.1%
	Talking on a handheld cell phone	1.27 (0.79-2.04)	2.7%
	Talking on a handsfree cell phone	0.40 (0.10-1.63)	0.9%
Activity not phone-related	Talking to passengers	1.3 (0.79-2.04)	12.2%
	Talking/singing along	1.44 (0.99-2.08)	4.25%
	Adjusting the radio	1.57 (0.85-2.91)	1.3%

Table 2 shows that having a phone conversation, both handheld and handsfree, did not significantly increase risk - the 95% confidence intervals do not exceed 1. This finding corresponds to earlier ND studies [24] [25] [26]. It is a remarkable finding, since simulator studies prove, conversely, that having a phone conversation does impair driving behaviour (see the question *How does distraction affect driver behaviour?*). 'Self-regulation' is one of the possible explanations why driving behaviour deterioration, as found in driving simulator studies, does not result in a crash risk increase, as found in ND studies (see for example [29]). In actual traffic, the driving context may determine a driver's decision whether and when they will have a phone conversation. When drivers are observed in actual traffic (as is the case in the ND study), they do indeed prove to be more inclined to use their phones in less demanding traffic situations, such as waiting at traffic lights, than in complex traffic situations [17]. Driving simulator studies usually leave no scope for this kind of self-regulation. In these studies, drivers are usually told to perform a certain mobile phone task at a given moment.

7 Is handsfree phone use less dangerous than handheld?

Drivers

Many (often somewhat older) driving simulator studies conclude that handsfree calls have no significant advantage over handheld calls. The negative effects on the driving task, such as increased reaction time, are similar for handheld and handsfree calls [30]. During a phone conversation, irrespective of it being a handheld or a handsfree call, drivers are preoccupied with the conversation (cognitive distraction), even though their eyes are on the road. A recent American analysis found that having a phone conversation in the car (handsfree or handheld) did not increase crash risk [16], possibly because drivers compensate for the cognitive distraction, for example by choosing to have a phone conversation in less demanding traffic situations. The same American analysis, however, shows that holding a phone, but also operating a screen to enter a phone number for instance, does increase risk (also see the question *How dangerous is it when drivers are distracted in traffic?*). This could imply that handsfree calls are to be preferred above handheld calls.

Apart from making calls, some handsfree systems enable drivers to use other phone functions by means of voice control. Research has shown that the use of voice-controlled infotainment systems (among other things for entering a phone number, searching for a specific song, operating the navigation system, or texting) while driving results in a deterioration of driving behaviour: drivers zigzag more, react more slowly and more often miss visual objects [31]. An increase of the cognitive workload and reaction times has also been found [32] [33] [34]. Although these negative effects appear to be smaller than for operating an infotainment touch system, a voice-controlled system will take more time to complete a task [32]. Similar to the effects of a phone conversation, the observed deterioration in driving behaviour may not necessarily lead to an increased crash risk. Again because, in actual traffic, drivers can choose the appropriate moment to operate the infotainment system or can otherwise compensate for the associated cognitive distraction.

Cyclists

Cyclists riding with one hand on account of handheld calls have a harder time maintaining their balance than when they cycle with both hands, in particular when making an emergency stop [35]. During handheld calls cyclists are slower to react to a stop signal than during handsfree calls. No difference, however, has been found between handsfree and handheld calls by cyclists as far as speed, and visual or auditory perception are concerned [36].

Pedestrians

Pedestrian behaviour is also negatively affected by a handsfree call [37]. A reduction of walking speed, longer reaction times and deteriorated visual perception constitute the main findings.

8 Do navigation systems also distract?

Although a navigation system proves to facilitate the driving task, operating the system while driving diverts attention from other traffic. Navigation systems have clear advantages for users, provided drivers receive high quality data (updated and correct information). Drivers report to have more control over their journey (almost 80%), to be less stressed (almost 70%) and to have less trouble focusing their attention on the road (60%). Drivers using a navigation system also need to make less of a mental effort than drivers doing without such a system, measured both subjectively and objectively [38].

Operating a navigation system, however, results in less attention being paid to the surrounding traffic. American research showed that entering a destination into a navigation system is more mentally demanding and takes more time than other secondary activities, such as operating audio equipment, making phone calls, or texting [39]. From a road safety point of view, a user of a navigation system needs to enter the destination before departure at all times. A large majority of drivers agree that it is dangerous to set the system while driving. In spite of this, 64% of the interviewees reported having sometimes or frequently done this [40]. A recent Dutch Naturalistic Driving study shows that during journeys with an active navigation system, drivers spend 5% of their time operating the system. In about 65% of this operating time, drivers drove at a speed of 10 kms/hour or higher [41].

9 How distracting is roadside advertising?

Advertising billboards may result in changes in driver behaviour and visual attention. Research shows that drivers are slower to react, need longer braking distances and zigzag more in the presence of advertising billboards (see for example [42] [43] [44]). A majority of studies into the effects of advertising billboards on visual attention find that drivers more often take their eyes off the road in the presence of advertising billboards. This is particularly true for billboards with moving images, emotional advertisements or billboards in one's central field of view (for an overview see [20]). The number of studies that examine the effects on crashes and crash risk is limited and the conclusions are not clear-cut. According to Vlakveld & Helman [45] only two out of five identified studies showed sufficient scientific quality; one found a crash risk increase near digital advertising billboards [46], while the other found no effect at all [47].

In addition to commercial ads, road safety is also 'advertised', and information about traffic flow and congestion is given. Although these information signs are meant to improve road safety, they could also distract drivers in the same way as billboards do, with a contrary and unintentional adverse effect on road safety. Research into these unintentional adverse effects has, as far as we know, never been carried out.

Most countries have guidelines for (digital) advertising billboards along the road. In the Netherlands, a CROW guideline 'Advertisements along the roads' recommends diminishing distraction by advertising billboards by placing them at a safe distance from the road, not to let

them resemble traffic-relevant information and to avoid undesirable content (which may for example evoke strong negative emotions) [48].

10 How often are cyclists and pedestrians distracted in traffic?

Cyclists

Recent Dutch surveys and observational studies show that many cyclists are engaged in potentially distracting activities. In a survey, well over half the cyclists (56%) between the ages of 12 and 80 reported sometimes using their phones while cycling [4] (also see *Table 3*). In this study, for all mobile phone activities, young people (aged 12-17) were shown to use their phones while cycling more often than adults. Both adult and young cyclists reported most often using their phones to read messages (38% and 55.5% respectively) or send messages (33% and 54% respectively), to set navigation (33% and 36% respectively), or to take pictures or record videos (33% and 43% respectively). Listening to music also proves to be very popular among cyclists, in particular among young people. Over 70% of 16- to 18-year-old cyclists reported sometimes listening to music while cycling [49]. Recent observational studies found that 17-28% of cyclists used devices while cycling: most (15-22%) listened to music, 2-4% operated a screen, and 0-3% made a call [50] [51] [52] [53]. Telephone use among cyclists seems to increase, in particular the percentage of cyclists listening to music. In 2015, 19% of the cyclists observed were occupied with their phones, and in April 2019 the number grew to 28% [53] [54].

Pedestrians

Pedestrians prove to use their phones more often than cyclists or drivers (see also *Table 3* below): 84% of 12- to 80-year-old pedestrians reported sometimes using their phones while walking. Similar to cyclists, young pedestrians use their phones more often than adult pedestrians. Both adult and young (aged 12 to 17) pedestrians use their phones mainly to read messages (69% and 75% respectively) and send messages (64% and 75% respectively), to take pictures or record videos (64% and 75% respectively), and to make handheld calls (66% and 70% respectively) [4]. An observational study in six European cities, including Amsterdam, showed that 8% of pedestrians were texting while walking, almost 3% were phoning, and 5% were using ear phones [55]. In all, 16% of pedestrians were occupied with their smartphones. Notably, in Amsterdam the smallest share of pedestrians used a smartphone, viz 8.2%, in contrast to the highest share in Stockholm (23,5%).

Table 3. Percentage of cyclists and pedestrians reporting having been occupied with different distracting activities while cyling and walking respectively [4].

Distraction source	Distracting activity	% of cyclists engaged in an activity adults/young people	% pedestrians engaged in an activity adults/young people
Talking on the phone	Handsfree	21/41	41/58
	Handheld	28/37.5	66/70
Operating a screen	Reading messages	38/55.5	69/75
	Sending messages	33/54	64/75
	Searching for sth./checking one's phone	21/43	53.5/66
	Taking pictures/recording videos	30/43	64/75
	Setting navigation on phone	33/36	55/60
	Operating phone to play music	25/53	38/71
	Playing games	7/18	21/33

11 Hoe does distraction affect cyclist and pedestrian behaviour?

Cyclists

Research shows that cyclists who text or converse on the phone, cycle at a lower average speed, more often miss relevant matters and more often exhibit dangerous behaviour (such as wrong-way cycling, crossing an intersection with poor visibility of approaching traffic without braking or looking around first). Texting appears to affect cycling behaviour most. Cyclists who are texting cycle more towards the middle of the bicycle track/lane and swerve more than when they are not texting. When texting, cyclists less often look around, and also look at the bicycle track/lane less often and for a shorter period of time [56]. Furthermore cyclists themselves experience texting as the most dangerous activity [10].

Cyclists listening to music often miss important auditory information from traffic around them (a bicycle bell, horn), particularly those cyclists who are using in-ear headphones[3] or listening to loud or up-tempo music [36]. It has been observed that cyclists listening to music more often display behaviour that violates traffic rules or display other unsafe behaviour, e.g. jumping traffic lights, wrong-way cycling, or using the pedestrian crossing [57]. Listening to music does not appear to affect cycling speed, lateral position or glance behaviour.

3. In-ear phones are earphones placed in the auditory duct.

Pedestrians

Pedestrians using a phone while walking display less safe (crossing) behaviour: they are more careless, take longer to cross the road, or cross when a car is approaching [58]. Particularly phoning and texting lead to less safe behaviour, whereas listening to music affects behaviour to a lesser extent [13] [59]. Texting pedestrians walk more slowly, less often maintain a straight course and are more unsteady [60]; they also bump into something or someone more often, while someone else also bumps into them more often [13].

12 How dangerous is it when cyclists and pedestrians are distracted in traffic?

Cyclists

On the crash risk of distracted cyclists hardly any data are available. The results of a survey by VeiligheidNL (SafetyNL) indicate that, contrary to expectations, cyclists using their phones are *less often* involved in bicycle crashes than cyclists who never use their phones [11]. These outcomes might point to a - very opportune - adaptation of behaviour compensating for the effects of distraction. There are, indeed, indications of such a behavioural adaptation: a majority of cyclists indicate that, when phoning or listening to music, they adjust their behaviour by cycling more slowly and looking around more [49]. Nor can it be ruled out that other road users compensate for the behaviour of distracted cyclists. Another consideration to be taken into account is that the study by SafetyNL concerns self-reported behaviour, which depends on a respondent's recollection as well as his willingness to admit phone use while cycling. In view of the limitations of self-reported behaviour and the unexpected findings, more evidence is needed to draw conclusions about the crash risk of phone use among cyclists.

Pedestrians

For the Netherlands, no data are available about the crash risk of distracted pedestrians. In the United States, the percentage of pedestrians who die in a road crash while using a phone increased from less than 1% in 2004 to 3.6% in 2010 [13]. Although distracted pedestrians display unsafe behaviour, a study with crossing passengers in virtual surroundings did not find any direct evidence that phone use while walking results in a higher crash risk [37]. Since studies among these road users are scarce, it is difficult to draw solid conclusions.

13 What do regulations about phone use in traffic amount to?

In the Netherlands, handheld phone use (or use of other electronic devices that can be used for communication and information processing) while driving is prohibited [61]. Nor may telephones be clasped between ear and shoulder. However, operating a phone in a holder is allowed. All EU countries have banned handheld phone use. In most countries, handsfree mobile phone use is allowed. In many American states, however, a prohibition of handsfree mobile phone use by young drivers and school bus drivers applies. For information about the effectiveness of the phone use ban for drivers see the question *Which countermeasures targeting driver distraction are implemented, and how effective are they?*

Since July 2019, use of a mobile phone or other electronic communication and information processing devices while cycling has been forbidden in the Netherlands [61]. In Europe, legislation on this subject varies. In Sweden, Finland, Norway, Great Britain, and Ireland for example, handheld calling while cycling is not forbidden, whereas it is banned in Denmark, Germany and Austria. A prohibition of phone use while walking, on the other hand, is extremely rare, although in Lithuania mobile phone use while crossing is prohibited.

14 Which countermeasures targeting driver distraction are implemented, and how effective are they?

There are three kinds of countermeasures targeting driver distraction: people-focused, technical and infrastructural countermeasures (also see [62]).

People-focused countermeasures

People-focused countermeasures, such as education, and enforcement of the legal ban, may motivate drivers to abstain from distracting activities while participating in traffic. In the Netherlands, there have been a lot of public information campaigns to alert people to the dangers of distraction by devices (‘Don’t get distracted’, ‘OFFline ON the road’ and more recently the MONO campaign). The campaigns proved to be successful in that a large majority (97%) of Dutch drivers deem phone use while driving to be dangerous [4]. Nevertheless, 65.6% of drivers admitted having sometimes used a mobile phone while driving.

Handheld use of mobile electronic devices (among which phones, navigation systems, tablets and music players) intended for communication and information processing while driving is illegal (see the question *What do regulations about phone use in traffic amount to?*). It is hard to determine the effectiveness of a ban on mobile phone use. The available, mostly American,

studies of the effectiveness of this ban to decrease the number of road deaths do not present a clear picture, as shown by a recent review article by [63]. Some studies find that the number of road deaths decreased after the introduction of a ban specifically targeting handheld phoning or texting. Other studies, however, find no such correlation. After only a short period, a combined ban (both on handheld phoning and texting) appeared to be effective in decreasing the number of road deaths. Proof for the effectiveness of the ban was weak however, since the impact of other factors (for instance road safety measures whose introduction was concurrent to the ban) was not taken into account.

When introducing a legal ban, it is important to increase the (subjective) probability of detection and to impose substantial fines for engaging in distracting activities. In the Netherlands, in 2020, the fine for holding a mobile phone while driving was 240 euros. The probability of detection is low however. The ban is mostly enforced by means of police stops – but only after police have noticed someone holding a phone while driving. Technologies to increase the probability of detection are being developed. Since October 2019, Dutch police have used smart cameras that look through the windscreens of passing cars [64]. The camera recognises whether a driver is holding a phone and what the car's registration number is. Afterwards a police officer checks whether the camera observed the offence correctly. If so, the holder of the registration certificate will be sent a fine, which is similar to procedures for speeding fines.

Technical countermeasures

Technical countermeasures make use of technology to prevent distraction in traffic. On smartphones, apps may be installed (e.g. the 'Auto Reply App', 'Drive Safely Keep Focused', and 'Automodus') which discourage or disenable the use of some telephone functions while driving. Research shows that these apps diminish phone use by novice drivers [65] [66] [67] and by adults [68] while driving. Such apps are, however, not highly appreciated by drivers and may easily be circumvented.

Smartphones can also be made less (visually) distracting by replacing manual operation with voice-controlled operation. This is, however, no solution to prevent cognitive distraction (being preoccupied with something else than traffic). Moreover, distracting tasks take longer to complete by voice control (see the question *Is handsfree phone use less dangerous than handheld?*).

There are also new technical in-car systems to prevent (the consequences of) distraction. Special sensors may, for example, warn distracted drivers in case of danger. The downside is that this may unintentionally encourage drivers to engage in distracting activities.

Infrastructural countermeasures

Infrastructural countermeasures may ensure that the road environment is designed so that objects leading to driver distraction, for example advertisements, are absent (see the question *How distracting is roadside advertising?*). Certain infrastructural countermeasures, such as profiled road marking and obstacle-free road shoulders may mitigate the consequences of distraction.

15 Which countermeasures targeting distraction among cyclists and pedestrians are implemented and how effective are they?

Education and public information campaigns may contribute to cyclists' and pedestrians' awareness that phone use increases their risk in traffic. In the Dutch public information campaign 'ON the road I am OFFline', and 'MONO', both drivers and cyclists are incited to focus their attention on traffic and not to use a smartphone on the road. Cyclists may also download a special app (the Interpolis PhoNo app for instance) which awards points for cycling without handheld smartphone use, which will be converted into financial support of a charity.

Since July 2019, the Netherlands have banned handheld usage of phones or other devices while cycling. Cyclists ignoring the ban, risk a € 95 fine. As yet, little is known about the effectiveness of this countermeasure. Comparing self-reported phone use by cyclists before the ban was introduced [69] to phone use after the introduction [4] shows that adult cyclists made fewer handheld calls in 2019 than they did in 2017. The other phone activities (such as handsfree calls, texting, taking pictures or recording videos) did, however, not decrease. For young cyclists (aged 12-17), no difference was found for any distracting activity when comparing 2017 to 2019.

Publications and sources

Below you will find the list of references that are used in this fact sheet; all sources can be consulted or retrieved. Via Publications you can find more literature on the subject of road safety.

[1]. Ranney, T.A., Mazzae, E., Garrott, R. & Goodman, M.J. (2000). *NHTSA driver distraction research: past, present, and future*. National Highway Traffic Safety Administration NHTSA, Washington D.C.

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