Phoning while cycling: safety aspects

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Abstract
The risks of using a phone while cycling were studied from literature and using theory. The relative risk of being in a road crash while using a hands-free or handheld mobile phone is around 4 for car drivers. We expect the relative risk of the use of a hands-free mobile phone while cycling to be less profound. Cyclists have more time to process information and more opportunities to pace the cycling task. Most victims of bicycle accidents are people above 55 years of age who use their phone seldom while cycling. The risks of using a handheld mobile phone while cycling and while driving are assumed to be at the same level. Cycling with one hand may give rise to stability problems and accidents. The hypothesized effects of using hands-free and handheld cell phones need to be tested in future research.

Keywords: Bicycle, Mobile phone, Attention

Introduction
In March 2002 the use of handheld phones while driving a motor vehicle was banned in The Netherlands. In the beginning of 2006 a member of the Dutch House of Representatives asked about the risks of using a mobile phone while cycling. If using a cell phone while cycling and while driving are equally risky regulations may be justified. To support policy makers the Transport Research Centre conducted a study focussed on the following research question: ‘What are the risks of using a mobile phone while cycling?’ It can be divided in the following sub questions:

- What is known about the risks of using a mobile phone while driving a motor vehicle?
- How will the use of a mobile phone interfere with cycling performance?
- How will the use of a mobile phone influence cycling accidents?

Empirical studies and data about cycling accidents in relation to the use of mobile phones are lacking. Therefore the risk of using a mobile phone while cycling is studied from literature and using theory. The potential effects of regulations on cell phone use while cycling were studied as well in order to provide policy advice. Recommendations for further research are included in the discussion.

Knowledge about the risks of using a mobile phone while driving

The results of epidemiological studies strongly suggest that using a mobile phone while driving can increase the risk of being involved in a road crash up to four times (Redelmeier, Tibshirani, 1997; McEvoy, Stevenson, McCartt, Woodward, Haworth, Palamara, Cercarelli, 2005). In simulator studies and field experiments the following effects have been demonstrated:

- Missed information and slower reactions in case stimuli are noticed (Strayer, Johnson, 2001)
- Slower braking reactions (Lamble, Kauranen, Laakso, Summala, 1999; Alm, Nilsson, 1995; Strayer, Drews, Crouch, 2004; Green, 2000) with more intensive braking and shorter stopping distances (Strayer, Drews, Johnston, 2003).
- An increase of the standard deviation of steering wheel movements in busy urban traffic (Brookhuis, De Vries, De Waard, 1991).

The collection of information about mobile phone involvement in road crashes is neither widespread nor very systematic (Dragutinovic, Twisk, 2005). The effect of slower and more intensive braking is in accordance with Wilson, Fang, Wiggins and Coopers' (2003) finding that cell phone users had a higher proportion of rear-end collisions. The Japanese National Police Agency conducted a study in order to assess the frequency of mobile telephone use as an antecedent to a motor vehicle crash. Of 129 crashes, 76% involved rear-end collisions (Dragutinovic, Twisk, 2005). There is little other knowledge about how mobile phone use is related to accidents.

Interference of mobile telephone conversations with cycling performance

The use of a cell phone can interfere with both driving and cycling. Theory on multiple-task performance can be used to predict dual-task decrements. According to Wickens' (1984) Multiple Resource Theory the effects on performance when multiple tasks are concurrently executed depend on three dichotomies: stages (cognitive vs. response), sensory modalities (auditory vs. visual) and codes (verbal vs. spatial). Since driving is primarily visual-spatial and mobile phone use mostly aural-verbal, little interference should be expected. Studies of dual-task interference suggest that Wickens's elaborated resource model is over simplified (Haigney and Westerman, 2001). For instance, people process auditory information more efficiently when relevant auditory and visual stimuli are presented from the same, rather than different, spatial locations. This is related to recent findings showing that there are extensive cross-modal links in spatial attention (Spence, Read 2003). According to Crundall, Bains, Chapman and Underwood (2005) multiple resource theory can accommodate the notion that a conversation could draw upon the same attentional resources that are used for critical sub-tasks in driving. If the conversation requires cognition, this may interfere with any aspect of driving that employs those respective processing stages. Cognitive distraction by engaging in a phone conversation is the main cause of a deterioration of the driving behaviour according to Dragutinovic and Twisk (2005). The level of complexity of a phone conversation (its cognitive demands) also determines the extent of the effect on driving performance (Patten, Kircher, Östlund, Nilsson, 2004; Briem, Hedman, 1995). This finding may explain why hands-free cell phones can be as distracting as handheld cell phones (Strayer, et al., 2001; Relmeier, et al., 1997; McEvoy, et al., 2005).

There is little reason to assume that mobile telephoning will interfere far more or far less with cycling than with driving, although both are quite different tasks. Bailey's (1994) model can be used to compare cycling with driving (see picture 1). Cyclists and drivers both use visual information, but we expect auditory cues to be more important to cyclists than to car drivers. When a bike rider is on a winding road, he can hear a car approaching at too high speed long before he see him. Using stereophonic hearing, he can tell if the car behind is passing correctly without moving his head. During a conversation through a mobile telephone cyclists have to filter out the noise in their surroundings. Aural processing may be distorted. Especially when using handheld devises we expect interference with kinaesthetic processing while cycling. Cyclists have to steer with one hand and have to be careful not to lose balance. The use of a mobile telephone will affect both driving and cycling especially by interference with cognitive processing. We can expect cyclist to miss more information, to react and brake slower, and to have a tendency to wander. The standard deviation of steering wheel movements will be highest in case handheld devices are used. Also it may be more difficult for cyclists to keep their lane and to remain balance with only one hand. This is specific to the use of a handheld device while cycling. The next question is how the use of a mobile telephone will affect cycling accidents?

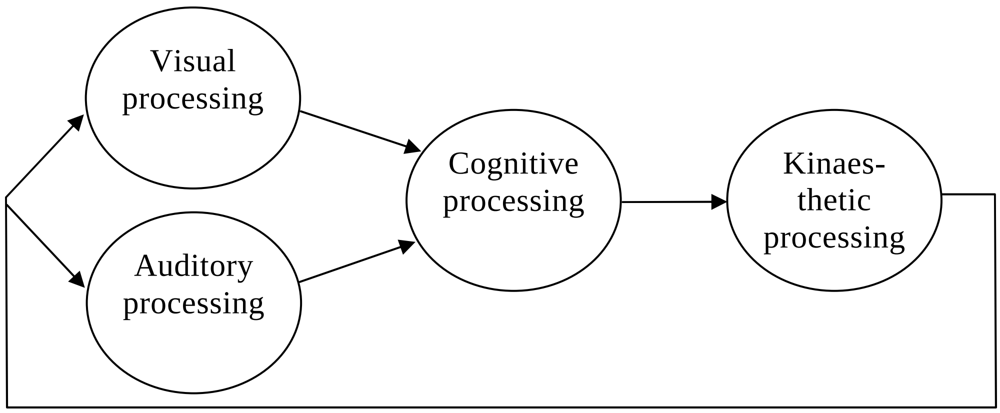

Figure 1 Different kinds of processing that may interfere between mobile telephoning and cycling

Cycling Accidents in the Netherlands
The national accident database BRON (‘Bestand geRegistreerde Ongevallen Nederland’) does not provide a good picture of cycling accidents because of the large scale of under-reporting. Especially bicycle-only accidents and accidents with less severe trauma and without severe material damage to cars are under-reported by the police. A comparison between car and bicycle accidents is hampered. Information about less severe cycling accidents was derived from the Injury Surveillance System (LIS, ‘Letsel Informatie Systeem’) from the Consumer Safety Institute (Ormel, Idenziel, 2006). LIS registers information about trauma-patients who are treated at a selection of hospitals in The Netherlands. These hospitals form a representative sample of Dutch hospitals, which have Emergency Departments. National estimates can be calculated. An estimated 67,000 cyclists are treated at hospital Emergency departments every year. A rough overview of the characteristics of these accidents is presented in table 1. Most (70%) are bicycle-only accidents: accidents only involving cyclists. In almost 9 in every 10 bicycle-only accidents cyclists fell of their bike. Over half of the collisions with moving cars or persons concern cyclist-car accidents.

Table 1 Bicycle accidents in the Netherlands (LIS)

Type of accidents	Number	Percentage
Bicycle-only accidents	47,000	70
Collisions with moving cars or persons	14,000	21
Collisions with objects, parked cars, and animals	4,500	7
Other	1,500	2
Total	67,000	100

The number of deaths among bicyclists in the Netherlands was determined by combining data from the national accident database BRON and the Statistics Netherlands (CBS) statistic on causes of death. Each year almost 200 cyclist die by road accidents (over 20% of all fatalities). More than half of the victims are older than 55 years (Consumer Safety Institute, 2006). According the Dutch National Travel Survey (AVV, 2005) people above 55 years of age are responsible for only 21% of the mobility with bicycles (AVV, 2006). Almost 70% of these accidents involve collisions with moving vehicles, for instance cars and trucks. Manoeuvres of severe bicycle-car accidents on 50- and 80-kilometer roads are presented in table 2. Most of these accidents happened on intersections (Kampen, Schoon, 2002).

Table 2 Severe accidents with deaths and hospitalized victims concerning collisions between cars and bicyclists on 50- and 80-kilometer roads (BRON)

	Maximumspeed	
Type of manoeuvre	50 km/h	80 km/h
Same road without turning:		
• Same direction	7 %	12 %
• Opposite direction	4 %	6 %
Same road while turning:		
• Same direction	14 %	15 %
• Opposite direction	20 %	18 %
Crossing road:		
• Without turning	32 %	38 %
• While turning	19 %	11 %
Other	4 %	1 %
Total (percentage)	100%	100%
Total number of victims (absolute[1])	5066	1251

[1] Cumulative 1995-1999

Relative risk of mobile phone use while cycling

The average speed of cyclists is lower than the average speed of car drivers. Both will have to deal with an increased reaction time while using a mobile phone but the effect will be more profound among car drivers. Redelmeier & Tibshirani (2001) found greater relative risks for calls in high-speed than in low-speed locations among car drivers (5.4 versus 1.6, $p = 0.014$). Both drivers and cyclist have the deal with interference with visual and auditory processing but cyclists have more time to detect and process this information. The extent of negative effects like missed information and slow reactions will be less profound among cyclists. Some studies found that car drivers engage in risk-compensatory behaviour during mobile phone use, for instance by reducing their average speed. An explanation for this strategy could be the drivers' attempt to reduce performance goals, thus reducing driving task demands and the workload (Törnros, Bolling, 2005; Haigney, Taylor, Westerman, 2000). The possibilities to compensate are limited for car drivers. Their room is limited by vehicles in front and behind and oncoming traffic. The finding of the Japanese National Police Agency that 76% of the mobile phone accidents that they reported involved rear-end collisions clearly shows the difficulty to compensate for distraction. Both driving and mobile phone use are externally paced tasks. Cyclists have more opportunities to compensate for their distraction. An adequate speed can be chosen without obstructing other traffic. Bike riders can stop to answer their phone, slow down before crossing a busy junction or finish their conversation on a footpath, etcetera. The number of unexpected evens like a vehicle in front that suddenly brakes is limited for cyclists compared to car drivers. The cycling task is less externally paced. Unlike among drivers, the use of a cell phone will seldom cause rear-end collisions among cyclists. Extra processing time and opportunities to pace the cycling task can help to avoid accidents in which a bicyclist is crossing other vehicles. About 70% of all severe car-bicycle accidents involve these types of manoeuvres (see table 2). Studies have shown that young drivers use their cell phones most frequently while driving (Pöysti, Rajalin, Summala, 2005; Lamble, Rajalin, Summala, 2002). Use among drivers aged 60 and older was negligible according to McCartt & Geary (2004). More than 50% of the cyclists who die in traffic in the Netherlands are older than 55 years of age (Consumer Safety Institute, 2006). This is less than 25% among car drivers (BRON). We can assume that the group that is most at risk seldom uses a cell phone while cycling. The relative risk of being in a road crash while using a mobile phone is 4 for drivers (Redelmeier, et al., 1997; McEvoy, et al., 2005). We expect the relative risk of being involved in a cycling accident while using a hands-free mobile phone to be less significant. Cyclists have more time to process information, more opportunities to pace the cycling task and most victims of bicycle accidents are above 55 years of age.

The effects of using a cell phone are the same for handheld and hands-free devices among car drivers. Among cyclists we expect the use of handheld phones to be more risky. Cyclists may slow down to compensate for the distraction of a phone conversation, especially if they have to steer with one hand. This is advantageous for perception and processing of information but disadvantageous for kinaesthetic processing. A cyclist needs speed and two hands on the handlebar to keep balance. Handheld phones may pose a serious problem for the stability of cycling behaviour. Around 60% of the accident-patients who were treated at Emergency Departments in the Netherlands were involved in bicycle-only accidents and fell of their bike (Ormel, Idenziel, 2006). Around 30% of deaths among bicyclists concerned bicycle-only accidents. Not much is known about other characteristics of these accidents. Stability problems may give rise to severe overtaking accidents as well. The cyclist may swerve into the path of a passing car. Normally bicyclists will use their stereophonic hearing. While talking through the phone the cyclist has to focus on the conversation. This is risky in combination with a loss of stability. Around 10% of severe car-bicycle accidents involved manoeuvres in which both travelled in the same direction without turning (see table 2). Driving with one hand may affect manoeuvrability in critical situations as well. It can be difficult to move out of the way fast enough while using a handheld device. The risks of using a handheld mobile phone while cycling and while driving may be equally large.

Conclusion
Compared to phone use while driving we expect the risk of using a phone while cycling to be less profound if a hands-free device is used and to be at roughly the same level if a handheld device is used. These hypothesized effects need to be tested in future research.

Practical recommendations
AVV (Transport Research Centre) advised not to introduce a new regulation that prohibits the use of a handheld phone or similar device while cycling. The size of the risk would justify a ban on using handheld mobile phones while cycling, but we expect the effectiveness of a new rule to be small. A lot of countries banned the use of a mobile phone while driving. Studies on the effectiveness of this legislation indicate that it is difficult to reach lasting results (McCartt & Geary, 2004; TRL, 2006). When considering the number of issued fines, it seems that the effectiveness of Dutch legislation follows the common trend. Since the introduction of the ban on the use of handheld phones, the number of fines for using a handheld mobile phone while driving has risen significantly each year (Dragutinovic & Twisk, 2005). Instead of new regulations the Transport Research Centre advised to pay attention to the risks of mobile phone use while cycling in traffic education at secondary schools. The age group of 12 up to 17 years is responsible for almost one fifth of the total number of bicycle kilometres (AVV, 2005) and probably a much larger part of mobile phone use while cycling. Traffic education at secondary schools is aimed at an age group that cycles and phones a lot, is affordable and prepares future car drivers.

Research recommendations
It is difficult to predict how the risk of phone use while cycling will develop in the next decades. People may get more accustomed to the use of communication technologies. They may learn how to deal with double task in a safe way. On the other hand older age groups will probably increase their use of mobile telephones and the Dutch population is aging. This may result in additional injuries from falls among frail older people. The share of bicycle-only accidents that were reported by the police rose from 3% of all fatal bicycle accidents over 1988 till 1990 (7 deaths per year) to 9% over 2003 till 2005 (9 deaths per year). Around 70% of these victims between 2003 and 2005 were over 55 years of age (BRON). The real numbers will be worse. Bicycle-only accidents are under-reported by the police. Better knowledge is needed in order to prepare for these developments.

The hypothesized risks of cell phone use while cycling need to be tested in future research. Like Redelmeier & Tibshirani (1997) and McEvoy et al. (2005) did, the case-crossover design can be used in order to quantify the impact of mobile phone use while cycling on accident risk. It is a case control method in which the controls are the same people as the cases. The proportion of cyclist's who used their phones in a ten-minute period before their accidents have to be compared with the proportion of those who used their phone during the same time period the day before the accident. McEvoy et al. (2005) used participants who were involved in a crash and treated in hospital emergency departments, and reported owning or using a mobile phone. They interviewed drivers after medical or nursing staff permitted access and collected data on demographics, usual patterns of driving and mobile phone use, description of crash and preceding events (including phone use), and type of phone. The same research method can be considered in the Netherlands in cooperation with Emergency Departments at hospitals.

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